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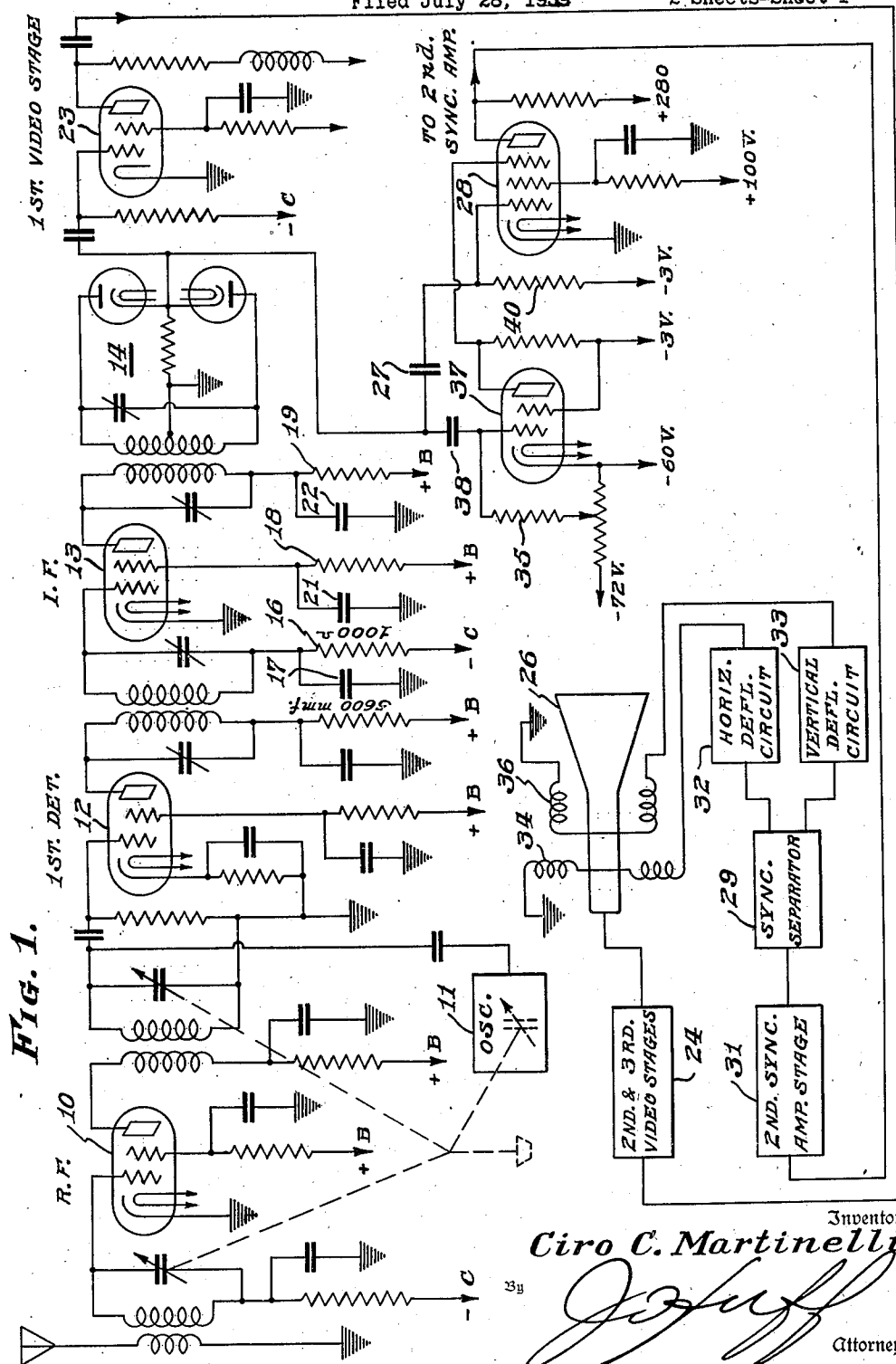
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2,299,333

NOISE SUPPRESSION SYSTEM

Filed July 28, 1939

2 Sheets-Sheet 1



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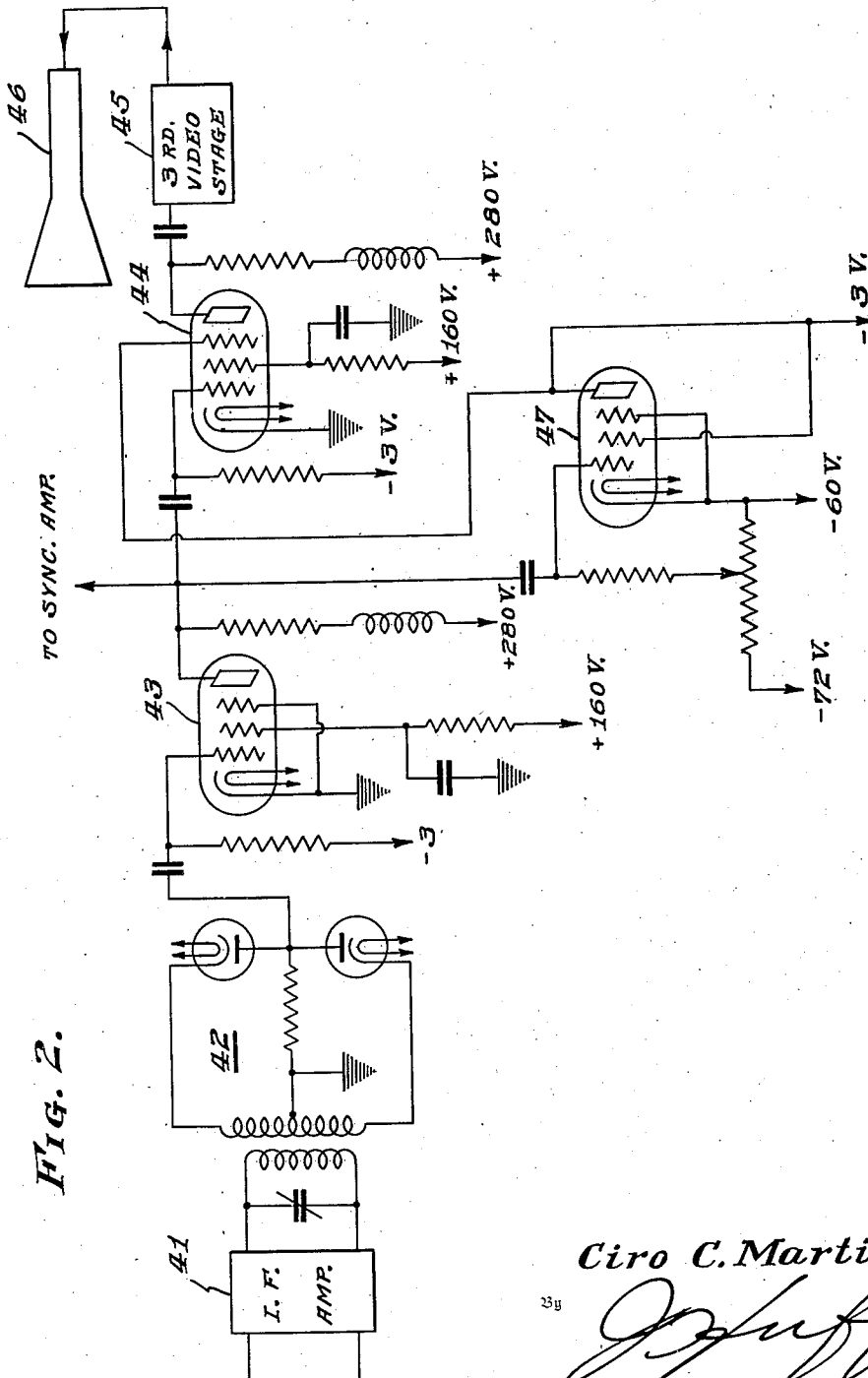
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2,299,333

NOISE SUPPRESSION SYSTEM

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10 Claims. (Cl. 178-7.5)

My invention relates to television receivers and particularly to the reduction of the effect of noise in the received picture.

Noise signals may affect a received picture in two different ways, namely, the noise may appear in the observed picture as either black dots or white dots depending upon whether the picture is transmitted with negative modulation or positive modulation and, also, the noise may cause the receiver to drop out of synchronism if the noise is of sufficient amplitude.

It will be understood that by "negative modulation" is meant the case where a signal representing a decrease in white in the picture causes an increase in the amplitude of the modulated carrier wave and that by "positive modulation" is meant the case where an increase in white is represented by an increase in the amplitude of the carrier wave.

It has been found that, in the case of negative modulation transmission and where the synchronizing impulses are in the "black" direction, the most objectionable effect of noise is to cause the receiver to drop out of synchronism. The effect of noise on the picture itself when the receiver remains synchronized is to put black dots in the picture which are not especially objectionable.

In the case of positive modulation, and again assuming synchronizing impulses in the "black" direction, the most objectionable effect of noise is to put white spots in the picture. The presence of white spots is much more objectionable than the presence of black spots, especially if the cathode ray receiver tube has a tendency to "bloom," that is, if the cathode ray spot on the fluorescent screen increases in diameter as the brightness of the spot is increased.

An object of my invention is to reduce the effect of noise signals on a television receiver.

A further object of my invention is to provide a television receiver of the type for receiving a negatively modulated carrier wave which is so designed that it is less likely to be thrown out of synchronism by noise signals.

A further object of my invention is to provide a television receiver of the type designed to receive a positively modulated carrier wave which produces a picture wherein the noise appears as black spots rather than white spots in the picture.

In the preferred embodiment of my invention, the first consideration is to make the time constants of the filter circuits such that the effect produced by a short noise pulse does not last for a longer time than the noise pulse itself.

This may be accomplished either by making the time constant very short or very long. For example, considering the grid circuit of an intermediate amplifier tube, the filter in this circuit may be given a time constant so short that, if a noise pulse drives the grid of the tube positive whereby grid current charges the filter condenser, the filter condenser will discharge so rapidly that it will not hold the grid of the tube at a high negative potential after the termination of the noise pulse and for the duration of a plurality of horizontal synchronizing impulses. Thus, the noise pulse does not cause a plurality of synchronizing impulses to be blanked out as previously has been the case.

The same improved results may be obtained by making the condensers in the tube filter circuits of such large capacity that the grid current produced by a noise pulse cannot charge them fully whereby the filter condenser charge does not hold the grid at such a potential as to blank out a group of synchronizing impulses after the termination of the noise pulse. This, however, cannot be done where an automatic volume control voltage is being applied to the tube.

By taking the above-described precautions in receiver design, the reception when noise is present will be substantially improved. It may be still further improved in the case of negative modulation transmission by blocking the synchronizing amplifier for the duration of a noise pulse whereby the deflecting circuit oscillator will not have a false "synchronizing" pulse applied thereto. The absence of one or two synchronizing impulses caused by blocking of the amplifier channel is not serious, however, since the oscillator (preferably, a blocking oscillator) is free running at a frequency close to the desired deflecting frequency.

In the case of positive modulation transmission, the reception in the presence of noise may be still further improved by reversing the polarity of the noise signals whereby they appear on the receiver screen as black dots rather than white dots.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which

Figure 1 is a circuit diagram of a television receiver embodying my invention, and

Figure 2 is a circuit diagram of another embodiment of my invention.

Referring to Fig. 1, I have shown my invention applied to a television receiver designed to receive a carrier wave having negative modulation

and where the synchronizing impulses are in the "black" direction. The video signal with which the carrier wave is modulated is of the same character as that described in Bedford British Patent 448,065, accepted June 2, 1936. The modulation (negative) is also the same as shown in this British patent.

The receiver may be of the superheterodyne type comprising a radio frequency amplifier 10, a tunable oscillator 11, a first detector 12, an intermediate frequency amplifier 13 and a push-pull second detector 14. This portion of the circuit is of conventional design except for the time constants of certain circuits. It will be understood that in most receivers there will be a plurality of I. F. amplifier stages rather than the single one illustrated.

It will be seen that the grids and plates of the amplifier tubes and of the first detector are supplied with bias and operating voltages through filters comprising series resistors which are bypassed by condensers. Referring specifically to the I. F. amplifier tube 13, the control grid of this tube is supplied with a negative biasing voltage through a filter resistor 16 bypassed or shunted by a condenser 17. Likewise, the screen grid and plate of the tube 13 are supplied with D. C. operating voltages through filter resistors 18 and 19, respectively, shunted by the filter condensers 21 and 22, respectively.

The video signal appearing in the output circuit of the second detector 14 is supplied through the first video amplifier stage 23 and through the second and third video amplifier stages indicated by the block 24 to the cathode ray tube 26.

The video signal is also supplied from the second detector output through a coupling condenser 27 to the synchronizing impulse amplifier 28 which, in the example illustrated, is a tube of the pentode type. The amplified signal is then impressed upon a separating circuit 29, which may be of any well-known type, for removing the picture signal from the synchronizing impulses. This separating circuit also includes suitable filtering circuits for substantially isolating the horizontal synchronizing impulses and the vertical synchronizing impulses. The separating circuit 29 may be preceded by a second amplifier stage 31 if desired.

The horizontal synchronizing impulses and the vertical synchronizing impulses are applied to the horizontal and vertical deflecting circuits 32 and 33, respectively, for causing saw-tooth currents to flow through the deflecting coils 34 and 36.

As will be described more fully hereinafter, a phase or polarity reversing tube 37 is also connected through a coupling condenser 38 to the second detector output circuit for applying noise signals to a grid of the tube 28 with such polarity as to block it, whereby noise signals are not fed into the deflecting circuits.

Referring again to the I. F. amplifier stage 13 and to the matter of the filter time constants, I have indicated, by way of example, on the drawing that the resistor 16 may have a resistance of 1000 ohms while the condenser 17 may have a value of 5600 micromicrofarads. This gives the filter 16—17 a time constant of 56—7 seconds, which is approximately the same as the duration of a single horizontal synchronizing impulse. The important feature as to the time constant of this filter circuit is that it preferably should be so small that a charge on the filter condenser will have time to leak off to a

low value between successive horizontal synchronizing impulses. Preferably, this time constant is as short as or shorter than the duration of a horizontal synchronizing impulse. However, it will be apparent from the foregoing that the time constant of the filter may be longer than indicated, the result of this being that possibly one more synchronizing impulse will be lost than with the shorter time constant. For example, if the time constant is made ten times the above-mentioned value, it will then be about equal to the time between successive horizontal synchronizing impulses, and a noise pulse will ordinarily cause the loss of only one synchronizing impulse.

The remarks in the preceding paragraph apply, of course, to the embodiment of the invention where the filter time constant is very short. As to the other embodiment in which the time constant is made very long, the condenser 17 may be given a capacity of from 0.25 microfarad to one or more microfarads, assuming that the resistance of the resistor 16 remains at the value of 1000 ohms. Obviously, the value of resistor 16 may vary within wide limits. The important design consideration in this particular embodiment is that the filter condenser has such a large capacity that the energy in a noise pulse is insufficient to charge the condenser to a voltage sufficient to block the amplifier tube. It is then immaterial whether the charge of condenser 17 caused by a noise pulse "hangs over" or not.

It may be found desirable to design either the screen grid filter or the plate filter, or both, in accordance with one of the above-described embodiments of the invention. For example, the filters 18—21 and 19—22 of the tube 13 may be given either very short time constants or very long time constants, as previously described. The need for this will probably be greater for the screen grid filter than for the plate filter, as a change in voltage across the screen grid filter condenser caused by a noise pulse will have a greater effect on the tube output than will a similar change in voltage across the plate filter condenser.

In one receiver embodying the invention, it was found that it was sufficient to shorten the time constants of the filters in the control grid circuits only of the I. F. amplifier stages.

It will be understood that the need for one of my above-described changes in the filter time constant is greatest where the amplitude of the signal is greatest, namely, in the last I. F. stages. Where a plurality of I. F. stages are employed in cascade, it may be unnecessary to consider the time constant of the first I. F. stage. Also, in the circuit of Fig. 1, the filters in the grid and plate circuits of the R. F. amplifier tube 10 may have time constants of conventional values. Obviously, there is no difficulty at this point due to the signal driving the control grid of the tube 10 positive.

It may be noted that the specific circuit values mentioned in the foregoing description are for a television system in which the horizontal synchronizing impulses occur at the rate of 13,230 per second and have a duration of approximately 0.15 of the time from the start of one impulse to the start of the next impulse and in which the framing impulses occur at the rate of 60 per second.

In receivers employing noise suppressors, it has been the usual practice to apply the suppression or limiting action to a point as close to the front end of the receiver as practicable to

minimize the effect of noise on the succeeding circuits. I have found that this action may be applied to the portion of the circuit following the I. F. amplifiers, that is, to the second detector or to the video amplifier or amplifiers providing the preceding circuits are designed with the proper time constants to reduce the "overhang" effect of noise as taught in the foregoing description.

For example, in Fig. 1, I have shown the noise suppressor tube 37 which amplifies the noise pulses and applies them to a suitable electrode, the suppressor grid, for example, for blocking the synchronizing amplifier tube 28 for the duration of the noise pulse whereby the noise pulse cannot prematurely trigger off the oscillators of the deflecting circuits 32 and 33. Since the I. F. filter circuits have been given the proper time constant, the tube 22 is unblocked immediately upon the termination of the noise pulse and the succeeding synchronizing impulses are applied to the deflecting circuits.

In the circuit of Fig. 1, since the noise pulses will be applied through the video stages 23 and 24 to the cathode ray tube 26 with such polarity that the noise causes black spots rather than white spots on the fluorescent screen, it is unnecessary to apply any noise suppression signal to any of these video stages.

In Fig. 2, there is shown a portion of a television receiver designed in accordance with my invention to receive a signal transmitted with positive modulation. The I. F. amplifier portion of the receiver, indicated at 41, is designed with the proper filter time constants as described in connection with Fig. 1.

The I. F. output may be demodulated by a push-pull detector 42 and the resulting video signal applied to the video amplifier which includes the stages 43, 44 and 45. This video signal may be the same as that described in the above-mentioned British patent to Bedford. Since the modulation is positive in this case, however, noise pulses will cause bright white spots in the picture unless some type of noise suppressor means is employed in the video amplifier.

In accordance with my invention, the noise pulses are caused to appear as black spots on the screen of the receiving tube 46 by utilizing a polarity reversing tube 47 through which the noise pulses are applied to a grid of the tube 44 with sufficient amplitude and with the proper polarity to block the tube 44 for the duration of a noise pulse. This blocking of the tube 44 will be for only the duration of the noise pulse if the time constants in the preceding circuits are properly selected as previously described.

While the invention has been described in connection with a superheterodyne receiver, it will be understood that its application is not so limited. For example, it may be applied to a receiver of the tuned radio frequency type. In that case, the radio frequency amplifier stages just preceding the detector would be designed with filter time constants as taught by the foregoing specification. Specifically, by way of example, the filter in the control grid circuit would be designed according to these teachings in any stage where the noise signal might be of sufficient amplitude to drive the control grid positive to cause a flow of grid current.

It may be noted that, in Figs. 1 and 2, the time constants of the input circuits of the controlling tubes 37 and 47 preferably are made

substantially the same as those of the input circuits of the tubes 28 and 44, respectively, which receive the controlling or noise suppression signal. For example, in Fig. 1 the time constant of the circuit including the grid condenser 38 and the grid resistor 35 preferably is the same as the time constant of the circuit including the grid condenser 27 and the grid resistor 40.

Instead of applying noise suppressor means to amplifiers following the second detector, as illustrated in Figs. 1 and 2, the noise suppression may be accomplished by means of a suitable balanced second detector circuit such as that described in McCutcheon Patent 2,087,063.

I claim as my invention:

1. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier and an amplifier succeeding said demodulating means for amplifying said composite signal, said first-mentioned amplifier stage comprising an amplifier tube having a control grid, and a filter comprising a resistor shunted by a condenser and through which a biasing potential may be applied to said grid, the time constant of said filter being a value which is not substantially greater than the time from the beginning of one of said high frequency synchronizing impulses to the beginning of the next succeeding high frequency synchronizing impulse.

2. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier and an amplifier succeeding said demodulating means for amplifying said composite signal, said first-mentioned amplifier stage comprising an amplifier tube having a control grid, and a filter comprising a resistor shunted by a condenser and through which a biasing potential may be applied to said grid, the time constant of said filter being a value which is not substantially greater than the duration of one of said high frequency synchronizing impulses.

3. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses, and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier, said amplifier stage comprising an amplifier tube having a control grid, a grid circuit including a filter resistor through which bias may be supplied to said grid, a filter condenser shunting said filter resistor, the time constant of the filter comprising said resistor and said condenser being not substantially greater than the time from the start of one of said high frequency impulses to the start of the next succeeding high frequency impulse, and means for acting upon the demodulated signal for reducing the effect of noise pulses received by the receiver.

4. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, a plurality of amplifier stages preceding said demodulating means for amplifying said modulated carrier, at least the last one of said amplifier stages comprising an amplifier tube having a control grid, a filter comprising a resistor shunted by a condenser and through which a biasing potential may be applied to said grid, the time constant of said filter being a value which is not substantially greater than the time from the start of one of said high frequency synchronizing impulses to the start of the next succeeding high frequency impulse, and means following said last stage for suppressing noise pulses.

5. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses, and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier, and an amplifier stage succeeding said demodulating means for amplifying at least a portion of said composite signal, said first stage comprising an amplifier tube having a control grid, a grid circuit including a filter resistor through which bias may be supplied to said grid, a filter condenser shunting said filter resistor, the time constant of the filter comprising said resistor and said condenser being not substantially greater than the time from the start of one of said high frequency impulses to the start of the next succeeding high frequency impulse, and means for blocking said second amplifier stage in response to and for the duration of a received noise pulse which exceeds a predetermined amplitude.

6. In a television receiver for the reception of a composite signal comprising picture signals periodically recurring high frequency synchronizing impulses, and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave which is positively modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier, and a video amplifier stage succeeding said demodulating means for amplifying said composite signal, said first stage comprising an amplifier tube having a control grid, a grid circuit including a filter resistor through which bias may be supplied to said grid, a filter condenser shunting said filter resistor, the time constant of the filter comprising said resistor and said condenser being not substantially greater than the time from the start of one of said high frequency impulses to the start of the next succeeding high frequency impulse, and means for blocking said video amplifier stage in response to the reception of a noise pulse exceeding a predetermined amplitude and substantially for only the duration thereof.

7. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses, and periodically recurring low frequency synchronizing impulses, deflecting circuits to be controlled by said impulses, means for demodulating a carrier wave modulated by

said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier, and a synchronizing amplifier stage succeeding said demodulating means for amplifying said synchronizing impulses and connected to supply them to said deflecting circuits, said first stage comprising an amplifier tube having a control grid, a grid circuit including a filter resistor through which bias may be supplied to said grid, a filter condenser shunting said filter resistor, the time constant of the filter comprising said resistor and said condenser being not substantially greater than the time from the start of one of said high frequency impulses to the start of the next succeeding high frequency impulse, and means for blocking said synchronizing amplifier stage in response to and substantially for the duration of noise pulses exceeding a predetermined amplitude received by said receiver.

8. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses, and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier, and an amplifier stage succeeding said demodulating means for amplifying at least a portion of said composite signal, said first stage comprising an amplifier tube having a control grid, a grid circuit including a filter resistor through which bias may be supplied to said grid, a filter condenser shunting said filter resistor, the time constant of the filter comprising said resistor and said condenser being such that said amplifier tube will not be blocked by a received noise pulse for a period any greater than that which will cause a loss of only one high frequency synchronizing impulse, and means for blocking said second amplifier stage in response to and for the duration of a received noise pulse which exceeds a predetermined amplitude.

9. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier and an amplifier succeeding said demodulating means for amplifying said composite signal, said first-mentioned amplifier stage comprising an amplifier tube having a control grid, and a filter comprising a resistor shunted by a condenser and through which a biasing potential may be applied to said grid, said filter condenser having such large capacity that the energy in a received noise pulse is insufficient to charge the condenser to a value sufficient to block the amplifier tube.

10. In a television receiver for the reception of a composite signal comprising picture signals, periodically recurring high frequency synchronizing impulses and periodically recurring low frequency synchronizing impulses, means for demodulating a carrier wave modulated by said composite signal, an amplifier stage preceding said demodulating means for amplifying said modulated carrier and an amplifier succeeding said demodulating means for amplifying said

composite signal, said first-mentioned amplifier stage comprising an amplifier tube having a cathode which is connected to ground and having a control grid, and a filter comprising a resistor shunted by a condenser and through which a biasing potential may be applied to said grid, the time constant of said filter being a

value which is not substantially greater than the time from the beginning of one of said high frequency synchronizing impulses to the beginning of the next succeeding high frequency synchronizing impulse.

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