

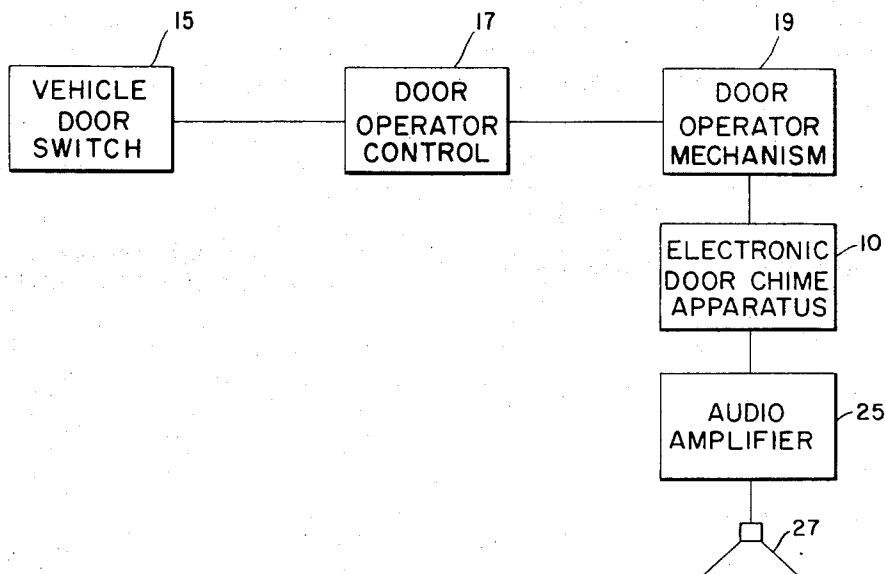
- [54] **TRANSIT VEHICLE DOOR SIGNAL APPARATUS**
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340/384 E
[51] Int. Cl. **B60q 5/00**
[58] Field of Search 340/52 R, 384 E,
340/274; 180/111
- [56] **References Cited**
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[57] **ABSTRACT**

A signal apparatus for use with the moving doors of transit vehicles or the like and which preferably takes the form of an electronic door chime means simulating the tonal quality of electromechanical chimes by using an arrangement of solid state components and thereby eliminating the use of moving parts. The door chime means includes first and second switching means, first and second decaying network responding to the switching means and driving first and second tone generators, and a time delay means between the first and second switching means to sequentially trigger the tone generators.

9 Claims, 3 Drawing Figures



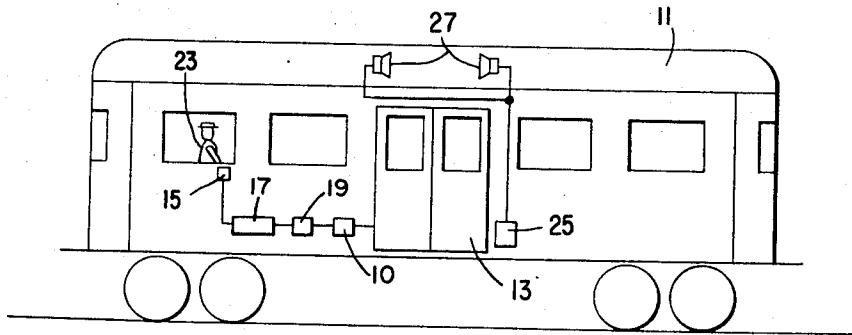


Fig. 1

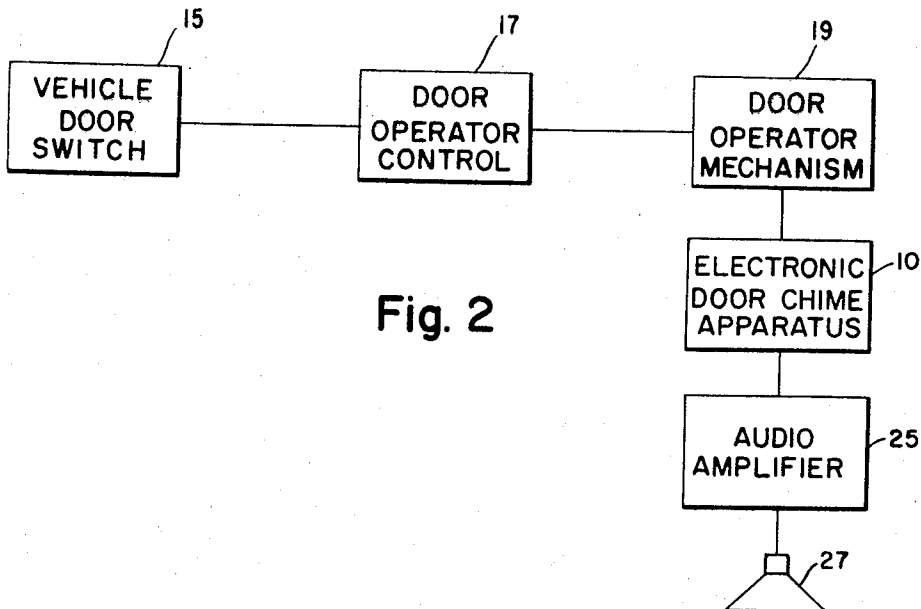


Fig. 2

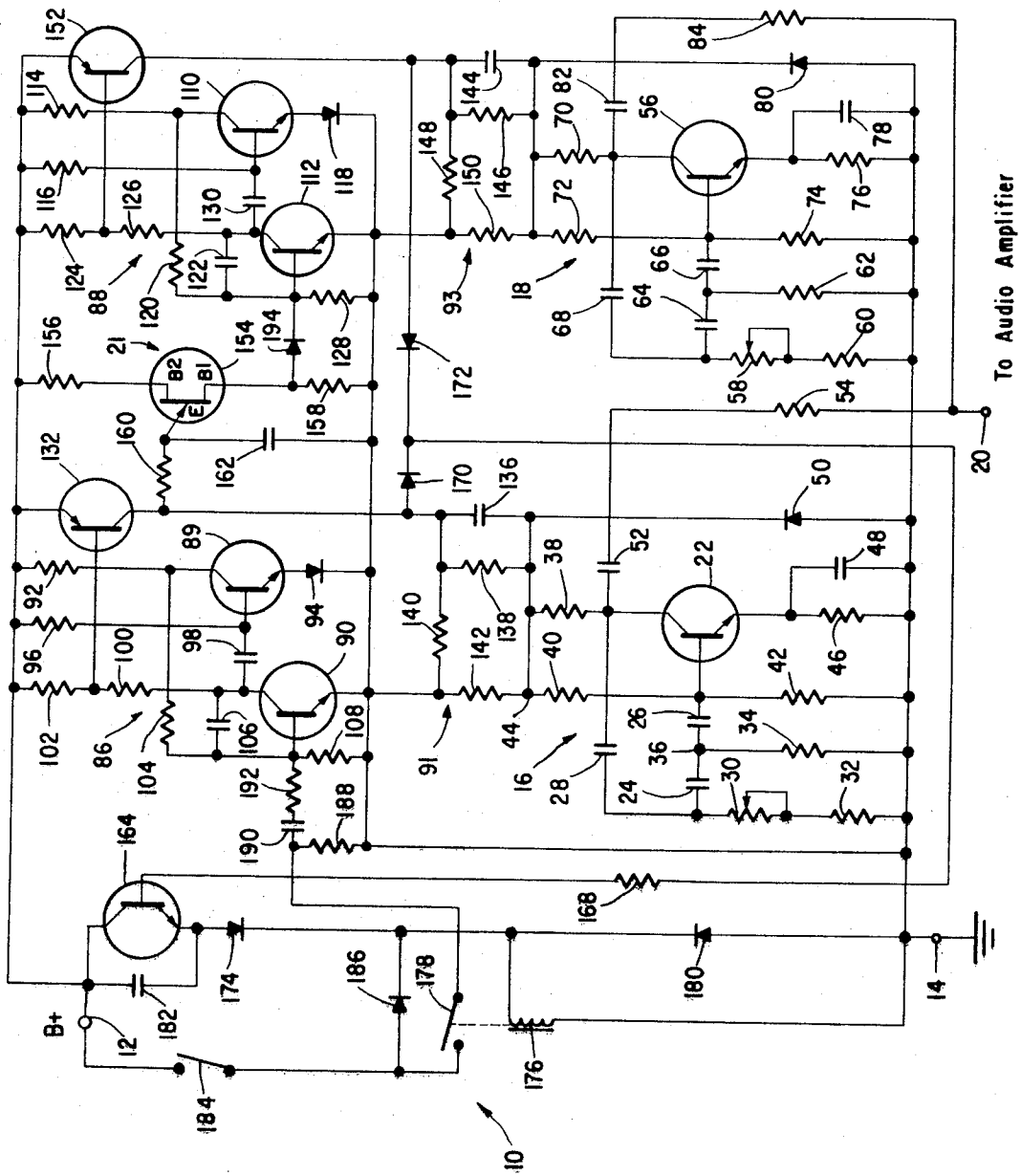


Fig. 3

TRANSIT VEHICLE DOOR SIGNAL APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to signal apparatus for the doors of transit vehicles or the like, and in particular, to a solid state electronic door chime apparatus for use in conjunction with the doors of transit vehicles to announce the door closings.

Signal apparatus, such as door chimes that are known in the prior art, frequently utilize an electromechanical system to create the audible tones. This system requires that a solenoid be energized causing a cooperating plunger to strike a tone bar. The tone bar is thus set into mechanical vibration and resonates at its natural frequency, thereby setting the surrounding air in motion creating the audible tone. Many modifications may be made to the tone bar and solenoid-plunger configuration to change the tone of the audible note or create multiple tones. For example, a second tone may be generated by the plunger being adapted to strike a second tone bar as it returns to its initial rest position. There are numerous means known in the art that generate several tones in sequence all of which utilize an electromechanical technique.

Chimes, because of their tonal qualities and their pleasing sound, have replaced the much older conventional apparatus such as alarms, door bells, etc. Generally, bells and chimes are designed for intermittent use in a relatively clean atmosphere. Since moving parts are involved in these types of apparatus, their reliability is relatively poor in the environment commonly found in transit vehicles or the like.

SUMMARY OF THE INVENTION

The preferred embodiment of the present invention simulates the tonal quality and effect of the mechanical resonance of electromechanical type chimes, including its decay characteristic, without moving parts. All solid state components are utilized in the fabrication of the electronic chime apparatus which makes it reliable during constant use in adverse environments. The electronic chime is energized by a door closing mechanism of a transit vehicle, prior to the start of the doors being closed, to warn the passengers that the doors are about to close.

An electronic signal apparatus for use in conjunction with the doors of transit vehicles to announce the door closings, in accordance with the principles of the present invention, comprises, first and second switching means having input and output terminals, each adapted to be connected to a source of operating potential and each providing a DC voltage at each of the output terminals for first and second periods of time, respectively, in response to an intermittent DC voltage being coupled to the input terminals; first and second tone generator means each having input and output terminals, for providing a first and second voltage at a predetermined frequency, respectively at the tone generator output terminals. Also included, are first and second means for providing a decaying DC voltage for the aforementioned first and second periods of time, respectively, the first means being coupled between the first switching means output terminal and the first tone generator means input terminal, the second means being coupled between the second switching means output terminal and the second tone generator means input terminal. Further included, are time delay means

having input and output terminals, for providing a delayed DC voltage at the delay means output terminal in response to a DC voltage at the delay means input terminal, the time delay means input terminal being coupled to the first switching means output terminal and the time delay means output terminal being coupled to the second switching means input terminal; and utilization means coupled to the output terminals of the first and second tone generator means for providing a first and second audible tone for the first and second periods of time, respectively, the first and second audible tones being separated by a time interval equivalent to the time delay of the delayed DC voltage and the tone having a volume substantially decreasing in accordance with the amplitude of the decaying DC voltage.

DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic view of a transit vehicle for illustrating the door closing and control system and the electronic signal apparatus;

FIG. 2 is a block diagram illustrating the functional operation of a door closing and control system with the electronic signal apparatus; and

Fig. 3 illustrates a schematic circuit diagram for a transit vehicle electronic signal apparatus utilizing the principles of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 generally illustrate the operation of a door closing control and operator mechanism in conjunction with an electronic door chime apparatus. For illustrating the invention a transit vehicle 11 is shown including doors 13, a vehicle door switch 15, a door operator control 17, and a door operator 19. A Human operator 23 by pressing the vehicle door switch 15, activates the electrical circuits of the door operator control 17, which in turn supplies the necessary energy to the door operator mechanism 19 to close the vehicle's doors 13. The electronic door chime apparatus 10, shown in the schematic circuit diagram of FIG. 3, may be placed in any convenient location, preferably in close proximity with the audio amplifier 25 and speaker system 27 of the vehicle and may be activated by either the vehicle door switch 15, door operator control 17, or the door operator mechanism 19 by incorporating the switch contacts 184 (FIG. 3) therewithin and providing for either electrical or mechanical activation.

A schematic circuit diagram of a preferred embodiment of an electronic door chime apparatus 10 is shown in Fig. 3. A source of DC operating voltage, not shown, is connected to terminal 12, which voltage in the preferred embodiment of the invention, is 36 volts DC. A ground reference terminal 14 is provided which is preferably connected in common with the ground reference normally found in a public address system associated with present day transit vehicles. The audio frequency output voltages from the tone generators 16 and 18 are coupled, via terminal 20, to the audio amplifier and speakers of the public address system, not shown, where the audible tones are heard by the persons entering the transit vehicles. The electronic door chime apparatus 10 is comprised of two independent functional paths each of which generates a different tone that is separated in time by a time delay circuit 21 described hereinafter. Each functional path comprises a multivibrator circuit (86, 88) a decay network

(91,93) and a tone generator (16, 18) which are described hereinafter in detail with the similarities in each path carefully noted.

The audio frequency tone generator 16, in the first path, is a resistance-capacitance phase shift oscillator which includes a transistor 22, phase shift capacitors 24 and 26 coupled in series to the base electrode of transistor 22, and a feedback capacitor 28 connected from the collector electrode of transistor 22 to one end of capacitor 24 and variable resistor 30. The other end of variable resistor 30, which is used to adjust the frequency of the audio tone generator to obtain the desired pitch, is coupled via resistor 32 to a ground reference terminal 14 and with capacitor 24 comprises one portion of the phase shift network. Another resistor 34, coupled from the commonly connected point 36 of capacitors 24 and 26 to the ground reference terminal 14, in cooperation with capacitor 26 comprises another portion of the phase shift network. Both portions of the phase shift network in combination with feedback capacitor 28 insure oscillations whenever a DC operating voltage (B+) is coupled to the collector electrode of transistor 22, via a collector load resistor 38. Resistors 40 and 42 are connected in series from one end of resistor 38, at point 44, to terminal 14. The junction of resistors 40 and 42 is connected to the base electrode of transistor 22 and provides operating bias thereto. The emitter electrode of transistor 22 is coupled, via an emitter resistor 46 and a capacitor 48 connected in parallel, to terminal 14. Connected from point 44 to terminal 14 is a diode 50 which prevents a reversed voltage from appearing on the collector electrode of transistor 22. The AC tone voltage appearing at the collector electrode of transistor 22 is coupled, via a capacitor 52 and a resistor 54, to terminal 20 and then to the public address system as explained earlier.

The frequency of the audio phase shift tone generator (oscillator) is independent of the amplitude of the B+ applied and has an output AC voltage amplitude directly related thereto. In the preferred embodiment of the invention, the combination of the phase shift capacitors and the feedback capacitor in conjunction with the phase shift resistors preferably are designed to generate an audio frequency of approximately 650Hz.

The tone generator 18, in the second path, is also a resistance-capacitance phase shift oscillator which functions in the same manner as the tone generator 16, described earlier, except that it preferably is designed to generate a frequency of approximately 520Hz. Included in tone generator 18 are a transistor 56; a phase shift network, comprised of resistors 58, 60, 62 and capacitors 64 and 66; a feedback capacitor 68; a collector resistor 70; bias resistors 72 and 74; an emitter resistor 76, connected in parallel with a capacitor 78; a diode 80; and an output coupling capacitor 82 connected in series with a resistor 84. All the above enumerated components being connected in the same manner as their corresponding circuit element in the oscillator 16.

The DC operating voltage (B+) is connected to the monostable multivibrator circuit 86 in the first path and the monostable multivibrator circuit 88 in the second path, which couple the operating B+, via decay circuit networks 91 and 93, in the first and second paths respectively, to tone generators 16 and 18 in the first and second paths, respectively.

The monostable multivibrator circuit 86 is comprised of transistors 89 and 90. The collector electrode of

transistor 89 is coupled, via a collector load resistor 92, to the B+ terminal 12. The emitter electrode of transistor 89 is coupled, via diode 94, to ground reference terminal 14 and provides emitter bias voltage for transistor 89. The base electrode of transistor 89 is coupled, via a resistor 96, to B+ terminal 12 and supplies bias current to transistor 89 to maintain it in a normally on or saturated mode. A capacitor 98 is coupled from the base electrode of transistor 89 to the collector electrode of transistor 90 and couples therebetween any change in voltage appearing at the collector electrode of transistor 90.

The collector of transistor 90 is coupled to the B+ terminal 12, via the collector load resistors 100 and 102 connected in series. The base electrode of transistor 90 is coupled, via a resistor 104, to the collector electrode of transistor 89 and provides positive feedback thereto. A capacitor 106 is connected from the collector electrode to the base electrode of transistor 90 while a resistor 108 is connected between the base and emitter electrodes of transistor 90 to reduce the amplitude of the feedback voltage. In the preferred embodiment of the invention, transistor 89 is maintained in its off or non-conducting condition for approximately 0.8 seconds when the multivibrator is activated and then returns to its normally conducting or saturated condition.

The monostable multivibrator circuit 88 functions in the same manner as multivibrator circuit 86 and comprises transistors 110 and 112; a collector load resistor 114 for transistor 110; a current bias resistor 116; a bias diode 118; a feedback resistor 120; a capacitor 122; collector load resistors 124 and 126; resistor 128, connected from the base to the emitter electrode of transistor 112; and a coupling capacitor 130. Monostable multivibrator circuit 88 is designed so that transistor 110 is normally conducting and is maintained in its normally off condition for approximately 1.0 seconds when the multivibrator is activated and then returns to its normally conducting condition.

A driver transistor 132 in the first path, has its base electrode coupled to the junction of resistors 100 and 102 and its emitter electrode connected to the B+ terminal 12. The collector electrode of driver transistor 132 is connected, via the decay circuit network 91, to the point 44.

The decay circuit network 91, comprises a capacitor 136 which is connected in parallel with a resistor 138 to point 44. A resistor 140, which is connected from the collector electrode of transistor 132 to the ground reference terminal 14 and a resistor 142, which is connected from point 44 to terminal 14, in conjunction with resistor 138, which is connected across capacitor 136 are chosen to shape the decay characteristics of the network 91 to provide the fading or diminishing tonal sounds typical of a mechanical chime or bell.

The corresponding decay circuit network 93, in the second path, is comprised of a capacitor 144, connected in parallel with a resistor 146; and resistors 148 and 150; all of which function in the same manner as resistors 138, 140 and 142; and capacitors 136, respectively, described earlier.

A driver transistor 152, in the second path, has its base electrode coupled to the junction of resistors 124 and 126 and its emitter electrode to the B+ terminal 12. The collector of driver transistor 152 is connected, via the decay circuit network 93, to the tone generator

18 in a manner similar to the collector electrode of transistor 132.

The time delay circuit 21 includes a unijunction transistor 154 that has its second base (B2) coupled via a resistor 156, to the B+ terminal 12 and its first base (B1) coupled to the ground reference terminal 14, via a resistor 158. The emitter electrode (E) of unijunction transistor 154 is coupled, via a resistor 160, to the collector electrode of transistor 132. A capacitor 162 is connected from the emitter electrode of transistor 154 to the ground reference terminal, and in cooperation with the resistor 160 provides a conventional RC time delay before firing the unijunction transistor causing capacitor 162 to discharge, via the emitter-base (E-B1) junction, thereby generating a positive voltage relative to the ground reference terminal 14.

Further included in the electronic door chime apparatus is a clamping transistor 164, which has its collector electrode connected to B+, its base electrode coupled, via resistor 168 to the common cathode connection of diodes 170 and 172, respectively. The anode electrodes of diodes 170 and 172 are coupled to the collector electrodes of transistors 132 and 152 respectively. The emitter electrode of transistor 164 is coupled, via a diode 174 to a door chime relay coil 176, which has normally opened contacts 178 associated therewith. The other side of relay coil 176 is connected to the ground terminal 14. Relay coil 176 has a diode 180 connected in parallel to increase its dropout time and reduce transient voltages that are generated when transistor 164 turns off. A capacitor 182 is connected across the emitter and collector electrodes of transistor 164.

In operation, relay contacts 178 and 184 are normally open. With B+ coupled to terminal 12 transistors 89 and 110 are caused to be turned on or saturated by resistors 96 and 116, respectively while transistors 90 and 112 are non-conducting or off. Closing of the contacts 184 by mechanical means, or by a door closing relay, not shown, as in the preferred embodiment of the invention, couples the B+, via diode 186, to relay coil 176 which closes contacts 178. The B+ voltage is coupled through contacts 184, contacts 178, coupling capacitor 190 and resistor 192, to the base electrode of transistor 90. A resistor 188 is coupled from one side of capacitor 190 to terminal 14 to provide a discharge path for capacitor 190.

The DC voltage coupled to the base electrode of transistor 90 causes it to turn on (conduct current), thereby generating a negative pulse at its collector electrode, which is coupled, via capacitor 98, to the base electrode of transistor 89 causing it to become non-conductive. When transistor 89 stops conducting current the voltage at its collector electrode increases (becomes more positive) and is coupled to the base electrode of transistor 90, via resistor 104, keeping transistor 90 on until capacitor 98 discharges, whereby transistor 89 returns to its initial conducting state.

The increase in current flow through resistors 100 and 102 caused by transistor 90 turning on, causes a more negative voltage to appear at the base electrode of transistor 132, which turns it on, thereby coupling the B+ voltage to the decay circuit 91 and diode 170 as well as resistor 160, which energizes the time delay circuit 21. The B+ voltage coupled, via diode 170 and resistor 168 to the base electrode of transistor 164 turns it on coupling the B+ via diode 174 to relay coil

176, which energizes it and maintains it in the energized state as long as transistor 164 remains on. Thus, a momentary or intermittent closing of contacts 184 will cause the relay coil 176 to remain energized for a complete cycle of two tones even if the contacts 184 are opened thereafter.

The B+ voltage is also simultaneously coupled, via capacitor 136 of the decay circuit 91 to the tone generator 16 at point 44 causing the tone generator to provide a voltage at a frequency of 650Hz at the collector electrode of transistor 22. This voltage is coupled, via capacitor 52, resistor 54 and terminal 20, to the audio amplifier and speaker system of the transit vehicle. Note that as capacitor 136 charges the voltage slowly decreases at point 44 thus causing the amplitude of the 650Hz voltage to decrease without changing frequency thereby simulating the tonal quality of a bell or chime.

In the preferred embodiment of the invention, the B+ voltage coupled to the collector electrode of transistor 22 starts at approximately 20 volts and decreases to approximately 5 volts where the oscillations normally stop. The period of multivibrator 86 is chosen so that it reverts back to its initial state turning off transistor 132 and removing the B+ voltage from the oscillator after this time. Diode 50 prevents the emitter collector electrodes of transistor 22 from being reversed biased upon removal of the B+ voltage.

The time delay of time delay circuit 21 is sufficiently short with respect to the time constant of relay 176 and diode 180 in conjunction with capacitor 182 and transistor 164 to maintain relay 176 energized during the reset time of multivibrator 86 and the turning on of multivibrator 88.

When unijunction transistor 21 fires conducting the discharge current of capacitor 162 via its emitter base one (E-B1) junction a positive voltage appears across resistor 158 which activates multivibrator 88. A diode 194 couples the positive voltage across resistor 158 to the base electrode of transistor 112 turning it on. As noted earlier, multivibrator 88 operates in the same manner as multivibrator 86 so that turning transistor 112 on turns transistor 110 off. Transistor 152 turned on, by the negative voltage appearing across resistor 124 when transistor 112 turns on, causes the B+ to be coupled, via diode 172 and resistor 168, to the base electrode of transistor 164, which is kept in its on condition thereby maintaining relay coil 176 energized. Transistor 152 couples the B+ voltage, via the decay circuit 93 to the second tone generator 18, which provides a frequency of 520Hz, in the preferred embodiment, at the collector electrode of transistor 56 which is coupled, via capacitor 82, resistor 84 and terminal 20 to the audio amplifier and speaker system described earlier. Thus, an intermittent activation of switch contacts 184 by mechanical means or a relay by the operator of the door closing mechanism will provide two bell like tones in succession simultaneously with the activation of the door closing mechanism, thereby, providing a warning signal to the passengers prior to the closing of the doors. The signal apparatus will then return to its initial state until contacts 184 are closed again, when the tones will be repeated.

Although the invention has been described in conjunction with the door operating means of a transit vehicle, it should be understood that the invention is not so limited and that various modifications and alterations may be made in the invention without departing

from the spirit and scope thereof as defined in the appended claims.

Hereinbefore, has been disclosed an electronic signal apparatus for use in conjunction with the doors of transit vehicles which is reliable, small in size, and requires no moving parts to reproduce the total sound of bells or chimes.

I claim:

1. An electronic signal apparatus for use in conjunction with the doors of transit vehicles to announce the door closings, comprising:

- a. a first and second switching means having input and output terminals, each adapted to be connected to a source of operating DC potential and each providing a DC voltage at each said output terminals for first and second periods of time respectively, in response to an intermittent DC voltage being coupled to said input terminals;
- b. first and second tone generator means each having input and output terminals for providing a first and second voltage at a predetermined frequency, respectively, at said output terminals;
- c. first and second means for providing a decaying DC voltage for said first and second periods of time respectively, said first means being coupled between said first switching means output terminal and said first tone generator means input terminal, said second means being coupled between said second switching means output terminal and said second tone generator means input terminal;
- d. time delay means having input and output terminals for providing a delayed DC voltage at said output terminal in response to a DC voltage at said input terminal, said time delay means input terminal being coupled to said first switching means output terminal and said time delay means output terminal being coupled to said second switching means input terminal; and
- e. utilization means coupled to the output terminals of said first and second tone generator means for providing a first and second audible tone for said first and second periods of time, respectively, said first and second audible tones being separated by a time interval equivalent to the time delay of said delayed DC voltage and said tone having a volume substantially decreasing in accordance with the amplitude of said decaying DC voltage.

2. An apparatus according to claim 1 which further

includes clamping means coupled to said input terminals of said first switching means for providing a DC voltage to said switching means input terminal after the cessation of said intermittent DC voltage, until said second audible tone has been completed.

3. An apparatus according to claim 1 wherein said first and second switching means comprises a transistorized monostable multivibrator.

4. An apparatus according to claim 1 wherein said first and second tone generator means comprises a transistorized phase shift oscillator.

5. An apparatus according to claim 1 wherein said first and second means for providing a decaying DC voltage comprises first, second and third resistors connected in series and a capacitor connected in parallel with one of said resistors.

6. An apparatus according to claim 1 wherein said time delay means comprises a unijunction transistor and resistor-capacitor timing circuit.

7. An apparatus according to claim 1 wherein said utilization means comprises a transistorized audio amplifier and loudspeaker system.

8. An apparatus according to claim 1 wherein said intermittent DC voltage is coupled to said first switching means input terminal in response to activation by a door closing means.

9. The method of simulating an electro-mechanical chime for use in conjunction with the doors of transit vehicles to announce the door closing, comprising:

- a. providing first and second electronic tone generators capable of generating a fixed predetermined frequency output voltage through a change in operating voltage;
- b. activating a first switching means which couples said operating voltage to said first tone generator through a voltage decaying means;
- c. energizing a time delay means from said switching means;
- d. activating a second switching means which couples said operating voltage to said second tone generator, through a voltage decaying means from said time delay means; and
- e. combining said predetermined frequency output voltage in an audio amplifier and speaker means for providing first and second spaced audible tones decreasing in volume.

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