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M. BROWN

2,411,190

FREQUENCY RESPONSE COMPENSATING MEANS

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*Fig. 1.*

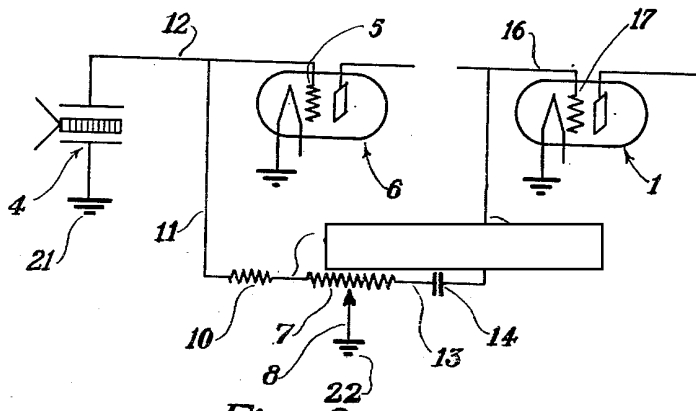


*Fig. 2.*

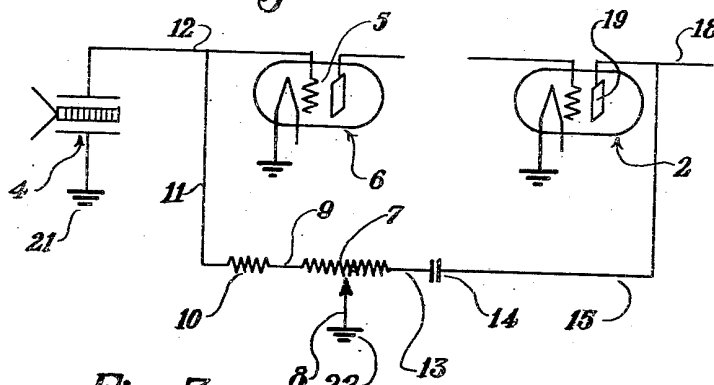


*Fig. 3.*

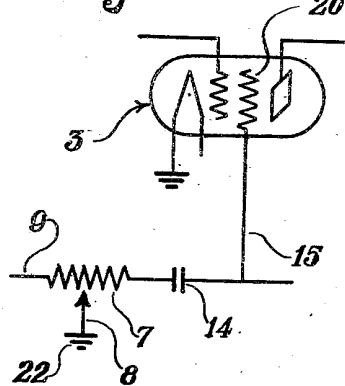
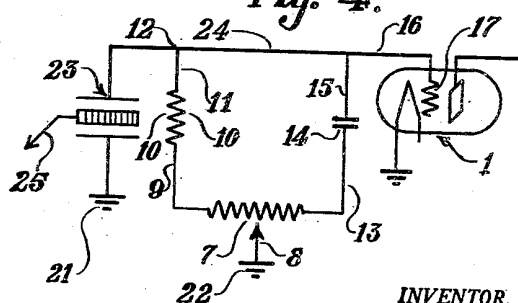


*Fig. 4.*



INVENTOR.  
MARSHALL BROWN  
BY  
Louis A. Bisson,  
ATTY.

## UNITED STATES PATENT OFFICE

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FREQUENCY RESPONSE COMPENSATING  
MEANS

Marshall Brown, Chicago, Ill.

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14 Claims. (Cl. 179—1)

1

The present invention relates to means for adjustably controlling or varying the frequency response of any audio amplifier and more particularly one using a piezoelectric unit such as a piezoelectric or crystal microphone in a hearing aid, or a piezoelectric or crystal phonograph pickup.

People who are hard of hearing have different types of hearing loss and this loss as shown by the audiogram or chart of their threshold of hearing may indicate, in one person, a loss of the high notes of the audio frequency range; in another person, a loss of the low notes thereof; in still another person, a loss in the middle or intermediate frequency; and in still a further person, a straight line loss of all the notes for the extent of the audible range.

Among the objects of the invention is to provide a novel device for adjusting the frequency response so as to give a correction for the particular type of loss desired to be corrected or compensated for and particularly to make a very gradual or very closely controlled adjustment by fine gradations or incremental changes which will be substantially smooth as distinguished from a jump or step adjustment or change.

Other objects, advantages, capabilities, features, or the like are comprehended by the invention as will later appear, or as are inherently possessed by the invention.

Referring briefly to the drawing:

Fig. 1 is a diagrammatic view of my invention shown in connection with a crystal unit and with the compensating means connected to the grid of the input tube and the grid of another audio tube;

Fig. 2 is a similar view with the invention similarly connected as in Fig. 1, except with the compensating means connected to the plate of another audio tube;

Fig. 3 is a partial similar view with the compensating means connected to the screen grid of any audio tube in the circuit;

Fig. 4 is a similar view with the invention used with a piezoelectric or crystal phonograph pickup and has the compensating means connected entirely to the grid of the input tube.

Referring more particularly to the drawing, the embodiments chosen to illustrate the invention are shown in connection with a tube 1 (Fig. 1), or a tube 2 (Fig. 2), or a tube 3 (Fig. 3), and with a crystal microphone 4, the latter being also connected, on the grid side thereof, to the grid 5 of the tube 6. It is to be understood, even though not shown in Fig. 3, that the microphone

2

4 is similarly connected to a tube 6 in the partial diagrammatic showing of Fig. 3.

My invention comprises the use of a potentiometer 7 having an adjustable or sliding contact 8, with the potentiometer connected at an end thereof via conductor 9 to a limiting resistor 10 which, in turn, is connected via conductor 11 to the grid circuit part 12 of the grid 5 and microphone 4, and with the potentiometer connected at the other end thereof via conductor 13 to a condenser 14 and thence via conductor 15 to the grid circuit part 16 of the grid 17 of tube 1 (Fig. 1), or to the plate circuit part 18 of the plate 19 of the tube 2 (Fig. 2), or to the screen grid 20 (Fig. 3). Suitable grounds 21 and 22 are connected to the microphone 4 and the sliding contact 8 for completing the circuit.

Referring more particularly to Fig. 4 the invention is shown in connection with a piezoelectric or crystal phonograph pickup 23 which is connected to ground on one side and via a conductor 12—24—16 to the grid 17 of the tube 1 on the other side. With this conductor is shunted a potentiometer 7 which is connected at an end thereof via conductor 9, a limiting resistor 10, and conductor 11 to the conductor part 12—24; and at the other end thereof via conductor 13, condenser 14, and conductor 15 to the conductor part 24—16. The potentiometer 7 has an adjustable contact or slider 8 connected to ground 22. The pickup 23 may have a stylus or the like 25.

The value of the limiting resistor 10 may be selected to limit the maximum amount of low frequency response cut-off of the microphone 4, or the pickup 23. Adjusting the sliding contact 8 along the potentiometer 7 toward the end thereof connected to the limiting resistor 10 effects a smooth graduated control of reducing or cutting down the low frequency response whereby there is a higher pitch or frequency response at the microphone or pickup, and adjusting the slider 8 along the potentiometer 7 toward the end thereof connected to the condenser 14 effects a smooth graduated control for reducing or cutting down the high frequency response whereby there is a lower pitch or frequency response.

A piezoelectric crystal is a mechanical vibrator electrically equivalent to a series-resonant circuit, and by varying the value of a resistor, or of a condenser, or both, shunted across it, its frequency response is accordingly changed.

While I have herein described and upon the drawing shown a few illustrative embodiments of my invention it is to be understood that the

invention comprehends other constructions, arrangements of parts, details, features, or the like without departing from the spirit of the invention.

Having thus disclosed the invention, I claim:

1. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground.

2. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, said circuit also including a limiting resistor to limit the maximum value of low frequency response cut-off of the unit.

3. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube.

4. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and to an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said microphone, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said tube having a grid and said condenser being connected to said grid.

5. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said tube having a plate and said condenser being connected to said plate.

6. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said tube having a screen grid and said condenser being connected to said screen grid.

7. In a device of the character disclosed and

which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor only connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said circuit also including a limiting resistor to limit the maximum value of low frequency response cut-off of the unit.

8. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said tube having a grid and said condenser being connected to said grid, said circuit also including a limiting resistor to limit the maximum value of low frequency response cut-off of the unit.

9. In a device of the character disclosed and which has a piezoelectric unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said tube having a plate and said condenser being connected to said plate, said circuit also including a limiting resistor to limit the maximum value of low frequency response cut-off of the unit.

10. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and an amplifying tube, the combination therewith of a circuit including a variable resistor connected in shunt with said unit to control the frequency response of said unit, and including an adjustable contact connected to said resistor and to ground, a portion of said resistor being connected in shunt with said unit and the other portion thereof connected with a condenser which is connected to said tube, said tube having a screen grid and said condenser being connected to said screen grid, said circuit also including a limiting resistor to limit the maximum value of low frequency response cut-off of the unit.

11. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and to an amplifying tube, the combination therewith of a connection from said unit to said tube, a circuit including a variable resistor only for shunting said unit to control the frequency response of said unit, and including an adjustable contact which is connected to said resistor and to ground, another portion of said variable resistor being connected to a condenser which is connected to said tube.

12. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and to an amplifying tube, the combination therewith of a connection from said unit to said tube, a circuit including a variable resistor shunting said unit to control the frequency re-

5

sponse of said unit, and including an adjustable contact which is connected to said resistor and to ground, another portion of said variable resistor being connected to a condenser which is connected to said tube, said tube having a grid and said connection being connected to said grid.

13. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and to an amplifying tube, the combination therewith of a connection from said unit to said tube, a circuit including a variable resistor shunting said unit to control the frequency response of said unit, and including an adjustable contact which is connected to said resistor and to ground, another portion of said variable resistor being connected to a condenser which is connected to said tube, said first mentioned portion of said resistor including a limiting resistor to limit the

6

maximum value of low frequency response cut-off of said unit.

14. In a device of the character disclosed and which has a piezoelectric crystal unit connected to ground and to an amplifying tube, the combination therewith of a connection from said unit to said tube, a circuit including a variable resistor only for shunting said unit to control the frequency response of said unit, and including an adjustable contact which is connected to said resistor and to ground, another portion of said variable resistor being connected to a condenser which is connected to said tube, said first mentioned portion of said condenser including a limiting condenser to limit the maximum value of high frequency response cut-off of said unit.

MARSHALL BROWN.