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AMPLIFIER FOR WAVE-FORM SIGNALS

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Fig-1

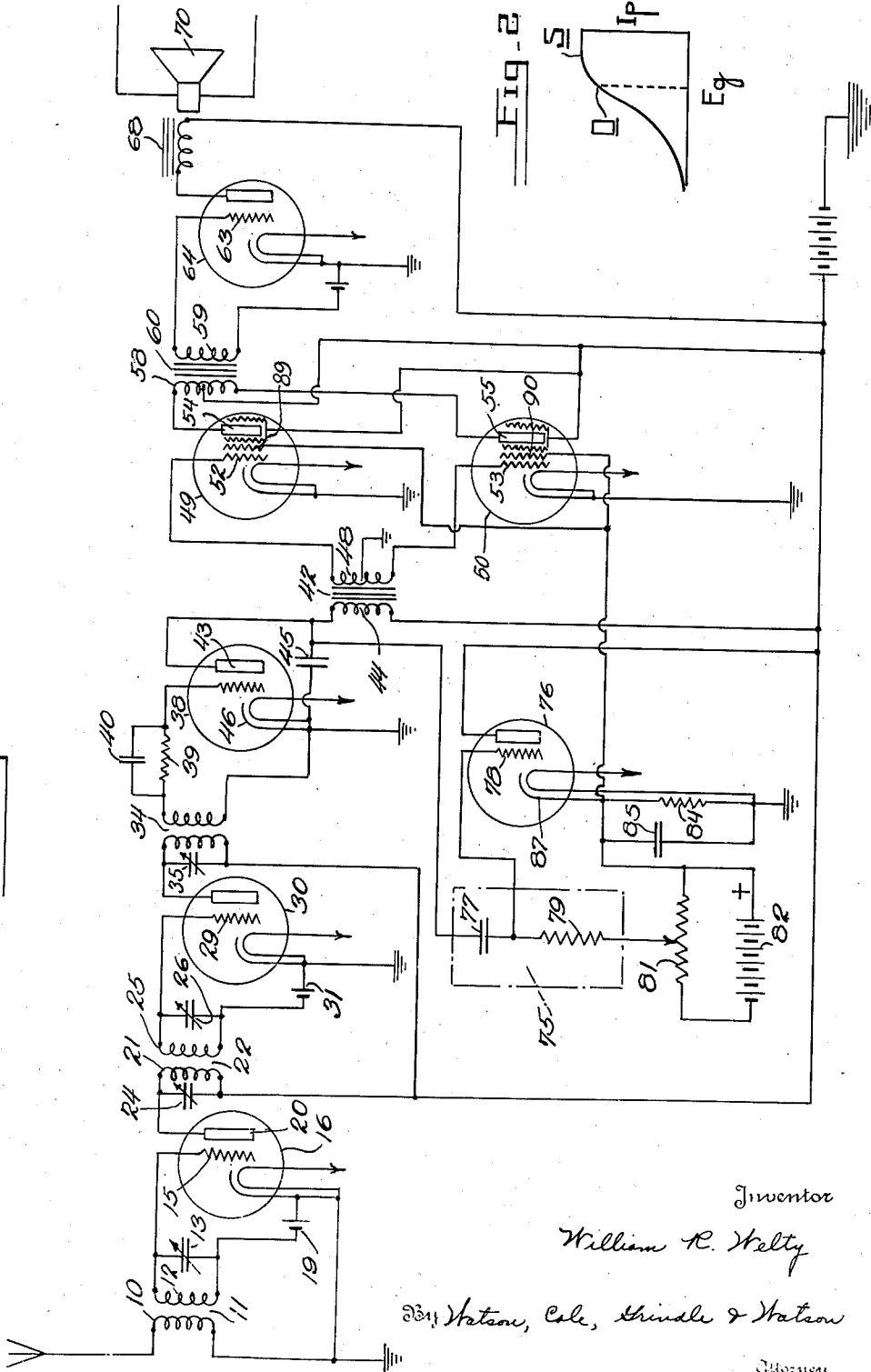


Fig-2

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AMPLIFIER FOR WAVE-FORM SIGNALS

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This invention relates to improvements in apparatus for the reception and amplification of wave-form electrical signals, and is especially concerned with the elimination of disturbances which produce noise and thereby interfere with the reception of the desired signal, for instance the disturbances resulting from static and other electrical discharges.

It has been heretofore proposed to provide control circuits for radio broadcast receivers to effect blocking of the receiver on the arrival of noise impulses, for example as suggested in the patents to Lamb No. 2,101,549 and Burrill No. 2,151,739. However, the control circuits disclosed in these patents are constructed to function in response to a signal which exceeds a predetermined amplitude, and thus may, in the course of reception of signals from different transmitting stations having different field strength, and from stations of comparable field strength which transmit carrier frequencies employing different modulation percentages, act to suppress desired signals in the absence of noise disturbances, provided the received signals exceed the predetermined limit.

It is well recognized that energy resulting from noise disturbances is propagated by waves having sharply sloping wave-fronts. In other words, the rate of change of energy on the arrival of a noise disturbance is quite high, as compared with the rate of change of normally modulated carrier wave signals. Thus it is possible to discriminate between the wanted and the unwanted signals by providing a device which is responsive to rate of change of signal energy, and to apply the output of such a device to the momentary suppression of the receiver.

It is therefore an object of the instant invention to provide, in conjunction with a receiver or amplifier for wave-form signals, a device for differentiating incoming signal energy with respect to time, and to apply the derivative thus obtained to the suppression of the receiver.

More specifically, it is an object of the invention to associate with a receiver for wave-form signals, a differentiating device, and a device energized by the output of said differentiating device, and responsive only when such output exceeds a predetermined minimum, for applying a control bias to the receiver to minimize the disturbance by momentary interruption of the normal functioning of the receiver. Preferably the interval of interruption of transmission or reproduction of signal energy in the receiver is determined by a time-delay device, the interval

being sufficiently short to pass unobserved in the case of audible reproduction of music, speech or the like signals.

Control is preferably applied to the receiver, in the case of reception of modulated carrier wave signals, at the audio frequency amplifier. Thus, in apparatus heretofore proposed for the control and suppression of noise energy, the suppressing signal has been applied to the carrier wave before demodulation, with the result that an audible disturbance, quite annoying to the listener, has been produced. Again, with a view to further reduction of audible disturbance, the control signal is preferably applied in the form of a more positive grid bias to a thermionic amplifier valve which is normally operated near the upper portion of the grid voltage-plate current (E_g-I_p) curve, whereby the variation in current output is materially reduced, and further reduction of noise is made possible.

Further objects and features of the invention will be apparent from the following description taken in connection with the accompanying drawing, in which

Figure 1 is a diagrammatic representation of one form of receiver circuit to which the instant invention may be applied; and

Figure 2 is a curve representing the operating characteristics of a valve to which control is applied.

In order to facilitate an understanding of the invention, reference will be made to the several embodiments thereof illustrated in the accompanying drawing and specific language will be employed. It will nevertheless be understood that various further modifications of the devices illustrated herein, such as would fall within the province of those skilled in the art to construct are contemplated as part of the present invention.

The invention has been illustrated as applied to a simple form of tuned radio frequency receiver, but the application of the invention to other forms of the receiver, for example the superheterodyne receiver, will be obvious.

Thus the incoming signal is fed through primary winding 10 of a transformer 11, the secondary winding 12 of which is broadly tuned to the desired carrier frequency by variable condenser 13. The signal voltage is then applied to the grid 15 of a thermionic valve 16, grid bias voltage being supplied by a source 19. The anode 20 of valve 16 is connected to one end of the primary winding 21 of a transformer 22, tuned by a variable condenser 24. The secondary winding 25 of transformer 22 is tuned by a variable

condenser 26, and applies control voltage to the grid 29 of a thermionic valve 30, grid bias voltage being supplied by a source 31. The output of valve 30 is fed to a transformer 34, the primary winding of which is tuned by a variable condenser 35, the output of transformer 34 being delivered to a thermionic valve 38, which functions as a detector, a grid leak resistance 39 and condenser 40 being employed.

It will be appreciated that the circuit thus far described is entirely conventional; other types of amplification may be employed in lieu of the cascade tuned circuits shown, and other methods of detection or demodulation may be used. The details thus far described constitute in themselves no essential part of the instant invention.

The output of detector valve 38 is applied to an audio frequency transformer 42. Thus anode 43 of valve 38 is connected to one end of the primary winding 44 of the transformer, a bypass condenser 45 being shunted across the anode 43 and the cathode 46 of the valve. Secondary winding 48 of transformer 42 is connected in a push-pull circuit including thermionic valves 49 and 50, the opposite ends of winding 48 being connected to the respective grids 52 and 53 of the valves. The anodes 54 and 55 of the push-pull valves are connected to the opposite ends of the primary winding 58 of transformer 60, the secondary winding 59 delivering voltage to the grid 63 of valve 64; the output of this valve is fed to the output transformer 68, with which is associated a reproducer or speaker 70.

It will again be appreciated that the arrangement just described for the amplification of signal energy following detection is conventional, and may be replaced by other known amplifying units. One method of applying the invention to a receiver or amplifier of the type illustrated will now be described.

Part of the energy output of the detector valve 38 is delivered to a differentiating or derivative taking circuit indicated generally at 75, this circuit being associated with a thermionic valve 76. Thus plate 43 of valve 38 is coupled through a condenser 77 to the grid 78 of valve 76, the grid circuit including a resistance 79 and a source of grid bias potential including a potentiometer 81 in shunt with a bias battery 82.

The value of resistance 79 and the capacity of condenser 77 are quite small, so that the voltage drop across the condenser 77 is far greater than across resistance 79. Accordingly, the voltage applied to grid 78 is substantially proportional to or representative of the derivative with respect to time of the total voltage applied across the derivative taking circuit 75. Other methods of applying to the grid 78 of valve 76 a voltage which is generally representative of the rate of change of incoming signal energy may replace the method chosen for illustration, and are contemplated by the present invention.

The potentiometer 81 is so adjusted that when desired signal energy only is being received, the negative bias on grid 78 of valve 76 is sufficient to block the valve. When, however, signal energy characterized by a sharply sloping wave-front, such as that resulting from static or other electrical disturbance, is impressed on the receiver, the differentiation of the energy effected by circuit 75 results in the application to grid 78 of a much less negative bias, and current flows in the anode circuit of valve 76. It will be observed

that a resistance 84 and a condenser 85 in shunt therewith are interposed between the cathode 87 of valve 76 and the ground, and thus the voltage drop across resistance 84 resulting from the flow of anode current is applied to condenser 85, discharging through the resistance. Cathode 87 is connected to auxiliary control grids 89 and 90 of valves 49 and 50 respectively in the push-pull audio circuit hereinbefore described. Thus when valve 76 responds to the arrival of noise energy, a positive bias, representing the voltage applied to condenser 85, is applied to auxiliary control grids 89 and 90. The interval during which this bias is applied is determined by the characteristics of the time-delay device including the resistance 84 and condenser 85, and is preferably about one-twentieth of a second, and during this interval valves 49 and 50 are blocked, so as to suppress signal energy flowing in the receiver. Normal persistence of hearing is such that suppression of signal energy for such a short period of time is not appreciated by the ear. If the time constant of the time-delay device including the resistance 84 and condenser 85 is too long, the silence is noticeable, and while not as disconcerting as static, may nevertheless be a source of slight irritation. If, on the other hand, the time constant is too short, it will fall within the audible range, and unless all constants are at critical values will produce a decided thump in the speaker.

The preferred method in which the voltage applied to the auxiliary control grids 89 and 90 is employed to silence the receiver is illustrated graphically in Figure 2 of the drawing, which represents the E_g-I_p curve of the valves 49 and 50. The normal operating point is indicated at O, near the upper portion of the curve. When voltage is supplied to the auxiliary grid of the valve, the operating point is displayed approximately to S, which lies on the substantially horizontal portion of the curve, so that the output of the valve is minimized or reduced to zero. Control of the valves in this manner requires considerably less voltage to effect the necessary reduction of output and reduces substantially the variation in plate current of the valves which must be balanced out in transformer 60. Thus if valves 49 and 50 are not identical in characteristics, suppression of the output by displacing the operating point to the lower portion of the E_g-I_p curve inevitably produces a "pop" in the speaker. Since little change in plate current is required, however, to displace the operating point from O to S, noise due to suppression is materially reduced or eliminated.

It is, of course, possible to apply the controlling or suppressing signal otherwise than as specifically disclosed herein, and in the broader aspect of the invention, such further modifications are contemplated.

It is advisable to employ radio frequency circuits in which the direct current resistance from the control grids is relatively low, in order to prevent blocking of the valves due to large incoming disturbances. It is also desirable, in the event automatic volume control is employed, to apply the control voltage to a separate control grid in order that a long time constant may be employed in the volume control circuit without danger of blocking the valve.

It will be appreciated that the foregoing circuit is capable of use in various fields where it is helpful to eliminate undesired energy having a sharply sloping wave front. For example, in

the field of seismic surveying, it can be shown that energy which has traveled through very little soil is characterized by a much steeper wave front than energy which has traveled appreciable distances through the ground. The latter energy, and particularly that which is reflected from strata at considerable depths, is most significant in determining contours, and a circuit of the type shown herein for suppressing signal energy on the arrival of sharply sloping waves can readily be applied to thermionic valve amplifiers of the type commonly used in seismic work, with the result that the less desirable waves are substantially eliminated from the record.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a receiver for wave-form signals, the combination with signal amplifying means, of means for suppressing the output of said amplifying means, and a signal derivative-taking device responsive to noise energy for initiating operation of said last named means.

2. In a receiver for wave-form signals, the combination with signal amplifying means, of means for suppressing the output of said amplifying means, and means for converting incoming energy into a form representative of the rate of change of such energy for energizing said suppressing means.

3. In a receiver for wave-form signals, the combination with signal amplifying means, of means for suppressing the output of said amplifying means, a signal derivative-taking device responsive to noise energy for initiating operation of said last named means, and time-delay means for determining the period of operation of said suppressing means.

4. In a receiver for wave-form signals, the combination with signal amplifying means, of means for suppressing the output of said amplifying means, means for converting incoming energy into a form representative of the rate of change of such energy for energizing said suppressing means, and time-delay means for determining the period of operation of said suppressing means.

5. In a receiver for wave-form signals, the combination with an amplifier for the signals, of means for suppressing signal energy in said amplifier, said last named means comprising a separate path for signal energy, including a signal derivative-taking device.

6. In a receiver for modulated wave-form signals, the combination with means for interrupting the output of said receiver, of means operable on arrival at said receiver of noise energy and responsive to the sharply sloping wave-front of such energy for initiating operation of said interrupting means, said last named means including a signal derivative-taking device.

7. In a receiver for modulated wave-form signals, the combination with means for interrupting the output of said receiver, of means operable on arrival at said receiver of noise energy and responsive to the sharply sloping wave-front of such energy for initiating operation of said interrupting means, said last named means in-

cluding thermionic valve means affording no appreciable response to signal energy below a predetermined amplitude, and a signal derivative-taking device delivering energy to said valve means.

8. In a receiver for modulated wave-form signals, the combination with means for interrupting the output of said receiver, of means operable on arrival at said receiver of noise energy and responsive to the sharply sloping wave-front of such energy for initiating operation of said interrupting means, said last named means including thermionic valve means affording no appreciable response to signal energy below a predetermined amplitude, a signal derivative-taking device delivering energy to said valve means, and time-delay means for determining the interval of interruption of receiver output.

9. In a receiver for modulated wave-form signals, including radio frequency and audio frequency amplifying circuits, the combination with means associated with the audio frequency circuit for interrupting the output of said receiver, of means operable on arrival at said receiver of noise energy and responsive to the sharply sloping wave-front of such energy for initiating operation of said interrupting means, said last named means including a device for differentiating incoming signal energy with respect to time.

10. In a receiver for wave-form signals, the combination with a thermionic valve amplifier, of means for momentarily suppressing the output of said amplifier in response to the arrival of noise energy, said means including a device for electrically differentiating incoming signal energy with respect to time to afford an output representative of rate of change of the energy, of means operable by said differentiated energy and appreciably responsive only to energy above a predetermined level for applying to said amplifier a suppressing grid bias.

11. In a receiver for wave-form signals, the combination with a thermionic valve amplifier, of means for momentarily suppressing the output of said amplifier in response to the arrival of noise energy, said means including a device for electrically differentiating incoming signal energy with respect to time to afford an output representative of rate of change of the energy, of means operable by said differentiated energy and appreciably responsive only to energy above a predetermined level for applying to said amplifier a suppressing grid bias, and means associated with said last named means for determining the suppression interval.

12. A method of treating modulated wave-form signal energy to eliminate static disturbances and the like, which includes the steps of amplifying and reproducing the wave-form energy, taking a derivative of a portion of the energy with respect to time to obtain a signal of increased amplitude on the arrival of noise energy, and applying the signal of increased amplitude to momentarily interrupt the amplification and reproduction of the signal energy.

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