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SIGNAL INTERRUPTING MEANS FOR AUDIOMETERS

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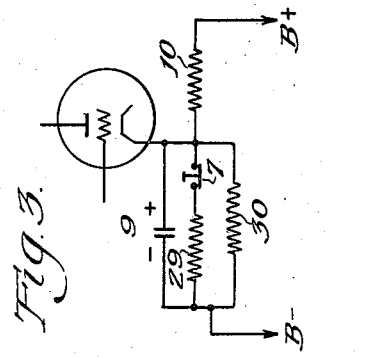


Fig. 3.

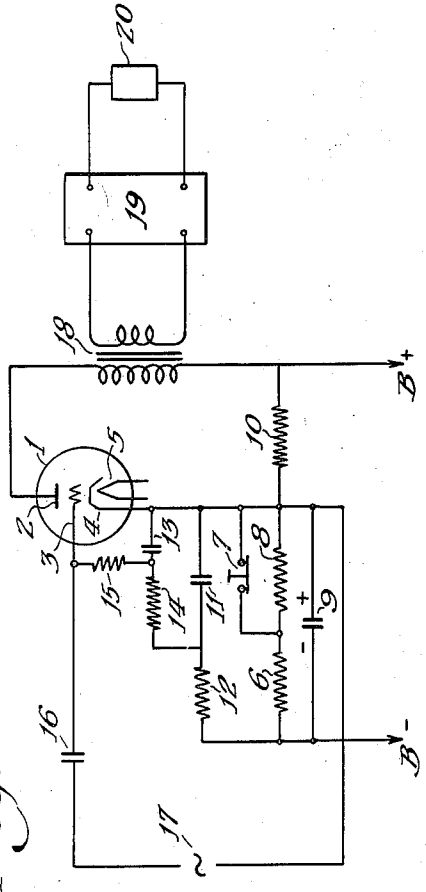


Fig. 1.

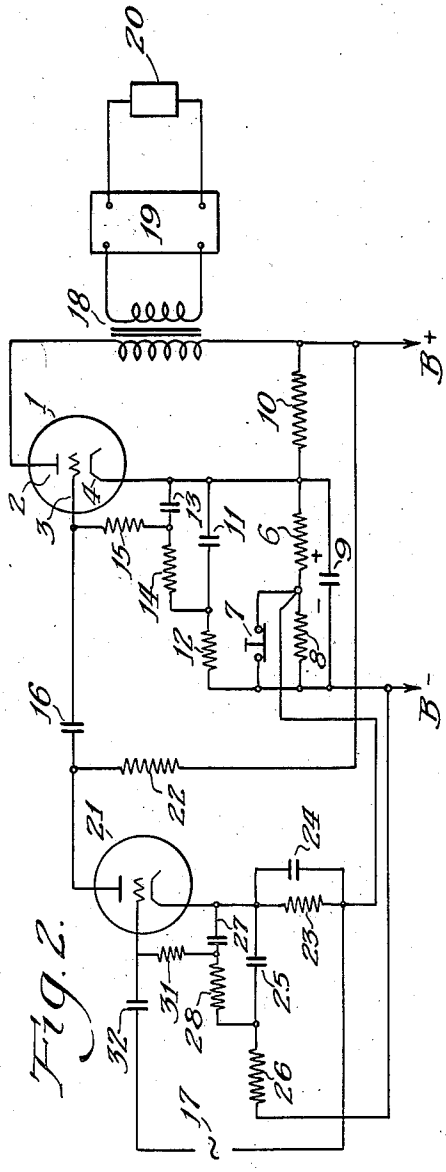


Fig. 2.

Inventor:
Morris Mages,
By: Zabel, Carlson, Fitzhugh & Wells
Attorneys

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SIGNAL INTERRUPTING MEANS FOR AUDIOMETERS

Morris Mages, Chicago, Ill., assignor to V. Mueller & Company, Chicago, Ill., a corporation of Illinois

Application January 26, 1942, Serial No. 428,326

6 Claims. (Cl. 179—1)

This invention particularly relates to the noiseless interruption and noiseless restoration of the signal or sound output of an audiometer. In an audiometer the method of testing consists of generating test tones of various frequencies and determining the loudness level at which the patient hears the tones. In such testing it is very desirable for the operator of the audiometer to be able to cut out the tone and restore it again noiselessly and without any click or other extraneous noises, as a check in determining whether the patient hears or does not hear the test tone at a given loudness level. The absence of any click in the switching process is necessary to avoid confusing the patient and to prevent a patient from guessing as to when the tone is on or off by means of the click. In some cases the click may be pronounced enough to startle the patient or render the testing process uncomfortable.

It has been found through experience that a click is bound to arise from switching whenever the change from a high level to a very low level is made very abruptly as in ordinary switching. It appears that the steep wave front which results from such a process necessarily generates a series of high frequencies which is heard as a click. The only satisfactory method of avoiding a click is to make the transition gradual so as to result in a "fading" out or in of the tone. The method for accomplishing this satisfactorily is the subject of this invention.

A brief description of the method follows. By means of a push button a high negative bias is applied to one of the tubes of the audiometer transmitting the signal, this negative bias voltage being automatically and gradually transmitted to the grid of the controlled tube by the delaying action of a condenser-resistance network. Conversely, when the proper operating grid voltage is restored by releasing the push button, the bias voltage between grid and cathode gradually assumes its normal value as the resistor-condenser network discharges, and the test tone is restored to full intensity.

The method is not limited to the control of one tube. Two or more tubes may be simultaneously controlled by arranging the condenser resistor networks and the circuit for the push button as shown in the drawing. Other modifications of the circuit such as the exact arrangement of the push button circuit, and modifications of the resistor condenser network, will be apparent to one skilled in the art.

Fig. 1 shows the method applied to a single tube placed between the source of signal voltage and the output device;

Fig. 2 shows the method applied to two tubes to make the action more positive; and

Fig. 3 shows a modification of the push button circuit.

Referring to Fig. 1, 1 indicates a triode tube functioning as a transfer tube or output tube in an audiometer. The elements of the tube are a plate 2, a grid 3, and a cathode 4. A filament 5 for heating the cathode is supplied from a transformer or other suitable source. A resistor 6 furnishes the normal grid bias voltage. An interrupter push button 7 shunts the resistor 8. The push button 7 is in a normally closed position for normal transmission of the signal through the tube 1. An electrolytic condenser 9 by-passes the resistors 6 and 8 to prevent ripple voltage from the B supply from being transmitted to the grid of the tube. A resistor 10 normally supplies a portion of the current through the resistor 6. When the push button 7 is operated current flows through both of the resistors 8 and 6 which results in a high voltage being set up between the cathode and B—. The elements 11, 12, 13 and 14 form a two section resistor-condenser network which furnishes the time delay action in response to the action of the push button 7. A resistor 15 and a condenser 16 are the usual grid leak and coupling condenser. The source of signal voltage 17 may be the plate circuit of another amplifier tube or the output terminals of an oscillator. The output of the tube 1 is transmitted through a transformer 18, through an attenuator 19, and then to an output device 20. The source of plate voltage for the tube 1 is indicated by B— and B+. The attenuator 19 may be that shown in my co-pending application, Serial No. 428,325, filed Jan. 26, 1942.

In Fig. 2 a more complete control circuit is shown wherein an additional tube 21 which amplifies the signal voltage 17 is also subject to the "fade out" control by the push button 7. All of the elements identical to Fig. 1 have the same numerical designations. An element 22 denotes a plate resistor for a tube 21. Normal bias is obtained through a resistor 23 and a by-pass condenser 24. Two resistor elements 26, 28 and two condenser elements 25 and 27 form a two section time delay network. Plate voltage for the tube 21 may be obtained from the same source of battery voltage as shown for the tube 1.

Fig. 3 shows a modification of the push button circuit in which the elements are arranged differently although the function is the same. A

resistor 29 is of a value to give the proper operating grid bias for the tube. A resistor 30 is high in resistance compared to the resistor 29. Operating the bush button 7 causes the resistor 30 to be substituted for the resistor 29 as a bias resistor thereby creadting a high bias voltage between the grid and the cathode of the tube.

Referring to the operation of the circuit shown in Fig. 1, the signal voltage 17 is applied to the grid and cathode of the tube through the coupling condenser 16. The actual grid bias is the voltage across the condenser 13. It is evident that after a condition of equilibrium has been reached this voltage will be equal to the voltage drop across the resistor 6 which is determined by the plate current of the tube 1 and the bleeder resistor 10. The tube 1, operating at normal grid bias, amplifies the signal voltage and it is transferred to the output transformer, through the attenuator and finally to the output device. In order to cause the signal to "fade" to inaudibility the push button 7 is pressed down and held open. This brings the resistor 8 into the circuit with the result that a high D. C. voltage is set up across the resistor 8 in series with the resistor 6. The cathode end becomes more highly positive with respect to the B— terminal. The change in voltage, however, takes a definite time to reach the grid of the tube as first the condenser 11 charges up through the resistance 12. As the voltage across the condenser 13 builds up, making the grid more negative with respect to the cathode, the plate current of the tube 1 is gradually brought to cut-off and there is no transfer of the signal voltage through the tube. Conversely, when the push button is released the condenser 11 discharges through the resistance 12 and then the condenser 13 discharges through the resistance 14, giving a gradual build up of the output signal to its normal or preset level. In this manner all trace of any click in the output is avoided either at the "on" or "off" position of the push button. Typical resistance and condenser values for a triode tube are: resistor 6=700 ohms, resistor 8=20,000 ohms, condenser 9=10 mf., resistor 10=250,000 ohms, condenser 11=8 mf., condenser 13=4 mf., resistor 12=50,000 ohms, and resistor 14=50,000 ohms.

In Fig. 2 two tubes are shown controlled by the push button 7. It may be desirable to do this if sufficient cut-off is not obtained by the tube 1 due to transfer of the signal through interelectrode capacities. The functioning of the tube 2 is the same as tube 1. Its normal bias may be made the same as for tube 1 or a tap may be taken off the resistor 8 and the elements 23 and 24 omitted.

In Fig. 3 the resistors furnishing the normal bias voltage and cut-off bias voltage are in parallel instead of in series.

Other modifications of the circuit may be made in the resistor capacity network such as changing the number of sections or altering the form of the network in such manner as would occur to one skilled in the art.

It must be understood that I do not limit myself to the particular type of tube shown, the particular type of resistance condenser network, or the push button circuits shown in this application. The method may even be applied to some other element than the control grid of a tube as for instance the screen grid or suppressor grid of a vacuum tube.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for causing a gradual interruption or restoration of a signal voltage being transmitted through a radio tube, consisting of means operating to cause a change in applied bias voltage to said radio tube, and a time delay network of resistors and condensers interposed between said means and the tube to effect the desired gradation of control.

2. In an audiometer having a load device adapted to produce audible tones of a given frequency in response to an input of electrical energy of said frequency, means for causing a gradual interruption or restoration of the tones, said means including a vacuum tube interposed between the source of energy and the load device, said tube having a cathode, a plate and a grid, means operable to cause a change in applied bias voltage to said grid, and time delay means interposed between the bias changing means and the grid including a network of resistors and condensers acting gradually to transmit the voltage change made by said bias changing means to the grid.

3. In an audiometer having a load device adapted to produce audible tones of a given frequency in response to an input of electrical energy of said frequency, means for causing a gradual interruption or restoration of the tones, said means including a vacuum tube interposed between the source of energy and the load device, said tube having a cathode, a plate and a grid, means operable to cause a change in applied bias voltage to said grid, and time delay means interposed between the bias changing means and the grid including a network of resistors and condensers acting gradually to transmit the voltage change made by said bias changing means to the grid, said bias changing means comprising a series of resistors interposed between the positive and negative voltage source leads for said tube, and a switch shunting one of said resistors.

4. In an audiometer having a load device adapted to produce audible tones of a given frequency in response to an input of electrical energy of said frequency, means for causing a gradual interruption or restoration of the tones, said means including a vacuum tube interposed between the source of energy and the load device, said tube having a cathode, a plate and a grid, means operable to cause a change in applied bias voltage to said grid, and time delay means interposed between the bias changing means and the grid automatically responsive to operation of said bias changing and acting gradually to transmit the voltage change made by said bias changing means to the grid.

5. Apparatus for causing a gradual interruption or restoration of a signal voltage being transmitted through a vacuum tube interposed between a source of energy and a load device, said tube having a cathode, a plate and a grid, means operable to cause a change in applied bias voltage to said grid, and time delay means interposed between the bias changing means and the grid including a network of resistors and condensers acting gradually to transmit the voltage change made by said bias changing means to the grid, said bias changing means comprising a series of resistors interposed between the positive and negative voltage source leads for said tube, two of said resistors forming the grid bias for said tube, and a switch shunting one of said bias resistors, two of the resistors in said series being

in parallel and said switch being in series with only one of said two resistors.

6. Apparatus for causing a gradual interruption or restoration of a signal voltage being transmitted through a vacuum tube interposed between a source of energy and a load device, said tube having a cathode, a plate and a grid, means operable to cause a change in applied bias voltage to said grid, and time delay means interposed between the bias changing means and the grid including a network of resistors and condensers acting gradually to transmit the voltage change made by said bias changing means to the grid, said network consisting of at least one section made up of a resistor and condenser in series, one end of the resistor being connected to a point of negative voltage with respect to the cathode, and one end of the condenser being connected to the cathode, a second section of resistor and condenser connected in shunt with the condenser of the first section, the condenser of the second section forming the connecting element between the cathode and lower end of the grid return path of the above mentioned tube, also bias changing means comprising a series of resistors interposed between the positive and negative voltage source leads for said tube, two of said resistors forming the grid bias for said tube, and a switch shunting one of said bias resistors, two of the resistors in said series being in parallel and said switch being in series with only one of said two resistors.

MORRIS MAGES.