Oct. 24, 1933. S. D. LAVOIE 1,931,664

AUDIO FREQUENCY TRANSMISSION CIRCUITS

Filed Aug. 21, 1930

Fig. 1.

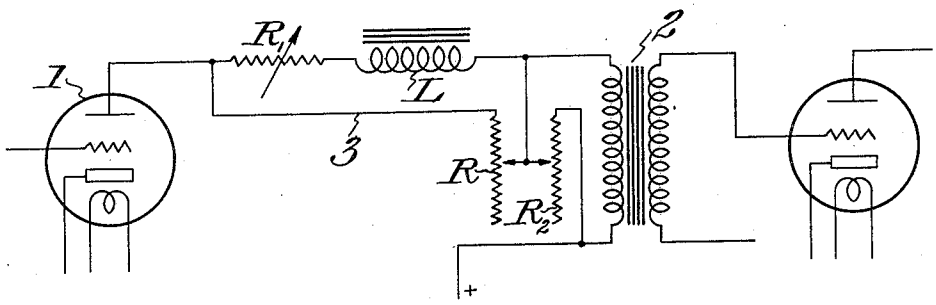


Fig. 2.

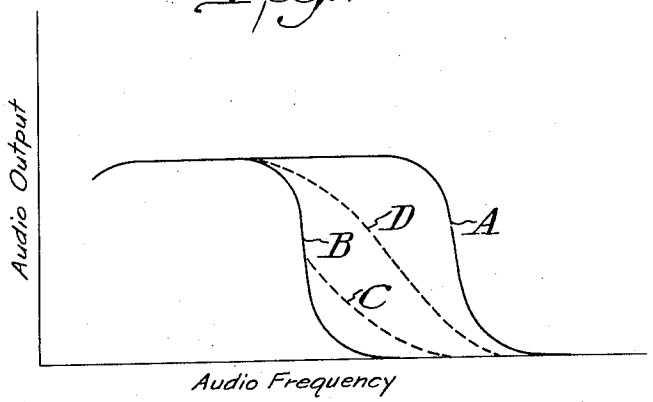
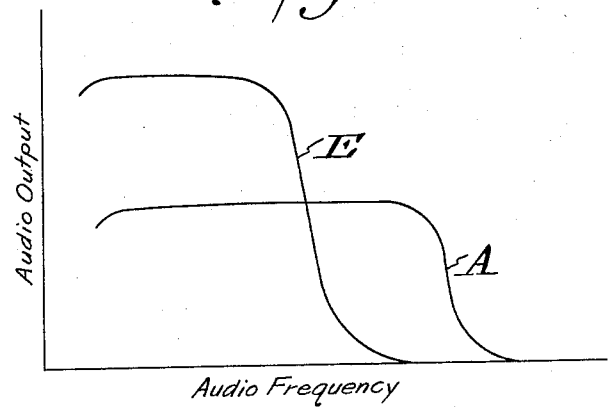


Fig. 3.



Inventor:

Stephen D. Lavoie,

By Byrnes, Townsend & Potter,

Attorneys.

Patented Oct. 24, 1933 1,931,664

UNITED STATES PATENT OFFICE

1,931,664

AUDIO FREQUENCY TRANSMISSION CIRCUITS

Stephen D. Lavoie, Winthrop, Mass., assignor, by mesne assignments, to Radio Corporation of America, New York, N. Y., a corporation of Delaware

Application August 21, 1930. Serial No. 476,847

12 Claims. (Cl. 179—171)

This invention relates to audio frequency transmission circuits and more particularly, to a tone control for regulating the width of the band of frequencies which may be transmitted.

In the electrical transmission of audio frequency signals, for example speech or music, it is evident that all frequencies within the useful audio range should be transmitted with equal gain, if the audio output is to be a faithful reproduction of the audio input. Within recent years considerable work has been done upon the design of audio frequency transformers and audion amplifier circuits, in an effort to secure a substantially uniform gain for all frequencies between 50 or 100 cycles and approximately 5000 cycles. The audio systems included in many commercial radio receivers are of this type and provide for an approximately faithful reproduction of a wide range of audio frequencies. In the absence of local electrical disturbances, which give rise to static noises, audio reproduction of good quality is obtained when receiving strong signals, for example signals from a local broadcasting station. When weak signals are received, however, the increased radio frequency amplification required to secure the desired audio output result in the appearance of static disturbances or of beat notes due to the heterodyning with an adjacent carrier frequency which, in part at least, mask the signal which is being received.

Fortunately, however, these disturbances which frequently appear when weak signals are received are, in general, of relatively high frequency and they may be reduced or eliminated by shifting the upper limit of the band of transmitted frequencies to a lower value. Although this lowering of the cutoff results in some distortion of the desired signal, the net effect is a material improvement in the quality of the audio reproduction since the disturbing noises may be reduced or completely eliminated.

An object of the present invention is to provide an improved tone control for use in an audio frequency transmission line, and particularly in an audio frequency amplifier employing vacuum tubes.

A further object of the invention is to provide a tone control of the type stated which includes adjustable elements for altering either the position or the slope, or both the position and slope, of the upper limit of the transmission-frequency characteristic curve.

These and other objects will be apparent from the following specification taken with the accompanying diagrams in which,

Fig. 1 is a circuit diagram illustrating the invention as applied to an audion amplifier, and

Figs. 2 and 3 are curves of audio output against audio frequency showing results obtained by use of the invention.

Referring to Fig. 1, the inductance L is inserted between an audio frequency amplifying tube 1 and its output transformer 2. The value of the inductance L is chosen to choke out all impulses above a predetermined high frequency. To control the point at which the high frequency impulses are cut out, the inductance L is by-passed by a line 3 which includes a variable resistance R. When the resistance R is all out the inductance L is ineffective. However, by increasing R, more current is forced through the inductance L with a consequent choking out of the high, undesirable frequencies. This resistance has a maximum impedance considerably higher than that of the inductance L, so that when the effective resistance reaches it maximum value, the inductance L will alone determine what high frequencies are passed.

The result accomplished by the invention as described so far, is shown by curves in Fig. 2. The curve A represents the values of audio output to audio frequency with the resistance R all out and the inductance L consequently by-passed by the line 3. As the resistance R is put in the circuit the higher frequencies are choked out by the inductance L and the transmission-frequency curve takes the form B. It can clearly be seen, therefore, that there will be no reception of impulses having higher frequencies than those determined by the curve B.

At times, it is desirable that the high frequency cutoff should not be sharp, as shown by curves A and B. Such a case arises when a particular loud speaker exhibits peaks at some frequencies. Also it is sometimes desirable to let through a few overtones even though accompanied by a sight disturbance. A resistance R_1 connected in series with the inductance L has the effect of changing the shape of the curve. This resistance is variable so that any desired shape may be given to the curve at cutoff. Such flattened curves are C and D as shown in Fig. 2.

Incidental to cutting of the high frequencies by the inductance L and controlling resistance R, there is a loss in output volume. In order to compensate for this loss, a gain-control resistance R_2 is shunted across the transformer 2, to regulate that portion of the load developed

across transformer primary which will be transferred to the succeeding tube. The resistances R and R_2 are coupled for simultaneous operation so that as the resistance R is increased and the output volume for a constant input is consequently decreased, the resistance R_2 is increased with a consequent increase in the gain provided by the transformer.

The result of the above described operation is represented in Fig. 3. The curve A represents the audio output to audio frequency when the inductance L is bypassed by the line 3. As the resistances R and R_2 are simultaneously increased the curve is moved to the left as a result of the higher frequencies being choked out by the inductance L and the curve is moved up as a result of the increased gain effected by the increase of the resistance R_2. As the areas under the curves afford a measure of the output volume, it is clear from Fig. 3, that as the point of frequency cutoff is moved back, the volume may be held approximately constant.

As an example of constants which have been found to be suitable in a circuit such as shown in Fig. 1, and in which the transformer 2 was of a standard commercial design having a relatively flat transmission characteristic, the following data is given for purposes of illustration, but the invention is not to be understood as limited to these particular values:—

L=10–15 henries

R=resistance variable from 0–500,000 ohms

R_1=resistance variable from 0–100,000 ohms

While the invention has been described in connection with an audion amplifier, it will be apparent that the tone control is equally applicable to other forms of audio frequency transmission circuits. The simultaneous control of amplifier gain and of the upper limit of the transmission band may be effected in other ways. For example, in a radio receiver in which the amplification is regulated by the adjustment of a control grid bias, the bias control and resistance R may be coupled mechanically for simultaneous operation.

These and other variations may be made without departing from the spirit of my invention as set forth in the following claims.

I claim:—

1. The combination with an impedance adapted to couple two sections of an audio frequency transmission line, of a composite impedance for controlling the transmission-frequency characteristic of said impedance and line, said composite impedance being in series with one section of said line and comprising a fixed inductance and variable resistor shunted by an adjustable resistance.

2. As a tone control for an audio frequency transmission line, the combination with an audio frequency transformer for coupling two sections of said line, of an inductance and variable resistor in series with the primary of said transformer, and an adjustable resistance shunted across said inductance.

3. As a tone control for an audio frequency transmission line, the combination with an audio frequency transformer for coupling two sections of said line, of a resistance and inductance serially connected with the primary of said transformer, and an adjustable resistance shunted across said first resistance and inductance.

4. In an audion amplifier adapted to transmit a band of audio frequencies, the combination with means for adjusting the width of the band of frequencies which may be transmitted, of means for simultaneously therewith adjusting the gain of said amplifier in a direction opposite to the variation of band width.

5. In an audio frequency amplifier circuit adapted to transmit a band of audio frequencies, the combination with means for adjusting the width of the band of frequencies which may be transmitted, with control means for simultaneously therewith adjusting the gain of said amplifier, said gain control means being arranged to increase the gain as said first means decreases the width of the transmitted band.

6. An audio frequency transmission system of the type having a plurality of electron tubes, said tubes having input and output circuits, and means for tone control, said means including an inductance and resistance in series with one of said output circuits, and means providing a path of adjustable impedance in shunt to said inductance.

7. A transmission system of the type having a plurality of electron tubes, said tubes having input and output circuits, and means for tone control including an inductance and a variable resistance having a maximum impedance greater than that of the inductance in parallel with each other and in series with one of said output circuits, and a variable resistor arranged for operation with the variable resistance.

8. A transmission system of the type having a plurality of electron tubes, said tubes having input and output circuits, means for tone control including a combination comprising an inductance and resistance in series with each other and in parallel with another resistance, said combination being in series with one of said output circuits.

9. An audio frequency transmission system of the type having a plurality of electron tubes, said electron tubes having input and output circuits, means coupling the output circuit of one of said tubes with the input circuit of another one of said tubes, means for tone control in series with said output circuit, and compensating means in parallel with said output circuit to increase the amplification of said system, and means for simultaneously operating the compensating means with the adjustment of said control means in that sense which reduces the width of the band of transmitted frequencies.

10. In combination in an audio frequency transmission network, a tube adapted to have its input electrodes connected to a source of audio frequency modulated electrical waves, a succeeding amplifier tube, an audio frequency transformer having its secondary connected to the amplifier input electrodes, means for controlling the transmission-frequency characteristic of the network connecting the output electrodes of the first tube to the transformer primary, said means comprising a coil connected between the anode of the first tube and one side of the transformer primary, and a variable resistor in shunt with the coil, the maximum impedance of the resistor exceeding that of the coil whereby when the resistor is varied to its maximum value the coil alone determines what high audio frequencies are transmitted to the said amplifier tube.

11. In combination in an audio frequency transmission network, a tube adapted to have its input electrodes connected to a source of

audio frequency modulated electrical waves, a succeeding amplifier tube, an audio frequency transformer having its secondary connected to the amplifier input electrodes, means for controlling the transmission-frequency characteristic of the network connecting the output electrodes of the first tube to the transformer primary, said means comprising a coil connected between the anode of the first tube and one side of the transformer primary, and a variable resistor in shunt with the coil, the maximum impedance of the resistor exceeding that of the coil whereby when the resistor is varied to its maximum value the coil alone determines what high audio frequencies are transmitted to the said amplifier tube and a variable resistor in series with the coil for regulating the sharpness of high audio frequency cut-off by said controlling means.

12. In combination in an audio frequency transmission network, a tube adapted to have its input electrodes connected to a source of audio frequency modulated electrical waves, a succeeding amplifier tube, an audio frequency transformer having its secondary connected to the amplifier input electrodes, means for controlling the transmission-frequency characteristic of the network connecting the output electrodes of the first tube to the transformer primary, said means comprising a coil connected between the anode of the first tube and one side of the transformer primary, and a variable resistor in shunt with the coil, the maximum impedance of the resistor exceeding that of the coil whereby when the resistor is varied to its maximum value the coil alone determines what high audio frequencies are transmitted to the said amplifier tube, and an adjustable resistor, operative simultaneously with said variable resistor, connected to the transformer to compensate for the loss in the output of said amplifier tube when said variable resistor is varied toward said maximum value.

STEPHEN D. LAVOIE.