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P. M. HAFFCKE

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MEANS FOR SUPPRESSING NOISE IN RADIO RECEIVERS

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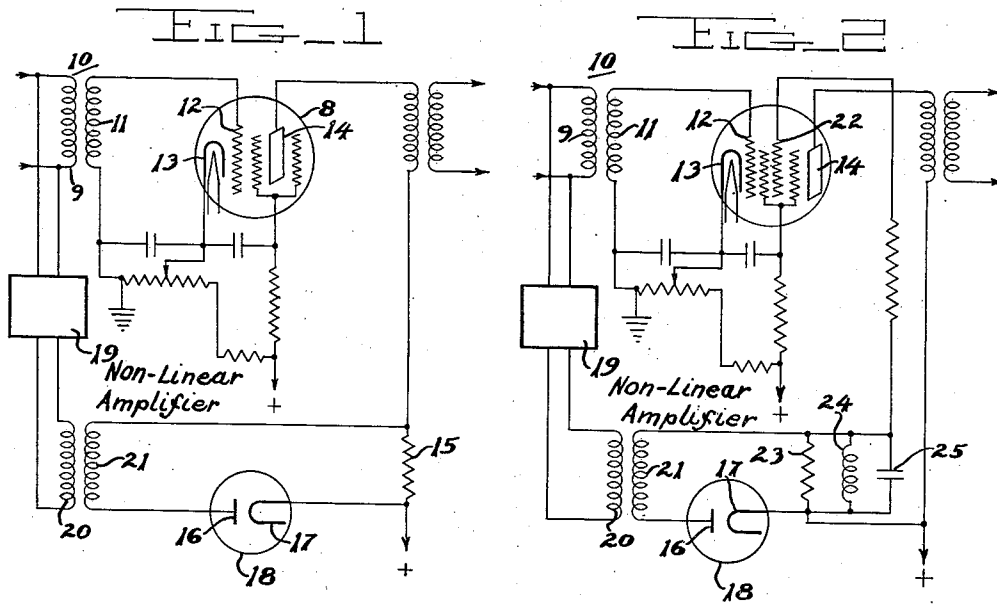


FIG. 3

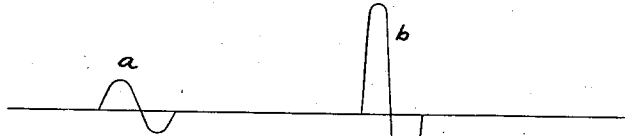


FIG. 4

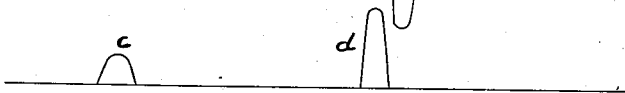


FIG. 5

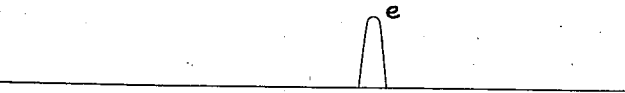


FIG. 6

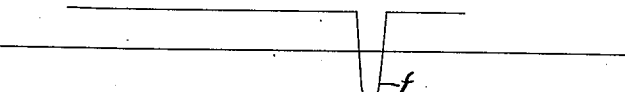


FIG. 7



INVENTOR
Philip M. Haffcke
BY
Robert A. Savander
ATTORNEY

UNITED STATES PATENT OFFICE

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MEANS FOR SUPPRESSING NOISE IN RADIO RECEIVERS

Philip M. Haffcke, Washington, D. C.

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9 Claims. (Cl. 250—20)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention relates to the suppression of noise in radio receivers, such as that due to the phenomenon commonly called static, and has among its several objects:

5 To provide means responsive to excessive surges of energy interceptable by a radio receiver to modify the plate or accelerating grid voltage proportionally to the excess amplitude of the energy and in a manner to offset the effects thereof;

10 To provide means for so modifying the form of the output wave of a receiver stage, in response to static surges, that the static affected portion of the wave is substantially excluded by the following stages;

15 To provide means for controlling the effect of static, which means is simple to apply to existing receivers and does not necessitate realigning of the set;

20 To provide means for effectively reducing the effect of static without causing impulse excitation in the following stages.

In the drawing:

25 Fig. 1 illustrates diagrammatically a circuit embodying my present invention wherein static control is achieved by reducing the plate voltage;

Fig. 2 depicts my invention applied to control the voltage on the accelerating grid of a vacuum tube;

30 Figs. 3 to 7 show various wave forms and amplitudes involved in the practice of the present invention, all of which will be explained in detail hereinafter.

It is known that noise suppression may be effected by applying to a grid immersed in the electron stream, the noise component on a signal channel, whereby the signal circuit is interrupted, or the transconductance of a tube altered. I find that the interruption for the duration of extreme surges may be accomplished by still another means and with the further advantage, that when desired this apparent interruption may be brought about without apparent shock, or rapid change of plate current, which would cause impulse excitation in the following tuned circuits in the output of the stage and in following stages.

Noise control may be effected by interrupting the path between the oscillator and the mixer stage for the oscillator frequency used for heterodyning, or frequency changing, but the connections required for this will require experts for installation who are equipped for rebalancing of the tuning circuits, because such oscillators are usually tuned by a variable condenser which is ganged with the condensers used for tuning the

signal frequency channel, and molesting the circuits of the oscillator throws those circuits badly out of tune by the added capacity afforded by even short lengths of wire.

However, if a tube can be placed in the path of oscillator frequency and be interrupted without requiring such retuning operations, or if any one of the RF (either TRF or IRF) circuits can be broken, or the tubes made inoperative without a rapid change in current flow, then the chances of shock excitation are reduced to a desirable minimum and the chances of reducing the effects of atmospherics without secondary shock effects nearly as bad as the static itself, become a reality.

The system herein proposed provides a method of accomplishing this by reducing the E_p of the stage to be affected, to either a low momentary value, or zero to even slightly negative in periods of excessive surges. By this method of plate voltage control, and by biasing the affected tube to a point where the $E_g - I_p$ is approximately zero during "no signal" periods, there can be very little or no change in the plate current in the output circuits of the tube when interrupting the signal channel. However, if the output of the tube is sharply tuned, its response can be reduced almost to zero due to the peculiar form of the wave delivered thereto.

Referring to Fig. 1, the tube 8 is of standard form and may be in either a tuned radio frequency stage, an intermediate radio frequency stage, an audio-frequency stage, or it may even be a detector. The output of the preceding stage is indicated by primary 9 of transformer whereof the secondary 11 is connected to grid 12 and cathode 13 in the input circuit of tube 8. The plate 14 of tube 8 is connected to a source of positive potential through a series resistance that is also in series with anode 16 and cathode 17 of a diode rectifier 18. Connected to the signal channel ahead of primary 9 is a non-linear amplifier 19 that will disproportionately amplify signal components that are of greater than predetermined amplitude and the output of this amplifier is coupled through primary 20 to secondary 21 in the anode-cathode circuit of rectifier 18. It will be apparent to those skilled in the art that the effect of a normal signal upon rectifier 18 will be negligible but upon the arrival of excessive surges in a static affected signal the rectifier 18 will be caused to pass a large current that will traverse resistance 15 and impress upon plate 14 a voltage drop proportional to the current flowing and in opposition to the constant

positive voltage impressed upon the plate, thereby reducing or even stopping entirely the flow of current in the output circuit of tube 8. It is apparent that the normal plate voltage should be adjusted to such value that the IR drop across resistance 15 will, during excessively heavy surges, completely buck out the normal plate voltage or in some instances actually change that voltage to a negative value. The amplifier 19 may readily be so designed as to cause the rectifier 18 to secure the results mentioned even though the normal plate voltage be of the order of 250 volts or more.

The circuit depicted in Fig. 2 is in general similar to that above described and the elements therein that are common to the two have been designated by the same reference characters. However, the method of control is somewhat different. The grid 22 in this figure is normally maintained at a suitable positive voltage to accelerate the passage of electrons from cathode 13 to plate 14 and is termed an accelerating grid. It will be seen that reducing the positive voltage on grid 22 or changing that voltage from a positive to a negative value will exert a strong controlling influence on the electron stream in the tube and therefore the IR drop due to current from rectifier 18 passing through resistance 23 is applied to oppose the normal positive voltage on accelerating grid 22. Instead of obtaining the entire voltage drop across resistance 23, an inductance 24 having a suitable impedance to cause the desired drop may be used therewith to secure certain beneficial results that follow therefrom, or the resistance 23 may be omitted and the entire drop be secured across the inductive impedance. The inductance 24 may be by-passed by a condenser 25. It is of course understood that all circuit elements are so chosen as to provide the desired time constants in the circuit. The voltage applied to grid 22 will drift from positive values of, say, 1 to 250 volts, to possibly 200 volts negative. When the constant voltage applied to grid 22 is on the order of 25 volts positive it will act as an efficient accelerator of the electrons and allow the tube to reproduce normal signals but when it drifts to a strong negative polarity it will act as a rapid cutoff for the plate current and will create harmonics in the output circuit earlier than might be possible by plate voltage control only when that plate voltage is quite high.

Fig. 3 shows at *a* the wave amplitude of a normal signal and at *b* an assumed amplitude of an excessive surge that might be impressed upon the control grid 12, which excessive amplitude it is desired to suppress.

Fig. 4 shows at *c* and *d* the normal output waves resulting from the incoming waves shown in Fig. 3 when tube 8 is biased to operate at approximately the cutoff point on the E_g-I_p curve, or slightly therebelow so that the negative half of the incoming wave does not affect the output circuit.

Fig. 5 illustrates the IR drop across the resistance 15 due to the output of rectifier 18. It will be observed that the drop due to normal signal amplitude *a* in Fig. 3 is negligible while the drop due to excessive amplitude *b* of Fig. 3 is shown at *e* to have a large value.

Fig. 6 shows the resultant voltage on plate 14 (Fig. 1) or grid 22 (Fig. 2) when the IR drop developed in the rectifier circuit is properly poled and the amplitude of the static surge is very large, the negative value of that voltage being indicated at *f*.

Fig. 7 illustrates the wave in the output of the tube for normal wave amplitudes at *g* and for excessive amplitudes at *h*, when the circuits are properly adjusted. It will be noted that the wave at *g* is unchanged on the positive half while the negative half is suppressed. When an excessive surge arrives the output builds up to normal or, due to a slight time delay in the circuit, a little above the normal value at which time the IR drop produced by the rectifier current is impressed and the amplitude of the output wave drops to zero until the incoming wave again reaches substantially normal value when the output builds up to approximately the amplitude reached before the suppressing action became effective. The fundamental wave is thus chopped into two waves of varying base line length and represents very little power at the fundamental frequency in the output circuit of the stage. If the coupling between the control stage and the one following be tuned, such harmonics will be efficiently filtered out and prevented from passing through the subsequent stages.

The invention herein described and claimed may be used and/or manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, and an anode, and an input circuit operatively associated with said tube, of means to feed signal energy to said input circuit, a non-linear amplifying device outside the signal channel through said receiver connected to said means, a diode rectifier, a resistance in series between the electrodes of said rectifier and also in series in the anode supply of said tube, and means coupling the output of said amplifier to the anode of said rectifier.

2. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, and an anode, and an input circuit operatively associated with said tube, of a non-linear amplifying device outside the signal channel through said receiver connected to divert a portion of the signal energy from said channel ahead of said stage, a diode rectifier, a resistance in series between the electrodes of said rectifier, and also in series in the anode supply of said tube, and means coupling the output of said amplifying device to the anode of said rectifier.

3. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, and an anode, and an input circuit operatively associated with said tube, of a non-linear amplifying device outside the signal channel through said receiver connected to divert a portion of the signal energy from said channel ahead of said stage, a diode rectifier, an impedance in series between the electrodes of said rectifier, and also in series in the anode supply of said tube, and means coupling the output of said amplifying device to the anode of said rectifier.

4. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, an accelerating grid and an anode, and an input circuit including a secondary inductance operatively associated with said tube, of means including a primary inductance coupled to said secondary inductance to feed signal energy to said input circuit, a non-linear amplifying device outside the signal channel through

said receiver connected to said primary, a diode rectifier, a resistance in series between the electrodes of said rectifier, and also in series with said accelerating grid, and means coupling the output of said amplifying device to the anode of said rectifier.

5. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, an accelerating grid and an anode, and an input circuit including a secondary inductance operatively associated with said tube, of means including a primary inductance coupled to said secondary inductance to feed signal energy to said input circuit, a non-linear amplifying device outside the signal channel through said receiver connected to said primary, a diode rectifier, an impedance in series between the electrodes of said rectifier, and also in series with said accelerating grid, and means coupling the output of said amplifying device to the anode of said rectifier.

6. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, an accelerating grid and an anode, and an input circuit operatively associated with said tube, of a non-linear amplifying device outside the signal channel through said receiver connected to divert a portion of the signal energy from said channel ahead of said stage, a diode rectifier, a resistance in series between the electrodes of said rectifier and also in series with said accelerating grid, and means coupling the output of said amplifying device to the anode of said rectifier.

7. The combination with a radio receiver stage that includes a vacuum tube having a cathode, a control grid, an accelerating grid and an anode,

and an input circuit operatively associated with said tube, of a non-linear amplifying device outside the signal channel through said receiver connected to divert a portion of the signal energy from said channel ahead of said stage, a diode rectifier, an impedance in series between the electrodes of said rectifier and also in series with said accelerating grid, and means coupling the output of said amplifying device to the anode of said rectifier.

8. A method of controlling noise in a radio receiver including a signal channel having a vacuum tube that includes a plate electrode, comprising the steps of diverting a portion of the signal energy from the signal channel through the receiver, non-linearly amplifying said portion, applying the resultant amplified portion to produce a unidirectional current when said amplified portion has an amplitude in excess of a predetermined value, utilizing said unidirectional current to produce a potential drop, and applying said drop to reduce the positive bias voltage on the said plate.

9. A method of controlling noise in a radio receiver including a signal channel having a vacuum tube that includes a plate electrode, comprising the steps of diverting a portion of the signal energy from the signal channel through the receiver, non-linearly amplifying said portion, applying the resultant amplified portion to produce a potential drop proportional to the amplitude of said amplified portion above a predetermined value, and applying said potential drop to the said plate to reduce the positive bias on said plate.

PHILIP M. HAFFCKE.