July 5, 1966 T. A. BYLES 3,259,691

SPEAKER CONTROL SYSTEM WITH REVERBERATION

Filed June 29, 1962

FIG. 1

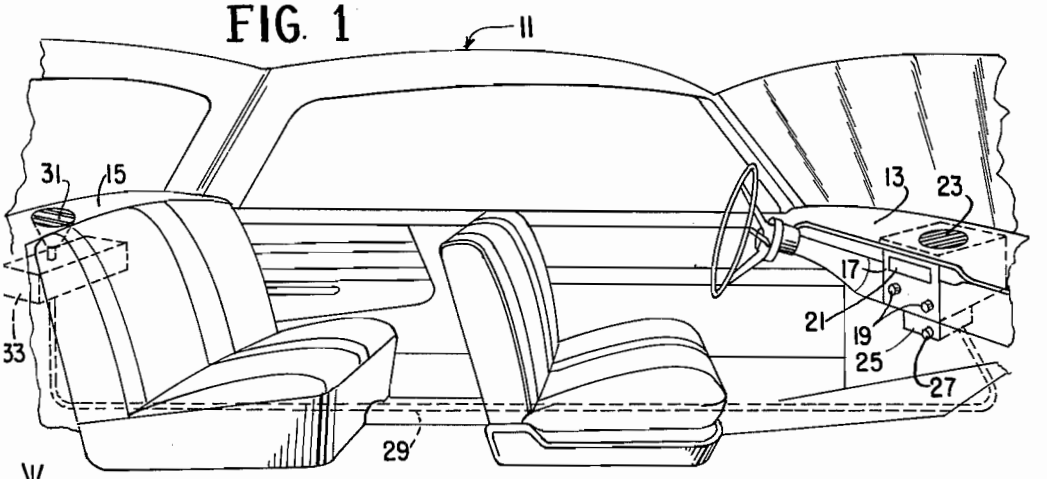


FIG. 2

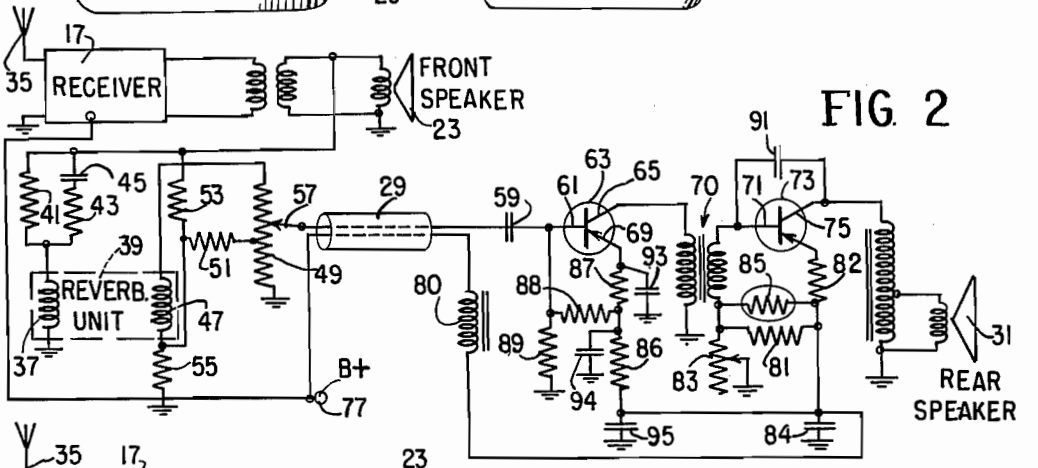
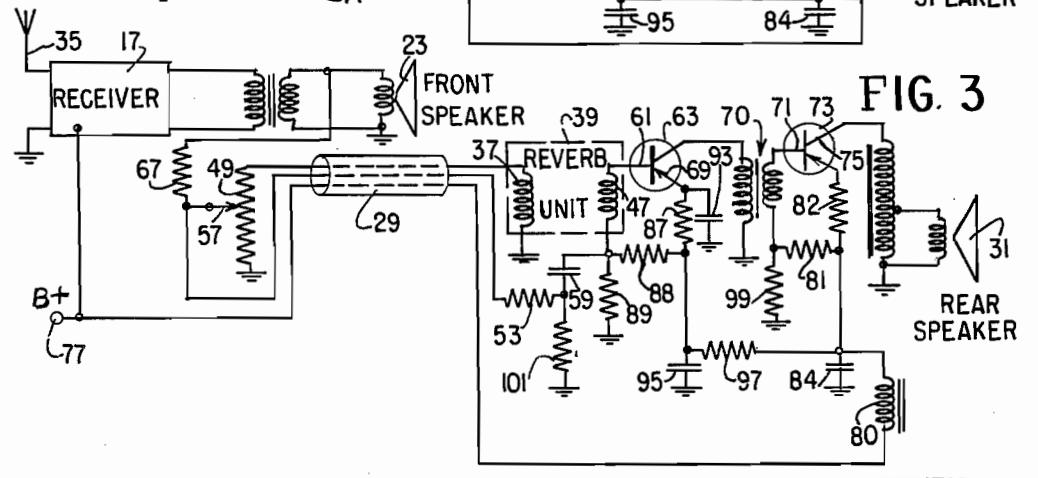


FIG. 3



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SPEAKER CONTROL SYSTEM WITH REVERBERATION

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This invention relates to sound reproduction and more particularly to a sound reproduction system for an automobile.

Sound reproduction in automobiles is beset with a number of difficulties not the least of which is the deadening effect resulting from the smallness of the passenger enclosure. It therefore becomes desirable to attain a subjective enlargement of the enclosure to enhance the quality of the reproduced sound. This may be done by adding a reverberated signal to the reproduced sound, the amount of which depends on the type of audio intelligence being reproduced. For example, human speech should be reproduced with little or no reverberation to insure a clear sharp quality that will be intelligible over engine and road noises. On the other hand, classical music is more faithfully reproduced by adding sufficient reverberated sound to create a concert hall effect.

Many automobile owners add an additional speaker in the rear to permit comfortable volume levels for all passengers in the vehicle. Furthermore, by mounting a speaker in the rear shelf above the trunk, the relatively large trunk space provides excellent baffling for the speaker. It would be desirable to add means for supplying a reverberated signal to the rear speaker at the time it is installed. This would permit the attainment of a subjective enlargement of the enclosure through a simple modification of the additional speaker circuit being installed.

The fact that the reverberated sound emanates from the rear of the listener adds to the realism of the effect since actual reverberation also normally comes from that direction. There should, however, be provision for non-reverberated sound reproduction by the rear speaker as well as the reverberated sound to avoid an overbalance of reverberated sound heard by a rear seat passenger. Further provision should be made for controlling the strength of the reverberated signal so that the system may be regulated according to the type of audio intelligence being reproduced.

Accordingly, an object of the invention is to improve the quality of sound reproduction in automobiles.

Another object of the invention is to provide a simple reverberation system for improving the quality of sound reproduction in automobiles.

Another object of the invention is to provide a low cost effective control for varying the amount of reverberated signals reproduced by an audio reverberation system.

A feature of the invention is the provision, in an automobile having front and rear speakers, of a reverberation system including a pair of circuits connecting an audio signal source to an amplifier for the rear speaker, one of which connects directly, and one of which connects through a reverberation unit.

Another feature of the invention is the provision, in an automobile having the previously mentioned reverberation

system, of a circuit connecting the audio signal source directly to the amplifier for the rear seat speaker, which circuit includes a resistance means and capacitance means in series with the juncture therebetween grounded through a resistor.

Another feature of the invention is the provision, in an audio reverberation system, of a control for varying the amount of reverberated and non-reverberated signal reproduced, which control includes a resistor with a variable tap, one end of the resistor being connected to the reverberation unit and the other end being connected directly to the audio signal source, and with the variable tap being connected to an amplifier.

In a particular form of the invention an automobile is provided with an audio signal source located in the dashboard, and a speaker connected to the audio signal source, also located in the dashboard. A second speaker is provided in the rear of the automobile and a driving amplifier for the second speaker is also provided in the rear of the automobile. A pair of circuits connect the audio signal source to the amplifier, one circuit containing a reverberation unit, so that both direct and reverberated signals are supplied to the rear seat speaker system. A control is mounted in the dashboard of the automobile for regulating the amount of reverberated signal applied to the driving amplifier for the rear speaker. Thus, the amount of reverberated and unreverberated sound reproduced in the automobile may be conveniently and easily regulated.

In the drawings:

FIG. 1 is a partial view of an automobile having the invention incorporated therein;

FIG. 2 is a schematic diagram of a circuit used in connection with the invention; and

FIG. 3 is a schematic diagram of an alternative circuit.

Referring now to FIG. 1, the interior of an automobile **11** is shown including a dashboard **13** and a rear shelf **15**. A conventional radio receiver **17** is mounted in dashboard **13** so that controls **19** are accessible and so that dial **21** is visible. A front speaker **23** is mounted in the dashboard for reproducing signals received by receiver **17**. Component enclosure **25** is mounted to receiver **17** under dashboard **13**, and is provided with a control **27**.

The various elements of the system of the invention that are located in the rear of automobile **11** are connected to the elements located in the front of the automobile by means of a shielded cable **29** which is run under the floor boards of automobile **11**. Rear speaker **31** is mounted in shelf **15**, and a component enclosure **33** is mounted under shelf **15** in the trunk of the automobile **11**.

In FIG. 2 a circuit used in connection with the invention is depicted schematically. Receiver **17**, having an antenna **35** which may be mounted in any convenient location on the exterior of automobile **11**, is coupled to front speaker **23**. A portion of the receiver signal output appears across the drive coil **37** of reverberation unit **39** by means of resistor **41** connected in parallel with resistor **43** and capacitor **45**. The output coil **47** of reverberation unit **39** is connected through resistor **51** across the upper portion of a variable resistor **49**.

A circuit for bypassing reverberation unit **39** is also provided. Resistor **53** is connected in series from the output of receiver **17** to resistor **55**, which is connected through resistor **51** across the lower portion of variable resistor **49**.

A variable tap 57 is connected through capacitor 59 from resistor 49 to the base electrode 61 of transistor 63. Collector electrode 65 of transistor 63 is coupled through transformer 70 to the base electrode 71 of transistor 73. Transistor 73 is forward biased by collecting a B+ supply 77 through shielded cable 29 and choke 80 to a bias network including resistors 81 and 82, variable resistor 83 and capacitor 84. Thermistor 85 is included in the bias circuit for temperature compensation. A capacitor 91 is connected across the base electrode 71 and collector electrode 75 of transistor 73. Forward bias for transistor 63 is provided by connecting the source of B+ potential 77 to a bias network including resistor 86, 87, 88 and 89 and capacitors 93, 94 and 95. Collector electrode 75 of transistor 73 is connected to drive speaker 31. Capacitor 59 is provided to isolate the resistor 49 from the D.C. bias for transistors 63 and 73, thereby preventing the bias from being upset as the variable tap is moved.

Transistors 63 and 73 may be mounted in component enclosure 33 (FIG. 1) and connected to the variable tap 57 located in enclosure 25 through shielded cable 29. Variable tap 57 is controlled by knob 27 and the reverberation unit and associated circuits are also contained in enclosure 25.

In operation, signals from receiver 17 are divided, a portion of which are reverberated and a portion of which bypass the reverberation unit 39. The unreverberated signal appears across the lower part of resistor 49 whereas the reverberated signal appears across only that portion of resistor 49 above the connection of resistor 51. As variable tap 57 is moved from the grounded end of resistor 49 up to resistor 51, the strength of unreverberated signal increases. As variable tap 57 is moved into that portion of resistor 49 above resistor 51, the unreverberated signal may remain the same or slightly decrease while the strength of the reverberated signal increases reaching a maximum when variable tap 57 is at the top of resistor 49.

In FIG. 3 an alternative circuit is shown. In this particular arrangement resistor 49 and variable tap 57 are placed ahead of reverberation unit 39 so that reverberation unit 39 would be mounted in enclosure 33 (FIG. 1) along with transistors 63 and 73, and would be connected to the front elements of the system through shielded cable 29. Bias for transistor 73 is provided by connecting B+ source 77 through choke 80 to a bias network including resistors 87, 82 and 99, and capacitor 84. B+ is also connected through resistor 97 to a bias network for transistor 63, which includes resistors 87, 88 and 89, and capacitors 93 and 95. Output signals from receiver 17 are applied to variable tap 57 through resistor 67. A bypass circuit, including resistor 53 and capacitor 59, is provided to bypass reverberation unit 39, and this circuit applies an unreverberated signal across the base 61 and emitter 69 of transistor 63. The juncture between resistor 53 and capacitor 59 is grounded through resistor 101. Resistor 49 is connected across the drive coil 37 of reverberation unit 39.

When variable tap 57 is near the grounded end of resistor 49, most or all of the receiver signal will be shunted to ground. As variable tap 57 is moved upward along resistor 49, the unreverberated signal appearing across the base 61 and emitter 69 of transistor 63, will increase, then level off, and finally, as variable tap 57 reaches the top of resistor 49, decrease slightly as drive coil 37 tends to shunt resistor 51 and capacitor 59 to ground. On the other hand, as variable tap 57 is moved along resistor 49 in the described manner, the level of reverberated signal appearing at the transistor 63 will steadily increase.

When the described circuits were provided with components of the following values, satisfactory results were obtained.

Fig. 2

Resistor 41	33 ohms.
Resistor 43	10 ohms.
Capacitor 45	5 mmf.
Resistor 51	1K ohms.
Resistor 53	10K ohms.
Resistor 55	10 ohms.
Resistor 49	10K ohms (two K of which are below the connection of resistor 51 and eight K of which are above).

Fig. 3

Resistor 67	12 ohms.
Resistor 53	4700 ohms.
Capacitor 59	.1 mf.
Resistor 101	10 ohms.

It may therefore be seen that the invention provides a controlled reverberation system for improving the reproduction of sound in an automobile, which system is low in cost and simple of construction.

I claim:

1. A reverberation system for sound reproduction in an automobile having a dashboard and a rear interior portion, said system including in combination, an audio signal source and a first speaker connected thereto for mounting in the dashboard, a second speaker and a driving amplifier coupled thereto for mounting in the rear interior portion of the automobile, reverberation means for producing a delayed signal of decaying amplitude, a first circuit connecting said audio signal source directly to said amplifier and coupling audio signals directly thereto, a second circuit connecting said audio signal source to said amplifier through said reverberation means and coupling delayed audio signals of decaying amplitude to said amplifier, cable means for carrying portions of said first and second circuits from the dashboard to the rear interior portion of the automobile, and a control connected in said first and second circuits to permit variation in the strength of the signal therethrough, whereby when said system is installed in an automobile, the controlled direct and reverberated audio output of said first and second speakers may provide faithful and intelligible reproduced sound to occupants of the automobile for all forms of audio intelligence.

2. A sound reproduction system for use in an enclosure having front and rear interior portions, said sound reproduction system including in combination, an audio signal supply means, a first speaker mounted in the front interior portion and connected to said audio signal supply means, a second speaker mounted in the rear interior portion of the enclosure, an amplifier coupled to said second speaker for driving the same, reverberation means for producing a delayed signal of decaying amplitude, a first circuit connecting said audio signal supply means directly to said amplifier and coupling audio signals directly thereto, a second circuit connecting said audio signal supply means to said amplifier through said reverberation means and coupling delayed audio signals of decaying amplitude to said amplifier and a control proximate to the front interior portion and connected in both said first and second circuits for varying the strength of the signals therethrough, whereby the direct and reverberated audio outputs of said first and second speakers reproduced as sound in the enclosure can be controlled for different forms of audio intelligence.

3. In an enclosure having front and rear interior portions, a sound reproduction system including in combination, an audio signal source, a first speaker mounted in the front interior portion and connected to said audio signal source, a second speaker mounted in the rear interior portion of the enclosure, an amplifier coupled to said second speaker for driving the same, reverberation means for producing a delayed signal of decaying amplitude, a first circuit including first resistance means and

capacitance means in series and second resistance means connecting the juncture therebetween to a reference potential, said first circuit connecting said audio signal source directly to said amplifier and coupling audio signals directly thereto, a second circuit connecting said audio signal source to said amplifier through said reverberation means and coupling delayed audio signals of decaying amplitude to said amplifier, and a potentiometer mounted in said front interior portion and connected in said first and second circuits for controlling the strength of the signal therethrough, whereby the direct and reverberated audio outputs of said first and second speakers reproduced as sound to occupants of the enclosure can be controlled for all forms of audio intelligence.

4. In an automobile having a dashboard and a rear interior portion, a sound reproduction system including in combination, an audio signal source mounted in the dashboard, a first speaker mounted in the dashboard and connected to said audio signal source, a second speaker mounted in the rear interior portion of the automobile, an amplifier coupled with said second speaker for driving the same, said amplifier having a first stage and a bias circuit therefor, reverberation means for producing a delayed signal of decaying amplitude, a first circuit including a first resistor and a capacitor in series and a second resistor connecting the juuncture therebetween to a reference potential, said first circuit connecting said audio signal source directly to said first stage of said amplifier without appreciably affecting the bias circuit therefor, a second circuit connecting said audio signal source to said amplifier through said revermberation means, and a potentiometer mounted at the dashboard and connected in said first and second circuits for controlling the strength of the signal therethrough, whereby the direct and reverberated audio outputs of said first and second speakers can be controlled for all forms of audio intelligence.

5. In an automobile having a dashboard and a rear interior portion, a sound reproduction system including in combination, an audio signal source mounted in the dashboard, a first speaker mounted in the dashboard and connected to said audio signal source, a second speaker mounted in the rear interior portion of the automobile, an amplifier coupled with said second speaker for driving the same, said amplifier having a first transistor stage with base and emitter and collector portions, said amplifier further having a bias circuit for said first transistor stage including first resistance means connected across the base and emitter portions thereof, reverberation means for producing a delayed signal of decaying amplitude, a first circuit including second resistance means and capacitance means in series and third resistance means connecting the juncture therebetween to a reference potential, said first circuit connecting said audio signal source directly to said base portion of said first transistor stage of said amplifier, and a second circuit connecting said audio signal source to said amplifier through said reverberation means, and a potentiometer mounted in said dashboard and connected in said first and second circuits for controlling the strength of the signals therethrough.

6. An automotive sound reproduction system operative in two modes for both producing substantially unreverberated sound and reverberated sound, said system being operative in an automobile having a source of sound signals and a first speaker for reproducing signals therefrom and positioned in a given location within the automobile, said system including in combination, a second speaker adapted to be positioned in the automobile spaced from the first speaker, reverberation means for producing a delayed signal of decaying amplitude, control means adapted to be connected to the source of sound signals and manually operable to select a reverberative or non-reverberative mode of system operation and including variable resistor means, signal coupling circuit means connected to said manual control means and to said second speaker for applying signals from the source of sound signals to said second speaker independently of said reverberation means in response to operation of said control means to select the non-reverberative mode, said variable resistor means providing a volume control for the unreverberated sound produced by said second speaker, said signal coupling circuit means including a signal path in shunt with said reverberation means and a signal path serially connecting said control means through said reverberation means to said second speaker in response to operation of said control means to select the reverberative mode for applying signals from the source of sound signals to said second speaker, so that both reverberative and non-reverberative signals are simultaneously reproduced by said second speaker and said variable resistor means provides volume control of the sound therefrom.

7. An automotive sound reproduction system operative in two modes for both producing substantially unreverberated sound and reverberated sound in an automobile, said system being operative in an automobile having a source of sound signals and a front speaker for reproducing signals therefrom and positioned within the automobile toward the front thereof, said system including in combination, a rear speaker adapted to be positioned within the automobile toward the rear thereof, a reverberation device for producing a delayed signal of decaying amplitude, control means adapted to be connected to the source of sound signals and manually operable to select a reverberative or non-reverberative mode of system operation, said control means including a variable resistor element positioned toward the front of the automobile, signal coupling circuit means including a signal amplifier and a cable extending between the front and rear of the automobile, said signal coupling circuit means having a first portion connected to said control means and to said rear speaker for applying signals from the source of sound signals to said rear speaker so that said variable resistor element provides a volume control for the unreverberated sound produced by said rear speaker, said signal coupling circuit means further having a second portion serially connecting said control means through said reverberation device and said signal amplifier to said rear speaker for applying signals from the source of sound signals to said rear speaker, said signal coupling circuit means including a signal path in shunt with said reverberation device with the second portion of said circuit means translating signals so that both reverberative and non-reverberative signals are simultaneously reproduced by said rear speaker and said variable resistor means provides volume control thereof for said rear speaker.

8. An automotive sound reproduction system operative for producing both substantially unreverberated sound and reverberated sound, said system being operative in an automobile having a source of sound signals and a first speaker for reproducing signals therefrom, said system including in combination, reverberation means for producing a delayed signal of decaying amplitude, control means manually operable to select a reverberative or non-reverberative mode of system operation and including variable resistor means, housing means enclosing said reverberation means and said control means and adapted to be mounted adjacent the location of the source of sound signals, a transistorized amplifier, a second speaker connected to said amplifier to reproduce signals translated thereby, an input circuit adapted to be connected to the source of sound signals, said circuit interconnecting said control means, said reverberation means and said amplifier so that variation of said resistor means controls the amount of delayed decayed signals applied to said amplifier, said circuit including a portion connected in shunt with said reverberation means for applying unreverberated signals through said amplifier to said second speaker so that the sound therefrom is partly reverberated and

partly unreverberated, and said control means being operable to a position for substantially eliminating reverberated sound output from said second speaker.

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