March 28, 1939. W. R. KOCH 2,151,775

REDUCTION OF NOISE

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FIG. 1.

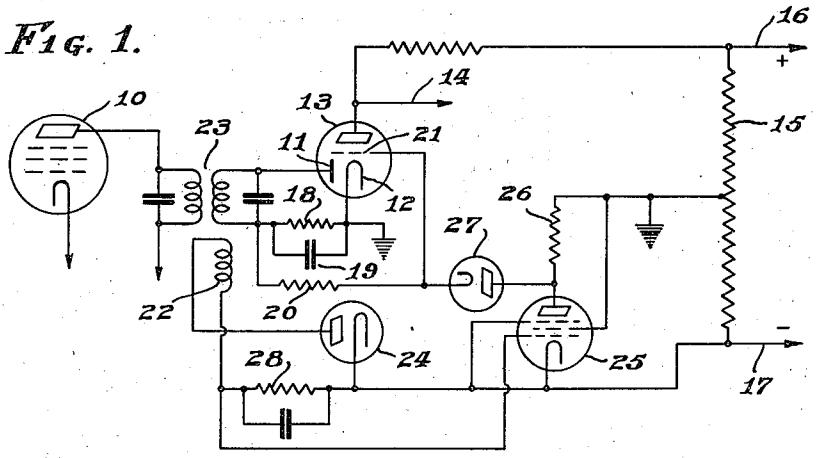


FIG. 2.

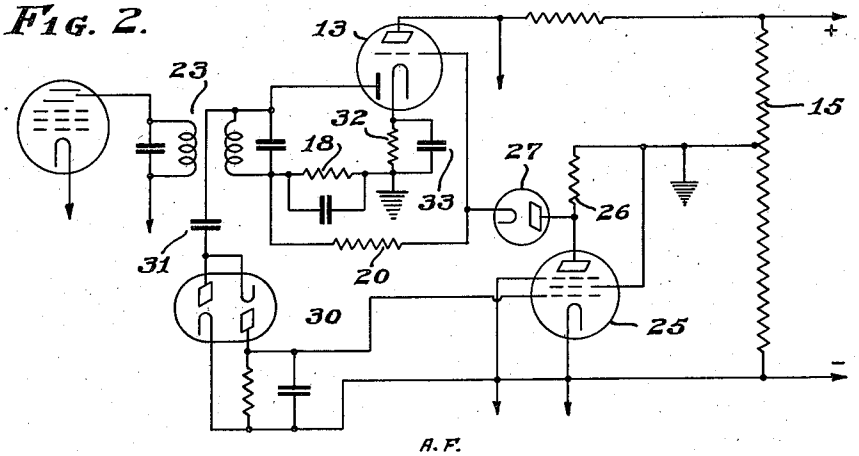
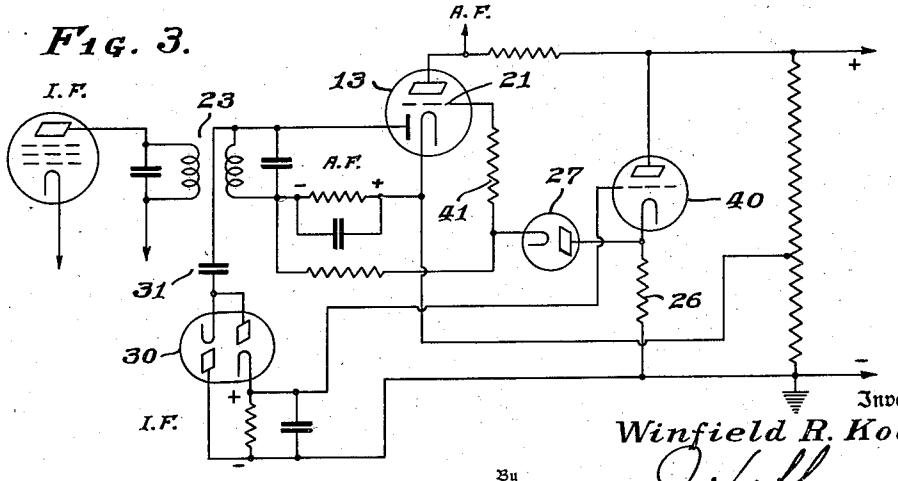


FIG. 3.



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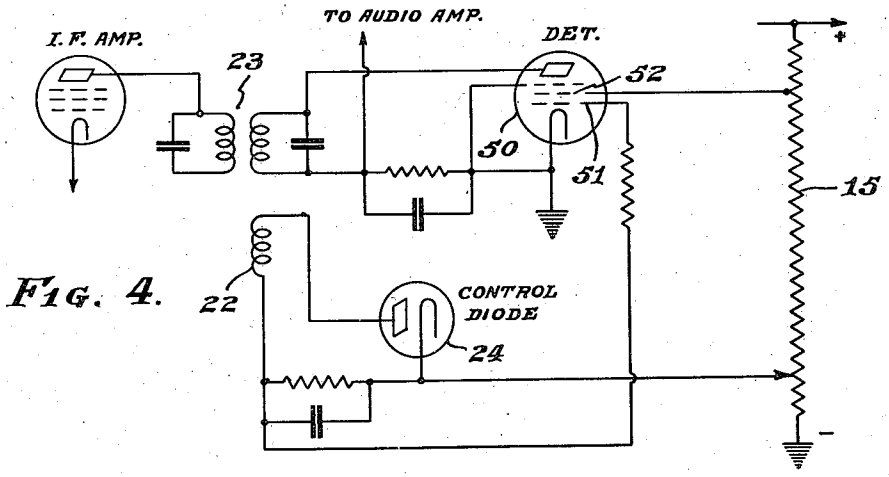


FIG. 4.

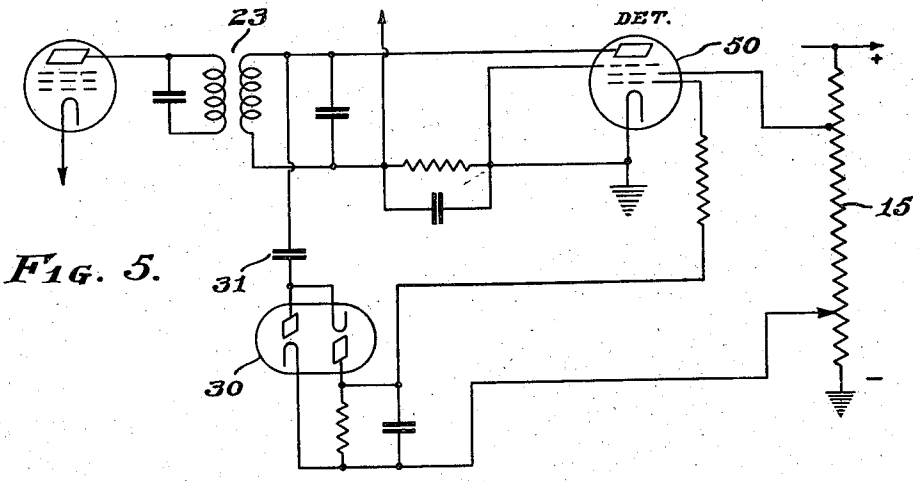


FIG. 5.

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REDUCTION OF NOISE

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Application May 29, 1936, Serial No. 82,417

8 Claims. (Cl. 250—20)

This invention relates to the reduction of noise such as that produced in radio receivers and like apparatus by impulses extraneous to the signal. It has for its principal object the provision of an improved apparatus and method of operation whereby the efficiency of the signal transmitting channel is varied or controlled to prevent the passage of noise impulses having an amplitude substantially in excess of that of the signal.

Various types of noise reduction systems have been heretofore proposed or used. Some of these systems have involved the use of means for balancing or neutralizing the effect of the impulses which tend to produce noise. Others have involved the use of a remotely located antenna, a limiter or peak clipper, special transmission circuits or means for short circuiting, open circuiting or otherwise controlling the transmitting efficiency of the signal channel for the duration of the impulses which tend to produce objectionable noise.

Some of these systems have not been altogether satisfactory for the reason that they are complicated and expensive or are not effective to reduce the noise to a point where it is unobjectionable. In accordance with the present invention, these difficulties are obviated or minimized by the provision of an improved circuit arrangement and method of operation whereby relatively high level noise impulses are caused to impair the transmitting efficiency of a radio receiver detector or are utilized to vary the load of the detector.

The invention will be better understood from the following description when considered in connection with the accompanying drawings, and its scope is indicated by the amended claims.

Referring to the drawings:

Fig. 1 is a wiring diagram of a noise reduction system including a control circuit provided with a pentode electron discharge device which operates in response to relatively high level noise impulses to reduce the control potential of a signal channel diode detector and audio frequency amplifier,

Fig. 2 is a similar wiring diagram which differs from that of Fig. 1 in that grid control potential is applied to the pentode tube through means including a voltage doubler and an impedance device is provided in the detector cathode circuit for more effectively suppressing the noise,

Fig. 3 is a wiring diagram similar to that of Fig. 2, from which it differs in respect to the location of its ground terminal and to the provision of a diode detector amplifier grid resistor for keeping a negative potential on the grid, and

Figs. 4 and 5 are wiring diagrams which are respectively similar in some respects to those of Figs. 1 and 2, but differ therefrom in that the noise suppressing control potential is applied directly to a pentode detector instead of to the detector through a pentode located in a separate control channel.

The system of Fig. 1 includes an intermediate frequency amplifier 10 from which signal impulses are applied to the diode detector electrodes 11—12 of a diode detector and audio amplifier 13. The high potential side of the audio frequency output circuit is indicated at 14, and plate potential for operating the various tubes of the signal and control channels is derived from a resistor 15 connected between the B supply terminals 16 and 17. It will be noted that the diode detector 11—12 is provided with a resistor 18 shunted by a capacitor 19, and with a resistor 20 connected in the circuit of its control grid 21.

The control or noise suppression channel includes a secondary winding 22 associated with the detector input transformer 23, a diode detector 24, a pentode tube 25 arranged to have its grid potential controlled by the output of the diode 24, a resistor 26 connected in the plate circuit of the pentode 25, and a diode 27 interposed between the low voltage terminal of the resistor 26 and the audio frequency amplifier grid 21.

In the absence of noise impulses, signal impulses are detected by the diode 11—12, amplified by the audio frequency amplifier 13 and supplied between the terminal 14 and the ground terminal in the usual manner. So long as the noise impulses are relatively low, the electrodes of the diode 27 are maintained at substantially the same voltage. Rectification is prevented as the impedance of the rectifier is high and no current flows. When the level of the noise impulses becomes relatively high, however, the potential drop of the diode circuit resistor 28 increases, the pentode 25 is biased to cut-off, the potential drop of the resistor 26 decreases, current is transmitted through the diode 27, and the grid 21 effectively shunted to cathode 12 by the relatively low impedance of the path including diode 27 and resistor 26. Under this condition, practically all the voltage of the noise impulse will be dissipated in resistor 20, which is of relatively high resistance, and only a small part of the noise impulse voltage will be impressed on the grid 21. The level at which the suppressor action begins may obviously be controlled by changes in the fixed bias, plate or screen grid voltage of the

pentode 25, by changes in the fixed bias of the diode 24, or by other suitable adjustments of the circuit.

The system of Fig. 2 differs from that of Fig. 1 in that (1) the diode 24 is replaced by a voltage doubling rectifier 30 which is connected through a capacitor 31 to the high voltage secondary terminal of the input transformer 23; and (2) a resistor 32 shunted by a capacitor 33 is connected in the cathode lead of the diode detector audio amplifier 13. As will be readily understood, the voltage doubling rectifier 30 provides a more convenient and more effective control than the diode 24 of Fig. 1, and the cathode lead resistor 32 is effective to control the average potential drop of the resistor 18, so that, for low percentage modulation signals, the noise suppression will be more effective, the surges being repressed in the downward as well as in the upward direction. The operation of the system of Fig. 2 will be readily understood in view of the previous explanation in connection with Fig. 1.

The system of Fig. 3 differs from that of Fig. 2 in that the pentode 25 is replaced by a triode 40, and a resistor 41 is connected in the grid circuit of the diode detector audio frequency amplifier 13 for preventing a positive potential at the grid 21. This system has the advantage that the negative terminal of the B supply circuit is grounded. Its operation is similar to that of the systems of Figs. 1 and 2 and will be readily understood without detailed explanation.

The system of Figs. 4 and 5 are respectively similar to the systems of Figs. 1 and 2, but differ therefrom in that (1) a pentode rectifier 50 instead of a detector diode is utilized; (2) the output potential of control diode 24 is applied to the control grid 51 of the pentode; and (3) the B supply resistor 15 is connected through its high potential terminal to a grid 52.

For large signal voltages the pentode 50 will be biased beyond cut-off and no detection can take place. The level at which the suppression occurs can be controlled by changing the return of the cathode of the diode, by a fixed bias on the control diode 24 or the like. The circuits may be simplified by using combination tubes. For example, the control diode 24 in Fig. 4 may be part of a diode triode with the triode used as an amplifier for audio voltages or as part of a diode pentode used for intermediate or audio frequency amplification.

Particular features may be incorporated in the receiver used with these noise suppression systems. For example, a separate channel amplified A. V. C. may be provided so that the characteristic curve of detector output vs. signal input voltage will fall slightly with increasing applied signal strengths, and the level at the detector will be highest for medium strength signals. Closer suppression will be then obtained with weak or medium strength signals, which is usually desirable. Various modifications of the circuits may be made to use test coils, shunt fed diodes, voltage doubling diodes, and the like.

I claim as my invention:

1. The combination of a signal channel including an electron discharge device provided with input and output circuits, means for controlling the transmitting efficiency of said device in response to a detected audio frequency signal component, a control tube, a diode rectifier connected between said input circuit and the output circuit of said control tube, and means including a diode rectifier for subjecting said control tube to a control potential dependent on a signal component different from that applied to the input circuit of said device.

2. The combination of a signal channel including an electron discharge device provided with input and output circuits, means for controlling the transmitting efficiency of said device in response to a detected audio frequency signal component, a control tube, a diode rectifier connected between said input circuit and the output circuit of said control tube, and means including a voltage doubling rectifier for subjecting said control tube to a control potential dependent on a signal component different from that applied to the input circuit of said device.

3. The combination of a signal channel including an electron discharge demodulator and amplifier device provided with input and output circuits, means for controlling the transmitting efficiency of said device in response to the audio frequency component of a demodulated signal, a control tube having a relatively low resistance output circuit, a diode rectifier connected between said input circuit and the output circuit of said control tube, a relatively high resistance device in circuit between the said input circuit and the diode rectifier, and means including a second rectifier for subjecting said control tube to a control potential dependent on a signal component different from that supplied to the input circuit of said device.

4. The combination in a signal transmission channel, of a signal amplifier device having a signal input circuit and a signal output circuit, a signal rectifier having an output circuit connected with said input circuit to apply thereto biasing and rectified signal potentials resulting from signal rectification, a series resistor in said connection, a rectifier and a second resistor connected in series across said input circuit, said second resistor being of relatively low resistance with respect to the first-named resistor, a second amplifier device having its space path connected through said second-named resistor, said last-named amplifier device having a control grid, and means for subjecting said control grid to a potential dependent on a rectified component of the signal carrier wave.

5. In a signal amplifying channel, the combination of an amplifier device having a signal input circuit and a signal output circuit, means for rectifying a received modulated signal, said last-named means being connected to said input circuit for applying thereto the rectified component of said modulated signal, a series resistor in said connection, a rectifier and a second resistor connected in series across said input circuit, said second resistor having a relatively low resistance with respect to the first-named resistor, and means for applying to said second resistor a potential dependent on a rectified component of the signal carrier wave.

6. In a signal amplifying channel, the combination of an amplifier device having a signal input circuit and a signal output circuit, means for rectifying a received modulated signal, said last-named means being connected to said input circuit for applying thereto the rectified component of said modulated signal, a series resistor in said connection, a rectifier and a second resistor connected in series across said input circuit, said second resistor having a relatively low resistance with respect to the first-named resistor, means for applying to said second resistor a potential dependent on a rectified component of

the signal carrier wave, said last-named means including an amplifier device having a plate circuit including said second resistor, a diode rectifier device having an output circuit connected to said last-named amplifier device to apply a controlling potential thereto, and means for applying a received modulated signal to said last-named rectifier device.

7. The combination with an electron discharge amplifier device having a signal input circuit and a signal output circuit, of a diode modulated signal rectifier having an output circuit connected with said input circuit to apply thereto the modulation and direct current components of a rectified modulated signal, means providing a series impedance in said connection, a diode rectifier device having a cathode connected with said input circuit at the high signal potential side thereof and having an anode electrode connected with the low signal potential side of said input circuit, means providing an impedance in said last-named connection which is relatively low with respect to said first-named impedance means, and means for establishing a potential across said last-named impedance means which varies in accordance with a rectified component of the signal carrier wave.

8. The combination with an electron discharge amplifier device as defined by claim 7, further characterized by the fact that said amplifier device is an audio frequency amplifier and that the first-named rectifier device is the second detector of a superheterodyne receiver.

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