Feb. 7, 1939. P. M. HAFFCKE 2,146,068

STATIC REJECTOR

Filed June 7, 1934 2 Sheets-Sheet 1

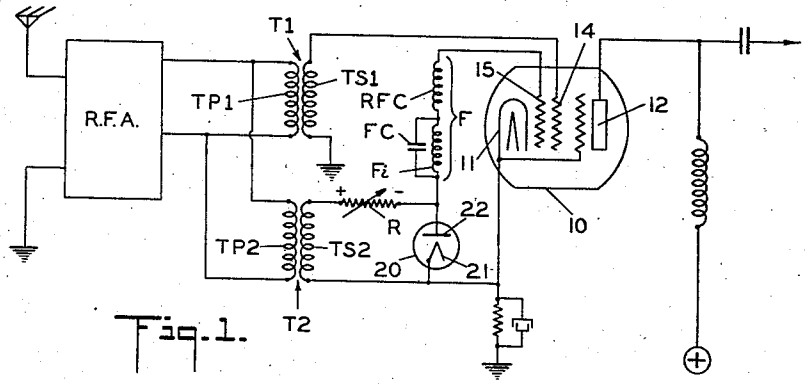


Fig. 1.

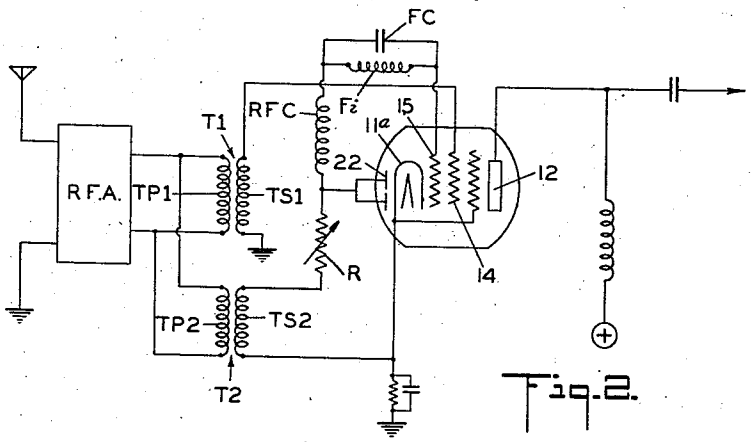


Fig. 2.

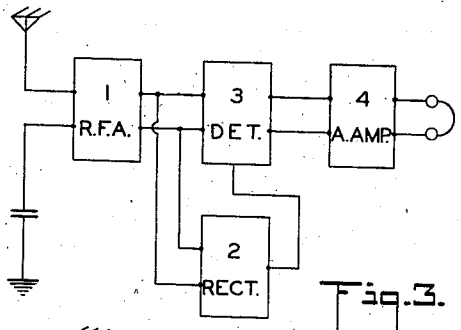


Fig. 3.

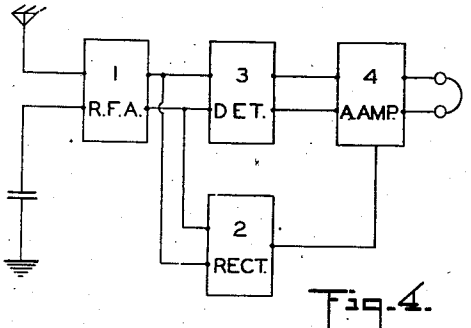


Fig. 4.

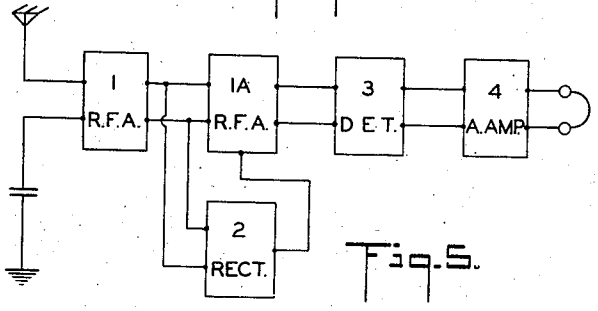


Fig. 5.

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STATIC REJECTOR

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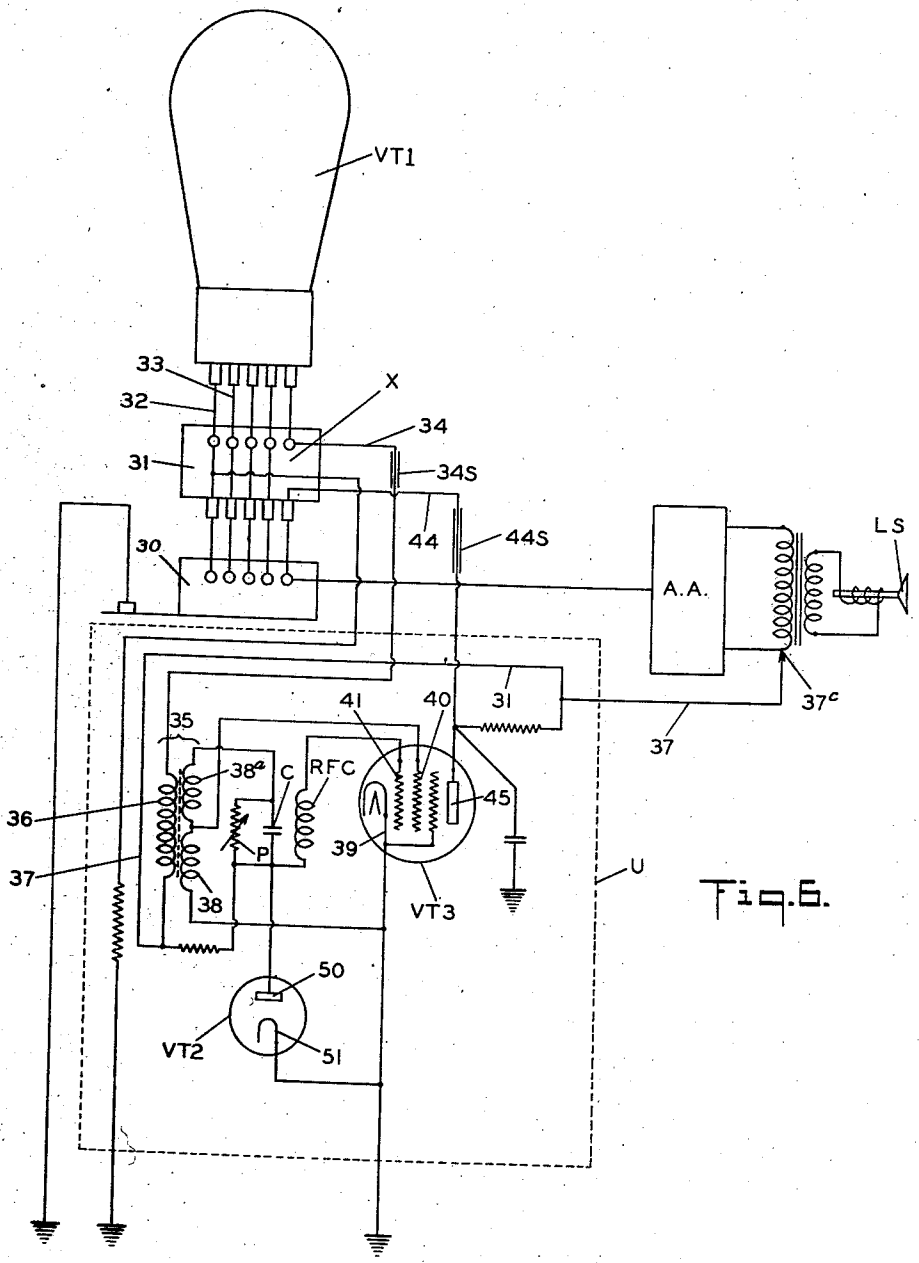


Fig. 6.

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UNITED STATES PATENT OFFICE

2,146,068

STATIC REJECTOR

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Application June 7, 1934, Serial No. 729,361

14 Claims. (Cl. 250—20)

This invention relates to electric-wave signaling systems, particularly to systems which may be subject to atmospheric or other parasitic or undesired disturbances, and has for its principal object, the provision of a receiving system having a definite static rejecting action.

Another object is to provide novel and efficient peak voltage actuated apparatus, adapted for use in speech or other signal modulated carrier wave systems and other systems for the communication of intelligence.

Another object is to provide a marginal translating system operable to discriminate between input currents of different amplitudes without substantially shifting the electrical position (working point) of its signal input electrode upon the Eg—Ip characteristic of said device, whereby time-lag, distortion and other disadvantages inherent with known marginal systems are substantially obviated.

Another object is to provide a static rejecting device operating independently of frequency selection.

Another object is to provide an intensity selector employing electron discharge apparatus of the type operating independently of gas ionization.

Another object is to provide a static rejecting unit, capable of being used as an operative adjunct to various types of radio receivers.

The present invention operates to discriminate betwen waves of different amplitude. It is, in this sense, an automatic volume control. Unlike the usual volume control which is designed either to reduce (stabilize) the fluctuations in the system with which it is associated, or to obviate inter-station noises of low intensity in said system, the present invention contemplates, and its construction provides, means for rejecting all waves, or portions thereof, whose amplitude exceeds a selectable predetermined maximum.

It is sufficient here to state that this "maximum" may, and preferably does, correspond normally to the amplitude of the useful signal impressed upon the apparatus with which the invention is associated.

The static rejecting characteristic of the invention will be more readily understood when it is recalled that the average static impulse is a single rise and fall of the earth's electric field, lasting one or two thousandths of a second, and of a strength many hundreds and even many thousands of times greater than any signal impulse (Appleton, Watson, Watt, and Herd "On the Nature of Atmospherics." Proc. Royal Society of London, A, 111, page 615, 1926.) It is to be understood that through this specification and the appended claims the terms "rectify", "rectifying", "rectified", etc., are used in their true sense. That is, they refer to a unidirectional current derived solely from an alternating current and not to a current that is, either in whole or in part, pulses of direct current of varying current strength. The only true rectified current flowing through a triode is in the grid-cathode circuit, since it is derived directly from an alternating source. The current in the plate circuit is merely pulsations of direct current of varying strength as the amperage in that circuit is reduced or permitted to increase by fluctuations of the grid voltage, and does not consist of unidirectional pulsations that are actual components of an alternating current. Since a single dot of the radio code at 600 meters comprises about 50,000 cycles and a discharge of static carries only a few cycles of oscillations (J. C. Williams, "Radio and Static", Radio News, a publication published in New York, August 1933, page 119), it will be apparent that if static affected waves are impressed upon a device capable of being automatically silenced for periods substantially coextensive with the duration of these almost infinitely brief disturbing impulses, "persistence of hearing" or other physiological phenomena will serve to abridge these "silent periods" so that their effect upon the human nervous system will be negligible.

In carrying my invention into effect I prefer to impress the static affected waves upon a circuit, the conductivity of which depends upon the maintenance of an electron stream between elements in the circuit, and electrically blocking or otherwise interrupting the flow of the electrons as determined by the instantaneous amplitude of the static bearing portion of the impressed waves.

Since "restoring time" is the essence of the invention, it is important that all elements of the circuit be maintained in an electrical condition ready for normal operation upon cesssation of the electron blocking action. Thus, assuming that the static bearing waves are impressed upon a thermionic vacuum tube amplifier, I have found it necessary and desirable to maintain the filament in its normally activated condition; similarly the source of plate current should be of fixed value; also the bias, if any, upon the signal grid should be constant (cf. U. S. patent to Affel No. 1,574,780, issued March 2, 1926) and

not subject to any "drifting" or "shifting" action as in known volume control systems.

In the case of undesired disturbances of appreciable or prolonged duration (whether oscillatory or non-oscillatory in character) the silent periods are certainly less objectionable than the raucous blasts usually attendant interference of this type. Regardless of the duration or force of the disturbing impulse, the action of my unit is such that impact or forced oscillation in the associated circuits is obviated.

Other objects will be apparent and the principle and apparatus of the invention will be more readily understood by reference to the following description taken in connection with the accompanying drawings, wherein:

Fig. 1 is a fragmentary circuit diagram of a radio receiver embodying the invention;

Fig. 2 is similar to Fig. 1, but shows both controlling and controlled tubes within a single envelope;

Figs. 3, 4 and 5 are schematic views illustrating the preferred "feed-forward" position of the controlling apparatus relative to the controlled tube; and

Fig. 6 shows how the static ejector of my invention may be incorporated into existing radio receivers.

The broad objects of the invention are achievable in electrical systems other than that described. It is to be understood therefore, that while the invention will be disclosed as employed in a typical electrical wave signaling system, the invention is not limited thereto, and the disclosure in this respect is merely illustrative for purposes of explaining the inventive concept.

Referring now to Fig. 1: In carrying my invention into effect I employ a plural grid tube 10, as the controlled tube, and a diode or other suitable rectifier 20 as the controlling tube. Both tubes are preferably of the high vacuum thermionic type and may, if desired, be contained within a single envelope. The signal bearing static affected waves are preamplified by radio frequency amplifier RFA and simultaneously impressed upon the coupling transformer T1 and T2.

The coupling system may comprise two primary coils TP1 and TP2 connected in parallel and having separate secondary windings TS1 and TS2, as shown, or it may comprise a single primary coil and a center tap secondary coil, or it may be of any other suitable or convenient type.

The high voltage terminals of the transformer secondary coils TS1 and TS2 are connected, respectively to the signal grid 14 of tube 10 and to the anode 22 of rectifier 20. The low potential terminal of TS1 is connected to a suitable ground and that of TS2 is connected directly, but for radio voltages only to cathode 21 of rectifier 20.

With this hook-up it will be apparent that the incoming signal energy will be simultaneously impressed upon both tubes 10 and 20 and, in the case of the incoming energy impressed upon signal grid 14 of tube 10, will modulate the plate current in a well known manner if there is nothing to interrupt the conductive path provided by the electrons passing between cathode 11 and anode 12.

There is a circuit connection, including an electrical filter F, between the output of rectifier 20 and the "second" or controlling grid 15 of tube 10. Grid 15 is electrically isolated from R. F. and other stray alternating waves by radio frequency chock RFC and the condenser FC and coil Fi, all of which form elements of the filter F.

The function of this non-signal bearing control electrode 15 is analogous to that of a "continuously variable valve", the number and/or speed of the electrons permitted to pass through the grid openings to proportionately vary the conductivity of the inter-electrode path varying with the strength of the varying voltage, which voltage is determined by the signal (or signal + undesired) voltage impressed upon the rectifier.

Thus in the absence of sudden and excessive impulses the direct current developed in the output circuit of rectifier 20 will merely tend to impede the flow of electrons, and the effect of this tendency may be conveniently overcome, if desired, by the addition of an added stage of R. F. amplification. A static impulse of an intensity greater than that of the normal signal level will cause the rectified voltage produced by tube 20 and present as a bias upon grid 15, to attain a value sufficient to interrupt the flow of electrons, and hence the passage of the signal, in tube 10.

The bias, or static potential, if any, upon the signal bearing grid 14 remains substantially constant regardless of the swing of the blocking grid 15.

The inter-electrode space is restored to its normally conductive condition immediately upon cessation of the disturbing impulse since, as previously set forth, the normal or signal voltage is insufficient to provide a voltage capable of interrupting the conductivity of the tube.

I have found that when the controlling voltage is impressed upon the grid next adjacent the cathode, as shown, a more positive action is obtained than if the position of the grids were reversed. However, the circuit connections may be transposed or the relative positions of any or all of the electrodes altered, the essential requirement being that the bias present upon the "rejector" (non-signal bearing) electrode be sufficient to dissipate waves of an amplitude greater than that of the desired signal.

The signal level to bias voltage ratio may be adjusted by means of variable resistor R included in the rectifier circuit. It may be said generally that with strong signals the resistance included in this circuit is preferably low to give sharp cut-off; with weak signals, as in the case of a distant station, the resistance should be comparatively high to obtain the same desired rejecting action.

As an example of the electrical values of the elements of the circuit of Figs. 1 and 2 for a receiver operating within the usual "broadcast" range: R=50,000 ohms to 3 megohms variable, RFC and Fi each approximately 85 millihenries, Fc .0001–1 microfarad.

The sensitivity of the device (RFA, Figs. 1 and 2) feeding the unit, and the strength of the biasing voltage provided by tube 20 is preferably adjusted so that the controlled tube 10 is operating at the apex of the response curve whereby any "noise" of greater amplitude than that of the desired signal will always be reproduced at a lower or zero volume relative to the signal.

The circuit and principle of operation of Fig. 2 is the same as that disclosed in Fig. 1, the only difference being that the rectifier from which the blocking E. M. F. is obtained is contained in the same envelope as the electronic stream to be controlled. A cathode 11a is common to all electrodes. In both Figs. 1 and 2 I have shown a capacity type of couple in the output of the controlled circuit. However any convenient type of

coupling suitable for the transfer of energy of the frequency employed may be used.

An important feature of the invention as above described is this: the current from which the electron blocking E. M. F. is created is obtained from a point preceding the tube to be controlled. This preferred arrangement of controlling and controlled tubes contributes materially to the successful operation of the invention, as it will be apparent that, should the position of the tubes be reversed (as in the usual automatic volume control), the controlled tube would momentarily register the full force of the disturbing impulse.

This "time lag" inherent in existing circuits is necessarily increased and its effect augmented if the condensers in the controlling circuit are of a value sufficient to hold down excessive R. F. feed-back between the tubes.

Figs. 3, 4 and 5 show preferred arrangements of controlling and controlled tubes.

Referring to Fig. 3: A conventional radio receiver is represented by a radio frequency amplifier 1, detector 3 and audio amplifier 4. A rectifier 2 receives a portion of the incoming signal energy at a point between 1 and 3. The direct current created in the output of the auxiliary device 2 is impressed upon, and directly controls, apparatus following the rectifier input circuit, in this case the detector 3.

In Fig. 4 the rectifier 2 receives its amplified signal energy from the radio frequency amplifier 1, as in Fig. 3, and in accordance with the principle of the invention the direct current output of rectifier 2 is connected to apparatus following the input thereof, in this case the audio amplifier 4.

In Fig. 5 the receiving system includes two radio frequency stages, designated 1 and 1*a* respectively. The control or bias lead is connected between rectifier 2 and the second radio frequency amplifier 1*a*. As in Figs. 3 and 4, the signal energy for the rectifier is tapped at a point preceding the controlled tube; the controlling circuit may therefore be said to be a "feed-forward circuit" instead of a "feed-back circuit" as in the usual automatic volume control.

The static rejector of my invention may be manufactured as a separate unit and readily installed in existing receiving sets.

Fig. 6 shows a typical installation. In the interest of simplicity, only so much of the set is shown as is necessary for an understanding of the invention, it being understood that my unit may be installed in sets of various types.

The detector socket of a T. R. F. set is designated #30, the audio amplifier AA and the loudspeaker LS. The unit is preferably enclosed in a metal container, indicated by the dotted lines U. The principle of operation of the combined set and unit is such that the detecting operation usually performed by tube VT1 is transferred to the "rejector-detector" tube VT3. Tube VT1, however, is preferably retained as part of the system, that is to say, I may by a change of biasing resistors convert the detector of the set into an additional stage of R. F. amplification.

Thus, assuming tube VT1 to be a #227 type employing a normal bias of 25,000 to 50,000 ohms, I substitute therefor a resistor of approximately 2000 ohms to shift the working point to the straight line portion of the E_g I_p characteristic curve.

An adapter 31 is placed between tube VT1 and socket 30. The R. F. voltage impressed upon the input electrode leads 32 and 33 are transferred without interruption through adapter 31 to tube VT1 where they are amplified in the usual manner.

The usual plate circuit 44 to tube VT1 is broken at X in the adapter 31 and connected to anode 45 of the rejector-detector VT3. Plate lead 34 is connected to primary 36 of transformer 35 of the unit. Leads 34 and 44 run through woven wire shields 34*s* and 44*s* which are preferably grounded to reduce capacity feed-back to other parts of the system.

The other terminal of transformer primary 36 is brought back to the plus (+) side of the power-pack through lead 37 to connection 37*c*. 37*c* is preferably in the form of a clip so that it may be conveniently attached to the positive side of the power supply output transformer which is usually located on the frame of the loudspeaker LS. In some broadcast receivers the plus side may be picked up at a terminal block (on the chassis of the set) provided for the purpose of connecting the cord from the speaker.

Transformer 35 supplies rectifier VT2 and rejector-detector VT3 with radio frequency voltages. Transformer secondary winding 38 is connected directly to the input electrodes comprising cathode 39 and signal control grid 40 of tube VT3.

The terminals of secondary 38*a* are connected to the anode 50 and cathode 51 of VT2.

As both windings 38 and 38*a* are supplied from the same primary source 36, the secondary currents will be of similar nature and amplitude at the same moment. When a surge of static arrives, both VT3 and rectifier VT2 will receive equal impulses and, unless some agent interferes, will be modulated into the plate current of tube VT3 and passed on to succeeding stages.

There is a circuit connection including a condenser C, between the output of rectifier VT2 and the "rejector" or non-signal bearing grid 41 of tube VT3. The signal grid 40, is electrically isolated from stray R. F. waves by chock RFC.

In the absence of sudden and excessive impulses the direct current developed in the output circuit of rectifier VT2 will tend to charge condenser C, which tendency is overcome by the leakage path P in shunt thereto. The "normal" bias passing through path P and present upon grid 41 will serve to moderately accelerate the electrons in their passage between cathode 39 and plate 45 and thereby increase the sensitivity of the tube for weak signals. A static impulse of an intensity greater than that of the normal signal level will cause the rectified voltage to attain a value sufficient to charge and discharge condenser C and thereby instantly to create a bias strong enough to interrupt the flow of electrons, and hence the passage of the signal, in tube VT3.

As set forth in connection with Figs. 1 and 2 the inter-electrode space is restored to its normally conductive condition immediately upon cessation of the disturbing impulse since the normal or signal voltage is insufficient to provide a bias capable of interrupting the conductivity of the tube.

In operation the effect of a sudden and transitory static impulse of high intensity is to silence the radio or other system for the duration of the undesired impulse (without any clicking sound) and to restore the set instantly upon cessation of that particular impulse.

With the unit operating to control a R. F. amplifier, as in Figs. 1 and 2, these silent periods are

seldom or never acoustically noticeable, but are visually indicated upon an oscillograph by minute breaks (say $\frac{1}{1000}$ of a second duration) in the wave.

With the unit operating to control the detector tube, as in Fig. 6, these silent periods may be noticeably prolonged, depending to some extent upon the electrical values of the condenser C and leakage path P. In no case, however, when the unit is properly adjusted will the static or other undesired disturbances register with an amplitude greater than that of the desired signal.

One important application of the invention is in the art of secret-signaling. Thus, in time of war, it is desirable to interrupt communication between enemy forces while nevertheless maintaining radio contact with allied forces. It is possible to transmit disturbing waves (with existing apparatus) capable of setting up impact or forced oscillations and hence "blanketing" receivers not equipped with my invention; but these waves will have little or no effect upon apparatus embodying the invention.

Another valuable use to which the invention may be put is in connection with receiving apparatus which, by reason of its proximity to an active transmitter, will register "key-clicks", With my invention incorporated in such a receiver, these often paralyzing disturbances are either not acoustically noticeable or, if noticeable at all, only as "background" below the desired received signal strength.

As a number of possible embodiments may be made of the above invention, and as changes may be made in the embodiments set forth, without departing from the spirit and scope of the invention, it is to be understood that the foregoing is to be interpreted as illustrative and not in a limiting sense, except as required by the appended claims and by the prior art.

What is claimed is:

1. Method of reducing the effects of parasitic disturbances in a signaling system, including a circuit the conductivity of which depends upon the maintenance of an electron stream between elements in said system, which comprises impressing static affected signal-bearing radio frequency waves upon said system, continuously rectifying the components of all amplitudes of a portion of said radio frequency waves, and utilizing the rectified components thereof to concomitantly vary the conductivity of said circuit responsive to the receipt of waves of a desired amplitude and to interrupt the conductivity of said circuit for periods corresponding substantially to the actual duration of parasitic components having an amplitude greater than a certain predetermined value.

2. Method of reducing the effects of parasitic disturbances in a signaling system, including a normally operative electronic repeater, which comprises impressing static affected signal-bearing radio frequency waves upon said repeater, simultaneously and continuously rectifying the components of all amplitudes of a portion of said waves and utilizing the rectified components thereof to disable said repeater for periods corresponding substantially to the actual duration of parasitic components having an amplitude greater than a certain predetermined value.

3. In a signaling system, the combination with a source of radio frequency signal energy, a translating circuit the conductivity of which depends upon the maintenance of an electron stream between elements in said circuit and means for impressing radio frequency signal energy from said source upon said circuit, of means for interrupting said electron stream when the energy impressed upon said circuit from said source exceeds a predetermined intensity, said means comprising a non-signal bearing electrode in the path of said stream, a device connected between said source and said circuit for converting a portion of said energy of all amplitudes into a potential proportional to said energy, said potential being capable of interrupting said electron stream when said energy exceeds a predetermined value and a conductive connection for said potential from said converter to said non-signal bearing electrode said device for converting a portion of said energy into a potential proportional to said energy being independent of the operation or the non-operation of said translating circuit.

4. In a signaling system, the combination with a source of signal energy, a circuit the conductivity of which depends upon the maintenance of an electron stream between elements in said circuit and means for impressing radio frequency signal energy from said source upon said circuit, of means for instantaneously controlling said electron stream in accordance with the amplitude of the energy impressed upon said circuit from said source, said means comprising a non-signal bearing electrode in the path of said stream, a device connected between said source and said circuit for converting a portion of said radio frequency energy of all amplitudes into a potential capable of increasing the conductivity of said electron stream in response to signal intensities below a predetermined maximum, and into a potential capable of interrupting the conductivity of said electron stream in response to intensities above said maximum, and a conductive connection for said potentials from said device to said non-signal bearing electrode.

5. In a signaling system, a normally operative electronic repeater, means for impressing static affected signal-bearing radio frequency waves upon said repeater, means for rectifying a portion of all of said waves, and means responsive to rectified parasitic components of said waves of an amplitude greater than a certain predetermined value for disabling said repeater for periods corresponding substantially to the actual duration of said components.

6. In a signaling system, a thermionic tube having at least two grids disposed between a cathode and an anode, a radio frequency signal input circuit connected between the cathode and that one of the two grids remote from said cathode, means for rectifying the components of all amplitudes of a portion of the input circuit radio frequency energy and means for continuously impressing upon the grid adjacent to the cathode a biasing potential proportional to the input circuit radio frequency energy and of such a value as to substantially block the flow of electrons between said cathode and said anode only at such times as the input circuit radio frequency energy exceeds a certain predetermined value.

7. Method of reducing the effects of parasitic disturbances in a signaling system, including a circuit the conductivity of which depends upon the maintenance of an electron stream between elements in said system, which comprises impressing static affected signal-bearing radio frequency waves upon said system, continuously rectifying components of all amplitudes of said waves, and utilizing the rectified components thereof to concomitantly vary the conductivity

of said circuit responsive to the receipt of waves of a desired amplitude and to interrupt the conductivity of said circuit for periods corresponding substantially to the actual duration of components having amplitude greater than a predetermined value.

8. Method of reducing the effects of static disturbances in a signaling system, including a control tube the conductivity of which depends upon the maintenance of an electron stream between elements of said tube, which comprises impressing static affected signal-bearing radio frequency waves upon said system, continuously rectifying the components of all amplitudes of at least a portion of said waves, and utilizing the rectified components thereof to concomitantly vary the conductivity of said control tube responsive to the receipt of waves of a desired amplitude and to interrupt the conductivity of said control tube for periods corresponding substantially to the actual duration of components having amplitude greater than a predetermined value.

9. In a signaling system, a normally operative electronic repeater, means for impressing static affected signal-bearing radio frequency waves upon said repeater, means for rectifying at least a portion of all of said radio frequency waves, and means responsive to rectified static components of said waves of an amplitude greater than a predetermined value for disabling said repeater for periods corresponding substantially to the actual duration of said components.

10. The combination in a signaling system of an input circuit responsive to static affected signal-bearing currents, an electronic relay tube including grid, cathode and anode electrodes, means coupling said tube to said input circuit, a two element rectifier, means coupling said rectifier to said input circuit, a resistance traversed solely by rectified currents connected to said rectifier elements, a connection from said resistance to said grid electrode to cause a negative bias to be applied to said grid in proportion to the envelope of normal incoming signal-bearing currents, and to instantaneously bias said grid to substantially interrupt the electronic currents in said relay tube in response to rectified currents in excess of a predetermined value.

11. A method of reducing the effects of static disturbances in a signaling system that includes a controlled tube whereof the conductivity depends upon the maintenance of an electron stream between elements of said tube, which comprises continuously rectifying, independently of a constant applied voltage, all amplitudes of at least a portion of the radio frequency energy being transmitted through the system, applying said rectified energy to produce a voltage drop that is linearly proportional to the amplitude of said energy before rectification, and applying said voltage drop to the electron stream in said tube to interrupt the conductivity of said tube for periods corresponding substantially to the duration of components of said alternating current having amplitude greater than a predetermined value.

12. A method of reducing the effects of static disturbances in a signaling system that includes a controlled tube whereof the conductivity depends upon the maintenance of an electron stream between elements of said tube, which comprises continuously rectifying, independently of a constant applied voltage, all amplitudes of a portion of the radio frequency energy being transmitted through the system, applying said rectified energy to produce a voltage drop that is linearly proportional to the amplitude of said energy before rectification, and applying said voltage drop to the electron stream in said tube to interrupt the conductivity of said tube for periods corresponding substantially to the duration of components of said alternating current having amplitude greater than a predetermined value.

13. A method of reducing the effects of static disturbances in a signaling system that includes a controlled tube whereof the conductivity depends upon the maintenance of an electron stream between elements of said tube, which comprises continuously deriving a rectified current immediately from all the components of at least a half-wave of a carrier frequency alternating current, said rectified current thus having characteristics identical with the utilized portion of said alternating current, applying said rectified current to produce a drop in voltage that is directly proportional to the amplitude of said alternating current, and applying said voltage drop to the electron stream in said tube to interrupt the conductivity of said tube for periods corresponding substantially to the duration of components of said alternating current having amplitude greater than a predetermined value.

14. In a wave-signaling system, a signal-translating radio frequency stage having signal input and output circuits and including a vacuum tube having input and output electrodes and an auxiliary control electrode, sources of operating voltages for said electrodes, said sources being so proportioned that an increase of the operating voltage of said auxiliary electrode beyond its normal value effects a sharp reduction in the gain of the tube, and means comprising a rectifier coupled to said radio frequency input circuit and including a parallel-connected resistor and capacitor in the direct current path thereof for deriving therefrom a biasing potential and for applying the same to said auxiliary electrode, said means having a time constant such that said biasing potential is dependent upon the instantaneous amplitude of the input current, whereby the translation efficiency of the system is sharply reduced when said instantaneous amplitude exceeds a predetermined value.

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