Jan. 24, 1967 A. R. MIKELEVICIUS 3,300,583

AUTOMOBILE SPEAKER SYSTEM WITH REVERBERATION

Filed May 13, 1963 2 Sheets-Sheet 1

FIG. 1

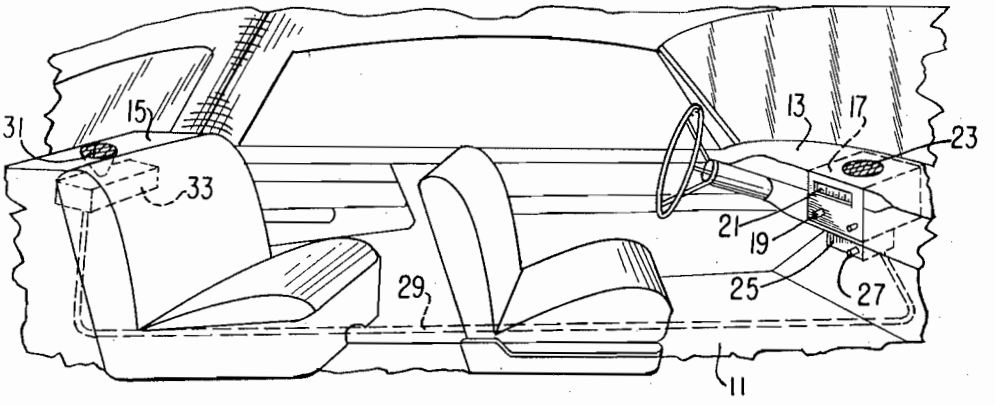


FIG. 4

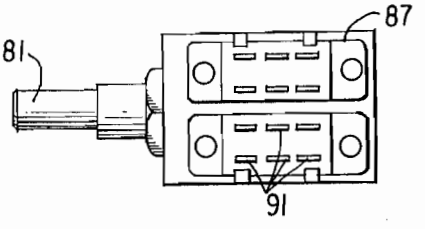
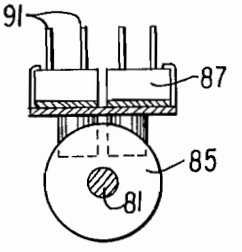


FIG. 6



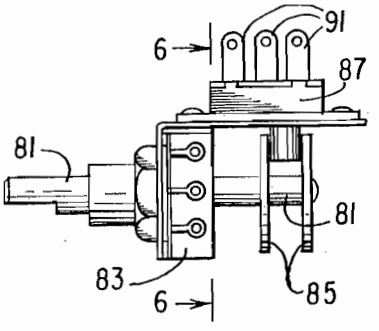


FIG. 5

INVENTOR.
Anthony R. Mikelevicius.
BY
Mueller & Nichols
Attys.

Jan. 24, 1967 A. R. MIKELEVICIUS 3,300,583

AUTOMOBILE SPEAKER SYSTEM WITH REVERBERATION

Filed May 13, 1963 2 Sheets-Sheet 2

FIG. 2

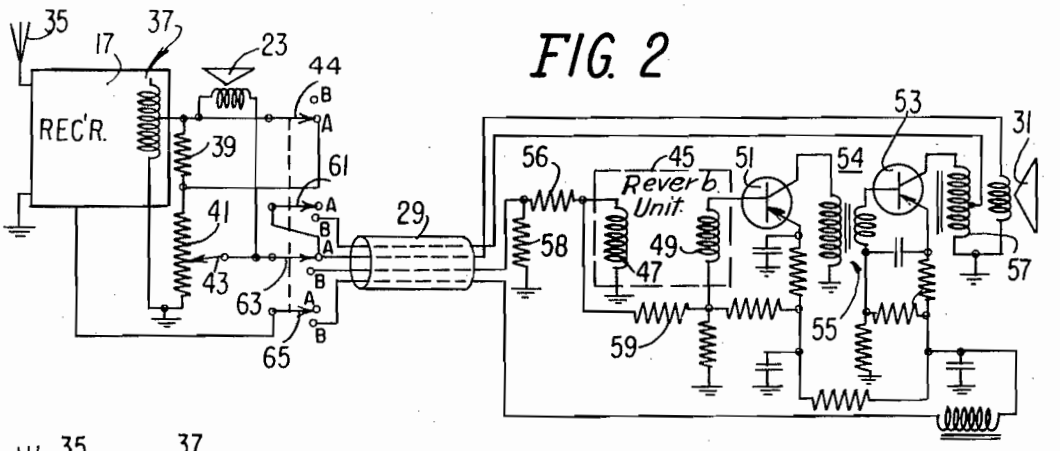


FIG. 3

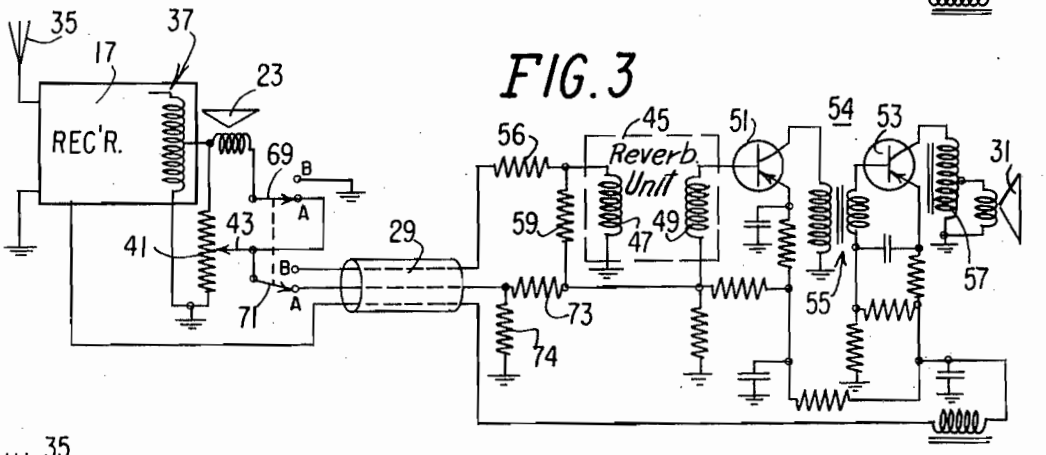
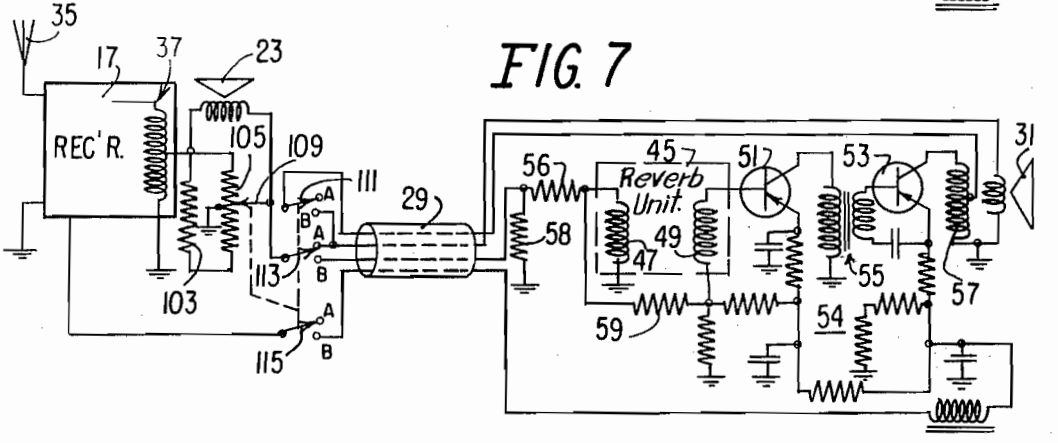


FIG. 7



INVENTOR.
Anthony R. Mikelevicius
BY
Mueller & Aichele
Attys.

United States Patent Office 3,300,583 Patented Jan. 24, 1967

3,300,583

AUTOMOBILE SPEAKER SYSTEM WITH REVERBERATION

Anthony R. Mikelevicius, Chicago, Ill., assignor to Motorola, Inc., Franklin Park, Ill., a corporation of Illinois

Filed May 13, 1963, Ser. No. 279,727
11 Claims. (Cl. 179—1)

This invention relates to sound reproduction, and more particularly to a sound reproduction system for an automobile wherein reverberation effects are provided.

One of the major difficulties associated with reproducing sound in automobiles is the deadening effect resulting from the relative smallness of the passenger enclosure. It therefore become desirable to enhance the quality of the reproduced sound by subjectively enlarging the enclosure. This may be done by adding a reverberated signal to the reproduced sound. In doing so, however, a problem is presented because the amount of reverberation which should be added depends on the type of audio intelligence being reproduced and upon the listeners' preference. 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 mount 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 has been proposed to add means for supplying a reverberated signal to the rear speaker, and since the reverberated sound would emanate from the rear of the listener, a realistic effect would be created because actual reverberation also normally comes from that direction. However, this may cause an overbalance of reverberated sound heard by a rear seat passenger.

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

Another object of the invention is to provide an improved reverberation system for use in automobiles.

A further object is to provide a reverberation system for use in automobiles wherein the amount of reverberated sound produced by one speaker can be controlled.

Still another object of the invention is to provide a simple, effective control, and a circuti arrangement used in connection therewith, for permitting selective operation of a dual speaker system for controlling both direct and and reverberated sound.

A feature of the invention is the provision, in an auto radio system having front and rear speakers, of a reverberation device and a circuit for controlling the sound from both front and rear speakers and which includes a plurality of switches connected in the circuit and selectively providing a first circuit configuration including the reverberation device and a second circuit configuration in which the reverberation device is not operative.

Another feature of the invention is the provision in the above described system, of a switching device comprising a bistable multicontact switch and a variable potentiometer, with the speakers connected across portions of the potentiometer in at least one circuit configuration for controlling the signals applied to the speakers.

Still another feature of the invention is the provision, in an auto radio system having front and rear speakers, of a circuit coupling both speakers across respective portions of a potentiometer which is coupled to the audio output. Further provision is made of a plurality of switches in the circuit providing selective operation in two

configurations, in one of which at least a part of the signals are applied to the rear speaker through a reverberation device.

A further feature of the invention is the provision in an auto radio system having front and rear speakers, of a circuit and switching devices operable to provide first and second circuit configurations by the setting of the switching devices, with the speakers connected across respective portions of a balancing potentiometer in the first circuit configuration, and with the rear speaker coupled through a reverberation unit and in parallel with the front speaker in a second circuit configuration.

In the drawing:

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;

FIG. 3 is a schematic diagram of an alternative circuit of the invention;

FIG. 4 is a top view of a bistable multicontact switch which may be used in the circuits of FIGS. 2 and 3;

FIG. 5 is a side elevation of the switch of FIG. 1;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5; and

FIG. 7 is a schematic diagram of another alternative circuit of the invention.

In accordance with the invention, an automobile is provided with an audio signal source located in the dash board, and a speaker connected to the audio signal source, also located in the dash board. A second speaker is mounted in the rear of the automobile, with a reverberation device and a driving amplifier for this speaker also mounted in the rear of the automobile. The reverberation device and driving amplifier could also be mounted under the dash board if room permits. A circuit interconnects the front and rear speakers and the audio signal source, and includes a number of switch connections to enable operation in a first circuit configuration wherein the speakers are connected across respective portions of a potentiometer coupled to the audio source, and in a second configuration wherein the signals applied to the rear speaker are applied through the reverberation device. A bistable multicontact switch is mechanically coupled to the potentiometer for one knob control of the various switch connections and the potentiometer for operation of the circuit in either configuration.

In certain embodiments of the invention, the speakers are connected in series across respective portions of a potentiometer in both circuit configurations. In the first configuration, both speakers are driven directly from the audio source, whereas in the second configuration, the rear speaker is connected through a reverberation device and a driving amplifier. In the second circuit configuration, a portion of the signal applied to the rear speaker may bypass the reverberation device. In another embodiment of the invention, the first circuit configuration is substantially the same as the described embodiments, but the second circuit configuration connects the front and rear speakers in parallel, with the reverberation unit and amplifier interposed between the audio source and the rear speaker.

Referring now to FIG. 1, the interior of an automobile **11** is shown including a dash board **13** and a rear shelf **15**. A conventional radio receiver **17** is mounted in the dash board **13** so that volume and tuning controls **19** are accessible and so that dial **21** is visible. A front speaker **23** is mounted in the dash board for reproducing signals from the receiver **17**. Component enclosure **25** is mounted adjacent to receiver **17** under dash board **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 an insulated cable 29 which extends 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 constructed in accordance 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 through transformer 37. A resistor 39 and a potentiometer 41 are connected across the secondary of transformer 37. Speaker 23 is coupled across resistor 39 to the variable tap 43 for resistor 41. A shunt switch 44 is connected across resistor 39.

Moving now for the moment to those components located in enclosure 33 in the rear of the automobile, there is included a reverberation unit 45 having a drive transducer 47 and pick up transducer 49. The pick up 49 is connected to a transistor 51 of driving amplifier 54 for rear speaker 31. Transistor 51 is coupled to transistor 53 by transformer 55, and the output of transistor 53 is applied to an auto transformer 57, which may be used to drive rear speaker 31 as will be explained. Appropriate bias networks, as shown, are provided for transistors 51 and 53.

Signals are applied through resistor 56 to the drive transducer 47 of the reverberation unit 45. Resistor 56 serves to limit current to reverberation unit 45 and prevent overload. Resistor 58 provides impedance matching for the reverberation system. A bypass circuit for applying a portion of the audio signal directly to the driving amplifier beigns ahead of transducer 47, and continues through mixing resistor 59 and transducer 49 to the base of transistor 51.

Returning now to the front portion of the automobile, there are shown three additional switches 61, 63 and 65. Certain of the A and B contacts of each of switches 61, 63 and 65 are connected through cable 29 to the components in enclosure 33 in the rear of the automobile. As may be seen from the drawing, when switches 61 and 63 are on contacts A, and switch 45 is also on contact A, front speaker 23 will be connected across the portion of resistor 41 above tap 43, and rear speaker 31 will be connected across that portion of resistor 41 below tap 43 by the connection established from contact A of switch 63 to the auto transformer 57. In this circuit configuration, both speakers will reproduce only direct sound signals. No signals are applied to the reverberation device 45 and the amplifier 54 is not energized.

On the other hand, when switches 44, 61 and 63 are moved to the B contacts, speaker 31 will be coupled across the secondary of transformer 57, and signals across the lower portion of potentiometer 41 will be applied through reverberation unit 45 and driving amplifier 54 to speaker 31. Switch 44 is also moved to contact B so that speaker 23 is connected across resistor 39 in series with the upper portion of potentiometer 41. In this circuit configuration, switch 65 is moved to the B contact to apply positive D.C. from receiver 17 to energize the driver amplifier.

Switches 44, 61, 63 and 65 may be ganged to simultaneously switch between their respective A and B contacts. With the switches in A or B position, movement of tap 43 toward the upper end of resistor 41 will increase the volume in the rear speaker 31 and decrease the volume in front speaker 23. Movement toward the lower end of resistor 41 will have the opposite effect. In the A position there is no reverberation in the rear speaker whereas in the B position, both direct and reverberated signals of constant proportion will pass to the rear speaker 31.

Referring now to FIG. 3, another embodiment of the invention is shown. Rear speaker 31 is coupled directly across the secondary of auto transformer 57 and not through a switch, as was the case in the embodiment of FIG. 2. The amplifier 54 for driving rear speaker 31 is connected in series with reverberation unit 45. Reverberation unit 45 and amplifier 54 may be of the same construction as in FIG. 2. Amplifier 54 is used in both circuit configurations provided by the system of FIG. 3 and is therefore energized through the receiver at all times that the receiver is turned on. In the front portion of the automobile, potentiometer 41 is connected directly in parallel with the secondary of transformer 37.

Switch 69 is connected in series with front speaker 23 and when in position A, connects front speaker 23 across the upper position of potentiometer 41, with the driver amplifier for speaker 31 being connected through switch 71 to the lower portion. When switch 71 is in position A, variable tap 43 of potentiometer 41 is connected through resistor 73 and transducer 49 to the base of transistor 51.

With switches 69 and 71 on contacts A, speakers 23 and 31 are coupled across respective portions of resistor 41, with variable tap 43 regulating the amount of signals in speaker 23 and amount of direct unreverberated signal bypassing reverberation unit 45 to the driver amplifier. Resistors 73 and 59 are relatively large compared to resistor 74 and there is no substantial coupling of signals to the reverberation unit in this circuit configuration. Accordingly, when variable tap 43 is near the top of resistor 41, with switches 69 and 71 on contacts A, rear speaker 31 will have substantially entirely direct sound emanating therefrom and the signal to front speaker 23 will be minimum. On the other hand, when variable tap 43 is moved to the lower end of resistor 41, no signal is applied to rear speaker 31, while the signal to front speaker 23 will be maximum.

On the other hand, when switch 69 is in position B, speaker 23 is connected across the secondary of transformer 37 and in parallel with potentiometer 41, which feeds speaker 31 through reverberation unit 45 and amplifier 54. When switch 71 is in position B, variable tap 43 is connected to the reverberation unit 45 through limiting resistor 56. With resistors 56 and 74 equal to 10 ohms, resistor 59 equal to 1800 ohms, and resistor 73 equal to 1500 ohms, satisfactory results have been obtained. With switches 69 and 71 on contact B, rear speaker 31 will reproduce reverberated sound, the volume of which will vary according to the setting of variable tap 43. Switches 69 and 71 may be ganged for simultaneous movement between respective A and B contacts to provide selective operation in either described mode by a single switching operation.

Referring now to FIGS. 4, 5 and 6, a control which might be used in connection with the circuits of FIGS. 2 and 3 is shown. This control is a multicontact switch combined with a variable potentiometer. The potentiometer is controlled by rotation of knob 27 (FIG. 1) on shaft 81 and is enclosed in a housing 83. Shaft 81 extends through potentiometer 83 and has a pair of actuating discs 85 mounted thereon. Shaft 81 is movable axially as well as being rotatable, and is disposed beneath a pair of multicontact bistable switch units 87. Switch units 87 have actuating members 89 extending therefrom into the space between discs 85. Accordingly, axial movement of shaft 81 will cause one of discs 85 to move actuating members 89 and throw the bistable switches 87. Switches 87 have upwardly extending terminals 91 which may be connected to the various circuit elements. Simultaneous switching of switches 44, 61, 63 and 65, or 69 and 71 may be accomplished by connections apparent from the schematic diagrams of FIGS. 2 and 3 to those skilled in the art.

Referring now to FIG. 7, another embodiment of the invention is shown. This embodiment is quite similar to that shown in FIG. 2. The secondary tap of transformer

37 is coupled directly to one end of potentiometer 105, and through resistor 103 to the other end of this potentiometer. As may be seen from the drawing, potentiometer 105 is center tapped to ground, but variable tap 109 is free to move over its entire length.

A switching arrangement including switches 111, 113, and 115 provides two circuit configurations. These switches are substantially similar to switches 61, 63 and 65 of FIG. 2 and perform identical functions as far as the mode of operation of the audio circuit is concerned. Switches 111, 113 and 115 are ganged with the variable tap 109 of potentiometer 105 so that when tap 109 is on the upper portion of potentiometer 105, switches 111, 113 and 115 will be in the A position; whereas when variable tap 109 is on the lower portion of potentiometer 105, switches 111, 113 and 115 will be in the B position. Accordingly, with the switches in the A position, the volume of speaker 23 will increase and the volume of speaker 31 will decrease as tap 109 moves toward the grounded center tap of potentiometer 105. Upon passing the center tap to the lower half of potentiometer 105, switches 111, 113 and 115 assume the B position. This applied signals to the rear speaker 31 through the reverberation unit 45, and continued downward movement of tap 109 will decrease the volume in front speaker 23 and increase the signal applied through the reverberation unit to the rear speaker.

It may therefore be seen that the invention provides a controlled reverberation system for improving the reproduction of sound in an automobile. The system is arranged to be operable in different circuit configurations to provide a plurality of modes by means of a simple switch control to optimize sound reproduction for any of the various types of audio intelligence that may be received.

I claim:

1. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the automobile, first and second speakers mounted respectively in the front and rear interior portions of the automobile, a reverberation device for producing a delayed signal of decaying amplitude, circuit means interconnecting said first and second speakers and said audio signal source and said reverberation device, said circuit means including a plurality of switches and conductor means providing a pair of circuit configurations according to the setting of said switches, with the first circuit configuration providing unreverberated sound from said first and second speakers and controlling the relative outputs thereof and with the second circuit configuration providing reverberated sound from said second speaker and controlling the relative outputs of unreverberated sound from said first speaker and reverberated sound from said second speaker.

2. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, a reverberation device for producing a delayed signal of decaying amplitude, and circuit means including a plurailty of switches interconnecting said audio signal source and said reverberation device and said front and rear speakers, said switches selectively providing a pair of circuit configurations for operating said front and rear speakers in two predetermined modes, said circuit means further including potentiometer means connected therein and controlling the strength of the signals applied to said front and rear speakers.

3. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the automobile, first and second speaker means mounted respectively in the front and rear interior portions of the automobile, a reverberation device for producing a delayed signal of decaying amplitude, circuit means interconnecting said first and second speaker means and said audio signal source and said reverberation device, said circuit means including a plurality of switches and conductor means providing a pair of circuit configurations according to the setting of said switches, one of said circuit configurations connecting said second speaker means to said audio signal source through said reverberation device and including a signal path bypassing said reverberation device to apply unreverberated signals to said second speaker means, the other of said circuit configurations effectively connecting said second speaker means to said audio source independently of said reverberation device, and potentiometer means connected in said circuit means for controlling the signals applied to said first and second speaker means.

4. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, first and second speakers mounted respectively in the front and rear interior portions of the automobile, circuit means for operating said first and second speakers and including a plurality of switches operable to predetermined positions to provide first and second circuit configurations, said first and second circuit configurations connecting said first and second speakers effectively in series across said audio signal source, potentiometer means connected across said audio signal source and having a variable tap connected between said first and second speakers, whereby the relative strengths of signals applied to said first and second speakers may be varied, and reverberation means for producing a delayed signal of decaying amplitude connected in said second circuit configuration between said audio signal source and said speaker, said first circuit configuration completely bypassing said reverberation means to provide only direct signals to said second speaker.

5. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, a circuit including a plurality of switches operable to predetermined positions to provide first and second circuit configurations for driving said front and rear speakers, potentiometer means connected across said audio signal source in said first and second circuit configurations and having a variable tap dividing said potentiometer into first and second portions, said first circuit configuration connecting said front and rear speakers across said first and second portions of said potentiometer respectively, said second circuit configuration connecting said front speaker in parallel with said potentiometer across said audio signal source, reverberation means for producing a delayed signal of decaying amplitude, and means including said reverberation means connecting said rear speaker across said second portion of said potentiometer in said second circuit configuration for shunting signals from said rear speaker.

6. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, means including a potentiometer connecting said front speaker across said audio signal source, reverberation means for producing a delayed signal of decaying amplitude and having input and output portions, an amplifier connected to said output portion of said reverberation means for amplifying signals therefrom, a first bistable switch having a first position connecting said potentiometer directly between said audio signal source and said rear speaker and a second

position connecting said potentiometer between said audio signal source and said input portion of said reverberation means, and a second switch having a second position connecting said rear speaker to said amplifier and a first position disconnecting said rear speaker and said amplifier, said first switch being simultaneously operable with said second switch between their respective first and second positions to provide selective modes of applying direct and reverberation signals to said rear speaker.

7. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, means connecting said front speaker to said audio signal source, a potentiometer connected to said audio signal source, a reverberation unit for producing a delayed signal of decaying amplitude, an amplifier connecting said reverberation unit to said rear speaker, a first bistable switch having a first position connecting said front speaker in series with said reverberation unit and a second position connecting said front speaker directly across said audio signal source, a second bistable switch having a first position connecting said potentiometer to said reverberation unit and a second position connecting said potentiometer to said amplifier bypassing said reverberation unit, said first and second switches being simultaneously operable between their respective first and second positions to provide selective modes of applying reverberated signals and direct signals to said rear speaker.

8. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, means connecting said front speaker to said audio signal source, a potentiometer having each end connected to said audio signal source and having a grounded center tap and a variable tap, reverberation means for producing a delayed signal of decaying amplitude, an amplifier connected in series with said reverberation means, a first bistable switch having a first position connecting said variable tap directly to said rear speaker and a second position connecting said variable tap to said reverberation means, and a second switch having a second position connecting said rear speaker to said amplifier and a first position disconnecting said rear speaker and said amplifier, said first switch being simultaneously operable with said second switch between their respective first and second positions according to the side of said center tap upon which said variable tap is positioned to provide selective modes of applying and controlling direct and reverberated signals to said rear speaker.

9. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, a potentiometer connected across said audio signal source and having a variable tap thereon, a reverberation device for producing a delayed signal of decaying amplitude at the output thereof, an amplifier coupled to the output of said reverberation device and having an energizing circuit, a first switch having a first position connecting said rear speaker directly across the portion of said potentiometer below said variable tap and having a second position coupling said reverberation unit and said amplifier across the portion of said potentiometer below said variable tap, a second switch having a second position coupling said rear speaker to said amplifier and a first position decoupling said rear speaker from said amplifier, and a third switch having a first position opening said energizing circuit for said amplifier and a second position closing said energizing circuit, said first, second, and third switches being ganged for simultaneous movement between their respective first and second positions, whereby selective two mode operation of said sound reproduction system is provided.

10. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, a potentiometer connected across said audio signal source and having a variable tap thereon, a reverberation device for producing a delayed signal of decaying amplitude and having input and output portions, an amplifier coupled to said output portion of said reverberation device for amplifying signals therefrom, means coupling said rear speaker to said amplifier, a first switch having a first position connecting said front speaker across that portion of said potentiometer above said variable tap and a second position connecting said first speaker across said audio signal source in parallel with said potentiometer, a second switch having a first position connecting said amplifier directly across that portion of said potentiometer below said variable tap and a second position connecting said input portion of said reverberation device across that portion of said potentiometer below said variable tap, said first and second switches being ganged for simultaneous operation between said first and second positions thereof, whereby selective two mode operation of said sound reproduction system is provided.

11. A sound reproduction system for use in an automobile having front and rear interior portions, said system including in combination, an audio signal source mounted in the front interior portion of the automobile, front and rear speakers mounted respectively in the front and rear interior portions of the automobile, a potentiometer having a first portion and a second portion connected in parallel across said audio signal source, said potentiometer having a variable tap thereon operable across said first and second portions, means connecting said front speaker between said audio signal source and said variable tap, a reverberation device for producing a delayed signal of decaying amplitude and having input and output portions, an amplifier coupled to said output portion of said reverberation device and having an energizing circuit, a first switch having a first position connecting said rear speaker directly to said variable tap and a second position connecting said input portion of said reverberation unit to said variable tap, a second switch having a second position coupling said rear speaker to said amplifier and a first position decoupling said rear speaker from said amplifier, and a third switch having a first position opening said energizing circuit for said amplifier and a second position closing said energizing circuit, said first, second, and third switches being ganged for simultaneous operation from said first positions thereof to said second positions thereof as said variable tap moves from said first portion of said potentiomeeter to said second portion of said potentiometer, whereby said sound reproduction system is selectively operable in two different modes according to the setting of said potentiometer.

References Cited by the Examiner

UNITED STATES PATENTS

2,572,221	10/1951	Voigt	179—1
3,200,199	8/1965	Bang	179—1.3

WILLIAM C. COOPER, *Acting Primary Examiner.*

R. MURRAY, *Assistant Examiner.*