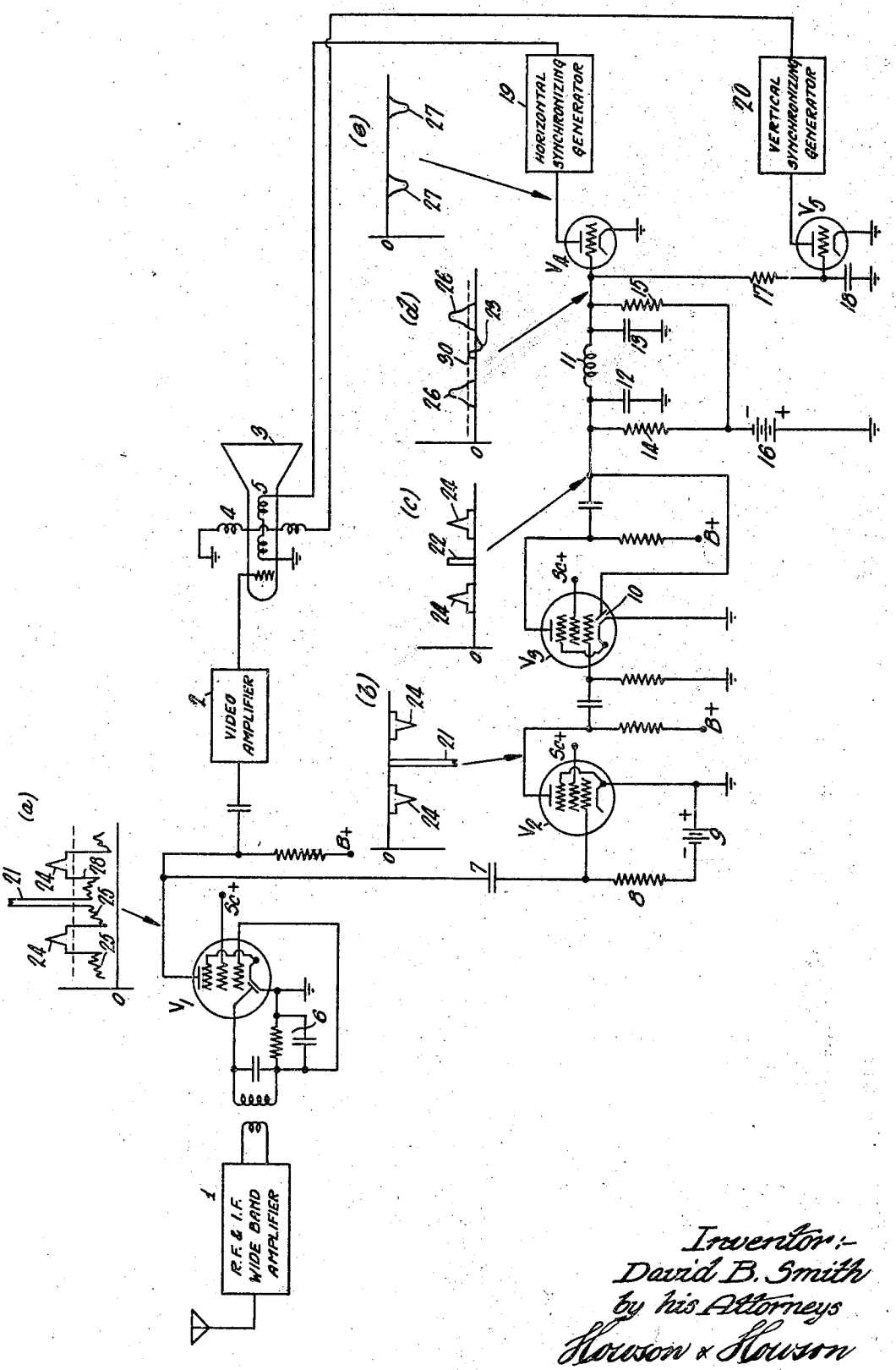
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NOISE REDUCTION IN ELECTRIC TRANSMISSION SYSTEM

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NOISE REDUCTION IN ELECTRIC TRANSMISSION SYSTEMS

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This invention relates to noise reduction in electric transmission systems and has for its general object to provide improved means for limiting the amplitude, steepness of wave front, and energy content of interfering noise signals and/or pulses in communication or control systems and the like.

The invention is particularly adapted for use in the synchronizing signal circuits of television and facsimile receivers. The noise limiting means disclosed herein are of particular importance when the desired synchronizing signals are relatively weak and where they are accompanied by erratically spaced short, sharp, noise pulses of an amplitude comparable to or greater than the amplitude of the synchronizing signals.

As is well known, in modern electronic television systems, means are normally provided at the receiver for generating the required horizontal and vertical scanning waves. These waves are generally of a sawtooth shape. Synchronism between the scanning operation at the transmitter and at the receiver is usually maintained by means of suitably timed and spaced synchronizing signals which are transmitted with the video signal, as is well known in the art. It has been found, however, that operation of the scanning wave generators may be initiated upon the arrival of ordinary noise or static pulses, thereby destroying the desired synchronism between the scanning operations at the receiver and transmitter. Under these conditions it has been necessary, in the past, to employ relatively insensitive circuits and to operate the receiver within a restricted radius from the transmitter where the desired signals are capable of overriding the undesired noise signals. By means of the present invention, however, it is possible to secure satisfactory television reception even in areas where the noise signal amplitude is considerably greater than the amplitude of the desired signals.

It has been found that a majority of the noise signals commonly encountered in the reception of carrier wave signals are of short duration as compared to the shorter periods of the modulation envelope, but they are of considerable amplitude as compared to the maximum amplitude of that envelope. Thus noise pulses produced by atmospherics, motor car ignition systems, the interruption of electrical circuits generally, and the like, may often have an effective duration of considerably less than a microsecond; yet because of their high amplitude such short pulses still possess a high energy content and when impressed on signalling circuits may give rise to transients of considerable magnitude.

According to the present invention there is provided in a television receiver or the like, a source of signals, wide-band signal transfer means, signal detector means, amplitude responsive means for deriving a synchronizing signal from the detected signal, a video signal channel, a synchronizing signal channel, amplitude limiting means disposed in said last-named channel for rendering said channel unresponsive to voltages exceeding a predetermined level, narrow-band signal transfer means, and a synchronizing signal utilization means.

Accordingly it is an important object of this invention to provide means for preventing the appearance of undesired noise or static pulses in the various synchronizing circuits and deflecting wave generators employed in television receiving systems and the like.

Another object of this invention is to provide an amplitude limiting means preceded by a wide-band signal transfer means and followed by a narrow-band signal transfer means for limiting the amplitude of undesired noise pulses to a value substantially less than that of the desired signals, and to provide thereafter an amplitude responsive device for completely removing said undesired pulses from said desired signals.

The invention may best be understood by reference to the accompanying drawing, the single figure of which is representative of the invention as employed in a conventional superheterodyne type television receiver.

In the drawing, the rectangle 1 represents the carrier frequency portion of a superheterodyne television receiver. In accordance with the invention, the radio frequency and intermediate frequency amplifier circuits contained therein should be capable of passing a wide-band of frequencies, not less than two and preferably three or more megacycles in width. The provision of such a wide-band system permits the passage of short, sharp, high amplitude noise pulses, with little distortion or widening-out of the pulses. The output of the amplifier 1 may be coupled to a conventional detector circuit which may comprise the diode-pentode V_1 and diode load 6, the demodulated signal from the load 6 being applied to the control grid of the pentode section of V_1, the latter functioning as the first video frequency amplifier. The signal appearing at the output of V_1 may be generally similar to that shown at *a* wherein there is represented a de-

tected composite signal comprising a video portion 25, a blanking pulse 26, and a synchronizing signal 24. At 21 there is represented a short, high amplitude noise pulse. This composite output signal may be applied to a further video amplifier 2 whose output may, in turn, be coupled to the control grid of a suitable picture reconstituting device 3.

The signal shown at *a* may also be impressed on the input circuit of a synchronizing signal pick-off tube V_2, which is preferably biased, by means of the battery 9, to a point below plate current cut-off, whereby only those parts of the signal *a* which exceed the amplitude level 28 are transferred by the tube V_2. The provision of such an amplitude responsive means results in the appearance, across the plate load of V_2, of a signal *b* from which the video signal 25 and part of the blanking pulses 26 have been removed. The signal *b* will, of course, be reversed in phase with respect to the signal *a*. The original phase relation may be obtained again however in the output of the pentode section of the amplifier V_3.

In shunt with the output of V_3 there may be connected a suitable amplitude limiting means, comprising, for example, the diode section 10 of the tube V_3. The anode of this diode may be given an initial negative bias, with respect to its cathode, derived from the voltage source 16, by way of the resistor 14. Preferably this bias is so adjusted that the maximum output signal amplitude at *c* (the junction of the diode anode and the resistor 14) cannot exceed the amplitude of the desired synchronizing signal 24. Accordingly the high amplitude noise pulse 21, as shown at *a* and *b*, is reduced in amplitude to that of the synchronizing pulses as illustrated by the noise pulse 22 at *c*.

Following the amplitude limiting means there may be provided a low-pass or narrow-band filter, comprising, for example, the series inductor 11 and shunt capacitors 12 and 13. This filter is preferably terminated at both ends in its characteristic impedance. These terminations may comprise the resistors 14 and 15 in combination respectively with the output impedance of V_3 and the input impedance of the tubes V_4 and V_5 as will be clear to one skilled in the art.

In passing through the low-pass filter 11—12—13, the signal *c* suffers a considerable attenuation of its higher harmonic components, appearing at the grid of the tube V_4 somewhat as represented at *d*. Thus the corners and peaks of the synchronizing pulses 24 shown at *c* are smoothed or rounded off, while the amplitude of these pulses may be reduced by perhaps 10 or 15%. However because of the very short duration of the noise pulse 22 accompanying the signal *c*, and because a large part of the energy of the noise pulse resides in very high frequency components, the noise pulse emerges from the low pass filter in a highly attenuated condition, as shown at 23 in the drawing *d*. It has been found that the pulse 23 will be generally of the form of a rapidly damped, low amplitude wave having possibly only one or two alternations, and whose maximum amplitude is possibly less than 15% of that of the synchronizing pulses 26.

By employing still another amplitude responsive device, as contemplated by this invention, the highly attenuated noise pulses 23 may be virtually completely removed from the desired pulse signals. Accordingly there may be provided a vacuum tube V_4 biased so far below plate current cut-off that only signals having an amplitude exceeding that indicated by the dotted line 30 are amplified by the tube. In some cases the bias voltage source 16 may be employed for this purpose in addition to its function as a bias source for the diode 10 as hereinbefore set forth. Alternatively a separate source may be employed when desirable. The signal appearing at the anode of the tube V_4 is represented at *e*, where it will be noted that the synchronizing pulses 27 are completely free of the undesired noise signal.

In the drawing the tube V_4 is employed to supply synchronizing pulses to a horizontal synchronizing generator 19. A second tube V_5 may be coupled to the output of the low-pass filter by means of a resistance-capacity low-pass filter 17—18, whereby the tube V_5 may be made responsive only to the vertical synchronizing pulses which occur at a lower rate than do the horizontal pulses. The tube V_5 may be made responsive only to the amplitudes in excess of the level 30 by connecting its grid to the grid of V_4 or to a separate biasing source. The tube V_5 may be employed to supply synchronizing pulses to the vertical synchronizing generator 20. The deflecting voltage waves generated in the generators 19 and 20 may be supplied to the horizontal and vertical deflecting coils 5 and 4 respectively, as is well understood in the art.

The system hereinbefore described was investigated with respect to a modern 441-line television system. In a 441-line, 30-frame per second, interlaced television system the horizontal synchronizing pulses occur at the rate of 13,230 per second. According to one system these pulses are of a generally triangular shape, and it was determined by means of an analysis of the pulse that about 97% of the energy content of the synchronizing pulse resides in frequency components below the 40th harmonic. Thus the synchronizing pulses may be passed, with no important loss or distortion, through a low-pass filter having a pass-band up to about one-half megacycle. But when the previously limited or truncated noise pulses are passed through such a relatively narrow-band filter they suffer a further considerable loss in their energy content and a further important improvement in the signal-noise ratio obtains. At the same time, the noise pulses also suffer a very material loss in amplitude. This obtains because of the entirely inadequate band width of the filter 4 insofar as the noise pulses are concerned. Consequently these short noise pulses may give rise only to low amplitude transients which frequently do not exceed 25% of the amplitude of the desired synchronizing pulses.

In an alternative arrangement, the circuit elements following the pick-off tube V_2 might be provided in duplicate, one channel being allotted to the horizontal, and the other to the vertical synchronizing pulses. Means for separating vertical and horizontal synchronizing pulses are too well known in the art to require illustration thereof. An advantage of such a system would reside in the provision of separate narrow-band filters in each channel, comparable to the filter 11—12—13 shown, but each especially designed in accordance with the frequency and wave shape of the synchronizing signals to be passed by it.

Although the invention has been described with particular reference to the embodiment illustrated in the drawings, it will be understood that the invention is capable of various forms of phys-

ical expression. Accordingly the invention is not to be limited to the specific disclosure, but only by the scope of the appended claims.

I claim:

1. In a noise limiting circuit, a modulated carrier wave source, said carrier wave having modulated thereon at least one desired signal, band-pass filter means connected to said source for transferring said waves, said filter being capable of passing a band of frequencies much wider than is required to pass said desired signals, signal detector means for demodulating said carrier wave, amplitude limiting means arranged to receive the demodulated signal from said detector and adapted to limit the amplitude of noise voltages accompanying the demodulated signal to substantially the amplitude of the desired portion of said signal, low-pass filter means following said amplitude limiting means and having a cut-off frequency just high enough to pass the most important frequency components of said desired signal, whereby the noise voltages are greatly attenuated, and an amplitude responsive transfer means adjusted to transfer only a predetermined and selected portion of the signal passing through said low-pass filter, thereby substantially to eliminate the attenuated noise voltages.

2. A noise limiting circuit in accordance with claim 1, characterized in that said amplitude responsive transfer means is adjusted to transfer only those portions of the desired signal which extend above the average noise level.

3. In a television receiver employing wide-band signal transfer means, a signal detector, a video signal channel and a picture reconstituting device coupled to the output of said detector, the combination of selector means for deriving synchronizing signals from the output of said detector, amplitude limiting means coupled to said selector means for reducing the amplitude of disturbance signals to a predetermined amplitude level corresponding substantially to the maximum amplitude of the synchronizing signals, low-pass filter means coupled to said amplitude limiting means for greatly attenuating the disturbance signals without detrimentally affecting the synchronizing signals, whereby the disturbance signals by virtue of their greater high frequency content are greatly reduced in amplitude relative to the synchronizing signals, means coupled to said filter means for generating deflecting voltage waves in synchronism with the synchronizing signals, and means for applying said waves to said picture reconstituting device.

4. In a television receiver employing wide-band signal transfer means, a signal detector, a video signal channel and a picture reconstituting device coupled to the output of said detector, the combination of selector means for deriving synchronizing signals from the output of said detector, amplitude limiting means coupled to said selector means for reducing the amplitude of disturbance signals to a predetermined amplitude level corresponding substantially to the maximum amplitude of the synchronizing signals, low-pass filter means coupled to said amplitude limiting means for greatly attenuating the disturbance signals without detrimentally affecting the synchronizing signals, whereby the disturbance signals by virtue of their greater high frequency content are greatly reduced in amplitude relative to the synchronizing signals, amplitude-responsive means coupled to said filter means for selecting the synchronizing signals substantially to the exclusion of the disturbance signals, means coupled to said last-named means for generating deflecting voltage waves in synchronism with the synchronizing signals, and means for applying said waves to said picture reconstituting device.

5. A television receiver in accordance with claim 4, characterized in that said selector means and said amplitude-responsive means each includes a vacuum tube biased below plate current cut-off, whereby only voltages exceeding a predetermined amplitude level are transferred by the tube, and said amplitude limiting means comprises a vacuum tube diode in shunt with the synchronizing signal channel and biased so as to be conductive only to signal voltages exceeding the maximum amplitude of the synchronizing signals.

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