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2,273,934

NOISE LIMITING DEVICE

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Fig. 1.

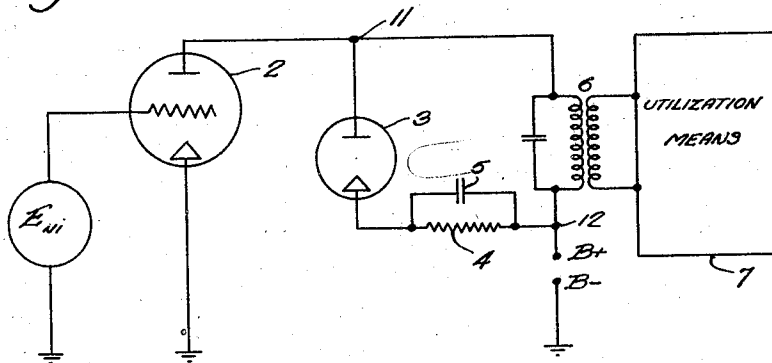


Fig. 2.

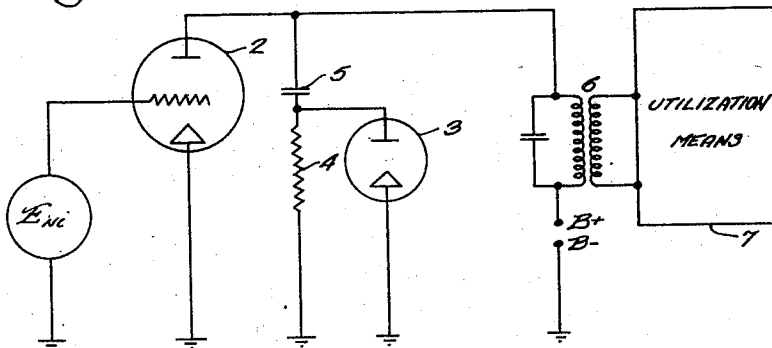
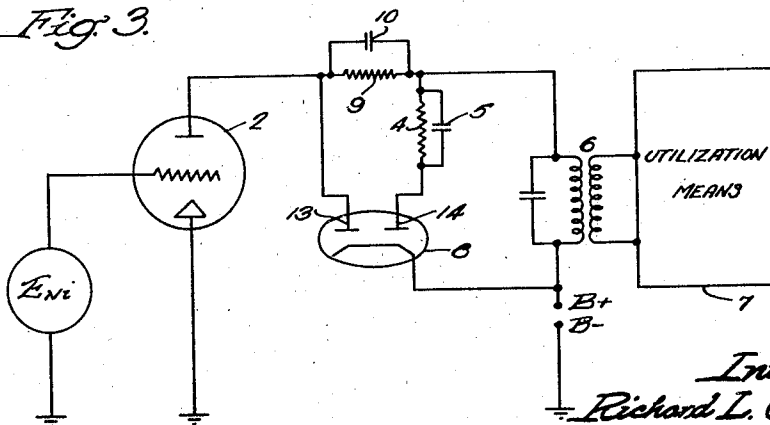


Fig. 3.



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NOISE LIMITING DEVICE

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10 Claims. (Cl. 178—44)

This invention relates to noise limiting circuits and more particularly to novel means for limiting the amplitude, steepness of wave front, and energy content of interfering noise signals in communication or control systems.

The principal object of the invention is to provide a novel and highly efficient circuit capable of greatly attenuating the transfer of noise pulses and the like in electrical transmission paths.

Another object of the invention is to provide an electronic system for attenuating noise pulses, whose operation depends primarily on the periodicity and/or duration of the undesired impulses rather than on their amplitude.

Still another object of the invention is to provide an electronic noise reducing system which exhibits highly advantageous frequency discriminatory characteristics of the low-pass type heretofore associated only with costly filter systems.

A further object of the invention is to provide in cooperative combination, an electronic noise attenuator of the class described, and a delayed type of diode amplitude limiter whereby a still further reduction in the amplitude level of noise pulses obtains.

The invention utilizes a non-linear impedance means with which are associated time delay circuits in such a manner that a transmission path including these means exhibits an effect similar to that of a low-pass filter to signals of short duration or of erratic occurrence, while having very little effect on signals of longer duration or of more regular occurrence. Such a discriminating means is of particular importance when the desired 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 desired signal amplitude. The present limiter differs markedly from known limiters in that such noise pulses are discriminated against even though their amplitude may be below that of the desired signal. The desirable qualities of the device may be further enhanced by suitably combining it with known types of limiters as hereinafter described.

According to the present invention, there is provided in an electrical system including a source of intelligence signals accompanied by interfering noise signals, a signal utilization means, signal transfer means coupling said source and said utilization means, non-linear impedance means in shunt with said signal transfer means, and time delay means so associated with said non-linear impedance means that noise signals having a time duration of less than a predetermined maxi-

mum are attenuated while said intelligence signals are transmitted with substantially no loss.

In the accompanying drawing:

Fig. 1 is a diagrammatic illustration of one embodiment of the noise limiter of the invention;

Fig. 2 is a similar illustration of a modified embodiment of the invention; and

Fig. 3 illustrates still a further modification of the invention wherein the added presence of a shunt amplitude limiter produces a combination capable of advantageous and novel results.

In the three figures, E_m represents a source of intelligence signals accompanied by noise signals. 7 represents a utilization means which may be a loudspeaker, facsimile or television components, electromechanical control devices, or the like. The signal E_m and the utilization means 7 are coupled by means of signal transfer elements which may include a control space discharge device 2 and a coupling means 6. This signal transfer means may also include additional amplifiers, detectors or other elements if desired.

Referring now to Fig. 1, there is shunted across the signal transfer means a non-linear impedance 3 which may be a diode, and serially connected therewith is a delay circuit comprising, in parallel, the resistance 4 and condenser 5. Assume, for the sake of illustration, that the source E_m provides a modulated carrier wave. If the time constant RC of the delay circuit 4—5 is comparable to the period of the highest useful harmonic of the modulation envelope, then the modulated signal will be transmitted through the system with substantially no loss. This action obtains because the condenser 5 acquires a charge which provides a potential across the resistor 4 that opposes the flow of current through the diode. Thus the diode 3 conducts only for a very short time for each cycle of the carrier, and hence only a negligible amount of energy is drawn from the transfer means. This action may be explained by noting that the time constant of the circuit 4—5 has been made low enough to permit the voltage thereacross to follow substantially the useful excursions of the carrier envelope. If now there arrives a noise pulse of short duration whose effect is to produce momentarily a sharp increase in envelope amplitude, the voltage across the circuit 4—5, will be unable to follow that excursion, and as a result the diode and associated delay network constitute, for the length of the short pulse, a heavy load on the signal transfer channel whereby the coupling means 6 is, for all practical purposes, completely short

circuited for that time. Note that this condition may at least partially obtain even though the noise pulse be of a lesser amplitude than the peak useful signal pulse.

In the embodiment of Fig. 2 the action is, in general, similar to that above described. The only difference here is that the non-linear impedance 3 and the elements 4 and 5 are combined in a slightly different manner. In both cases it will be seen that effectively the diode 3 and the condenser 5 are serially connected and shunted across the signal transfer means, and for D. C. and low frequencies the resistor 4 is shunted directly across the condenser 5.

Referring now to Fig. 3, it will be seen that, disregarding the resistance-capacitance circuit 9-10 and the diode section 13, the circuit is identical with that of Fig. 1 except that the resistance-capacitance circuit 4-5 has been placed in the plate lead of the diode section 14 rather than in the cathode lead. This part of the circuit then functions as does that of Fig. 1. However, there has been additionally shunted across the signal transfer means the diode section 13 across which any suitable polarizing or biasing potential may be impressed, for example, by means of a biasing battery or by means of the resistance-capacitance circuit 9-10. The bias may be so adjusted as to make the diode section 13 conductive for all signals exceeding a predetermined amplitude such as, for example, the amplitude of the desired signal. In this manner, the signal transfer means is effectively short circuited for all signals exceeding the amplitude of the desired signal. Thus in this embodiment there is provided a highly effective and novel circuit employing a combination of means whereby noise pulses may be discriminated against both on the basis of their amplitude, their wave front steepness, and their duration, and all of this without the use of expensive filters.

In one application, the circuit of Fig. 2 was employed in a remote control system for radio receivers wherein inductive means were utilized as the link between the remotely located control apparatus and the radio receiver to be controlled. The limiter was disposed in the carrier frequency channel of the control signal amplifier (located at the controlled point) and gave very satisfactory results in discriminating against interfering signals such as those occasioned by power lines, ringing of doorbells, and the operation of domestic and industrial electrical equipment and the like. Such a remote control system has been described in the copending application of Milton L. Thompson, Serial No. 220,356, filed July 20, 1938. In the specific application referred to, and with particular reference to Fig. 2 of the present application, the diode element 3 was one section of a 6ZY5G double diode, the resistor 4 had a magnitude of 750,000 ohms, and the condenser 5 a magnitude of 0.02 microfarad, the time constant RC of the delay circuit being about 0.15 second.

It is to be understood that various further modifications may be made without departing from the scope of the invention. For example, the coupling means 6 may be any form of coupling, and any desired bias may be applied to the non-linear impedance means for securing various characteristics. Moreover, it will be apparent to those skilled in the art that although the specific illustrations described herein show the present invention disposed in a high or carrier frequency signal channel the invention is by no

means limited thereto, and it is entirely practical to dispose the present invention in lower frequency signal channels, it merely being necessary to select the values of the time delay networks in accordance with the conditions and as taught herein. Hence the illustrated embodiments are merely illustrative of the principles of the invention and are not to be considered as limiting the invention to the specific forms shown.

I claim:

1. In a signalling system, a source of a carrier signal modulated at a relatively low rate which may be accompanied by noise signals of relatively steep wave front tending further to modulate said modulated carrier at a higher rate, transfer means for said carrier signal, a carrier signal utilization means coupled to said transfer means, a non-linear impedance means in shunt relation with said transfer means and providing a shunt signal path, and a resistance-capacity circuit associated with said non-linear impedance means and including a condenser whose impedance is negligibly small at the carrier and side band frequencies, said circuit having a time constant which is large compared to the duration of individual noise signals, whereby the noise modulation of said carrier signal is effectively removed therefrom.

2. In a signalling system including a source of desired intelligence or control signals which may be accompanied by interfering noise signals, means for utilizing said desired signals, signal transfer means coupling said source and said utilization means, non-linear impedance means in shunt relation with said signal transfer means, time delay means constructed and arranged in cooperative relation with said non-linear impedance means to control the operation of the latter in dependence upon the duration of received signals, the time delay characteristic of said time delay means being such that noise signals having a time duration substantially less than a predetermined maximum are attenuated while said desired signals are transmitted without substantial loss, a second non-linear impedance means in shunt with said signal transfer means, and means for applying a predetermined biasing or polarizing voltage to said second non-linear impedance means, whereby all signals which exceed a predetermined amplitude are bypassed by said second non-linear impedance means.

3. In a signalling system including a source of desired intelligence or control signals which may be accompanied by interfering noise signals, a signal channel for transferring said desired signals, means providing a shunt path across said signal channel, means for rendering said path substantially non-conductive for desired signals and conductive for noise signals having a time duration substantially less than a predetermined value, means providing a second shunt path across said signal channel, and means for rendering said second path non-conductive for desired signals and conductive for noise signals whose amplitude exceeds that of the desired signals.

4. In a signal transfer circuit including a vacuum tube having an input electrode, a cathode and an anode, an anode circuit for said vacuum tube comprising in series, a source of plate voltage, a tuned resonant load circuit, and a resistor, said resistor being shunted by a capacitor, a diode connected in shunt relation with the serially-connected resistor and resonant circuit,

the voltage drop across said resistor being applied across said diode and in such polarity that said diode is biased to render it non-conducting in the presence of desired signals, but conducting for signals exceeding the voltage across said resistor, and means for shunting said resonant circuit, said means comprising a serially-connected diode and capacitor, and a resistor connected in shunt with one of the last-named serially-connected elements.

5. In a modulated carrier signal receiving system, a vacuum tube having at least a control grid, an anode, and a cathode, a source of carrier frequency signals connected to the grid-cathode circuit of said vacuum tube, a carrier signal utilization means having an input circuit, a transformer having primary and secondary windings, said transformer being connected between the cathode-anode circuit of said vacuum tube and the input circuit of said utilization means, a diode and a capacitor connected in series across one of said transformer windings, and a resistor connected in shunt with one of said serially connected elements, the time constant of the circuit comprising said resistor and said capacitor being large compared to the duration of individual noise signals, but not large compared to the period of the highest useful harmonic of the modulation envelope.

6. A signal receiving system according to claim 5, characterized in that the transformer winding across which the diode circuit is shunted is tuned to resonance with the carrier frequency.

7. In a signal receiving system, a source of modulated carrier signals, a carrier signal utilization means, a carrier signal network connected between said source and said utilization means to transfer signals therebetween, a shunt signal path including a diode connected across the output circuit of said source, the frequency components of said carrier signals being impressed substantially without frequency discrimination on said diode, and a signal duration responsive circuit connected in said shunt signal path to control the impedance of said diode in accordance with the duration of carrier amplitude variations, said signal duration responsive circuit possessing a time constant such that noise signal modulation having a period substantially less than a predetermined maximum is greatly attenuated while desired signal modulation having a period substantially equal to or greater than said predetermined maximum is transmitted by said carrier

signal network without substantial attenuation.

8. In a signal receiving system, a source of modulated carrier signals, a carrier signal utilization means, a carrier signal network connected between said source and said utilization means to transfer signals therebetween, a shunt signal path including a diode and a condenser serially connected across the output circuit of said source, said condenser having negligible impedance at carrier frequencies whereby all of the frequency components of said carrier signals are impressed on said diode without substantial attenuation, and a resistor effectively connected in shunt with said condenser at least for direct current and low frequencies, said condenser and said resistor forming a circuit having a time constant which is large compared to the duration of carrier amplitude variations caused by individual noise pulses.

9. In a signal receiving system, a source of modulated carrier signals, a carrier signal utilization means, a carrier signal network connected between said source and said utilization means to transfer signals therebetween, a shunt signal path including a diode and a condenser serially connected across the output circuit of said source, said condenser having negligible impedance at carrier frequencies whereby all of the frequency components of said carrier signals are impressed on said diode without substantial attenuation, and a resistor connected in shunt with one of said serially connected elements, said resistor and condenser forming a signal duration responsive circuit to control the impedance of said diode in accordance with the duration of carrier amplitude variations, said signal duration responsive circuit possessing a time constant such that noise signal modulation having a period substantially less than a predetermined maximum is largely dissipated in said diode, while desired signal modulation having a period substantially equal to or greater than said predetermined maximum is transmitted by said carrier signal network without substantial attenuation.

10. A signal receiving system according to claim 9, characterized in the provision of a second shunt signal path, said second path including a second diode and having means for applying a predetermined biasing voltage to said second diode, whereby all signals which exceed a predetermined amplitude, irrespective of their duration, are dissipated in said second diode.

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