United States Patent

Ivy

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[54] **METHOD AND APPARATUS FOR SUPPRESSING AND SUBSTITUTING SIGNALS**

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[51] **Int. Cl.** **G11b 15/06**

[58] **Field of Search**................179/100.1, 100.1 C, 100.1 PS, 179/1 SW, 100.2 S, 100.2 MD, 100.3 B, 100.3 D

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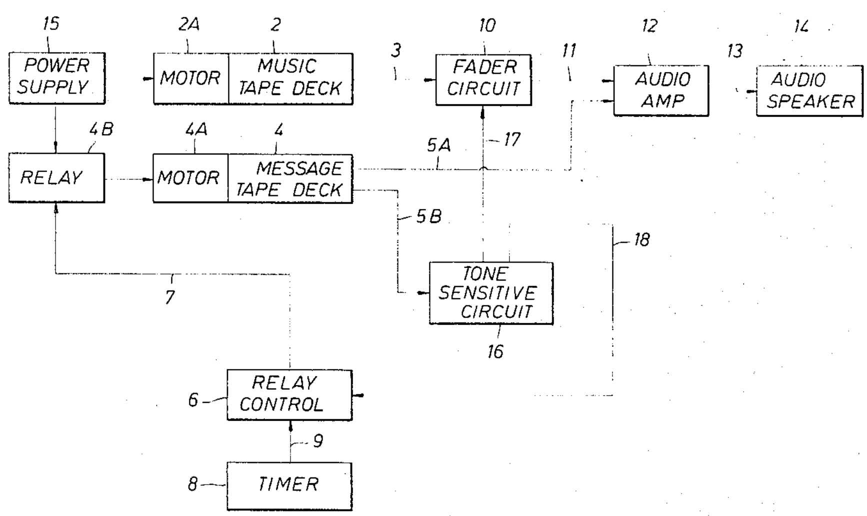
[57] **ABSTRACT**

A method and apparatus for progressively suppressing a primary electronic signal, and for substituting a secondary electronic signal for said suppressed primary signal, in response to a tone control frequency. The secondary signal and tone control frequency may both be recorded on a common magnetic tape which may be selectively played at preselected discrete time intervals.

14 Claims, 2 Drawing Figures



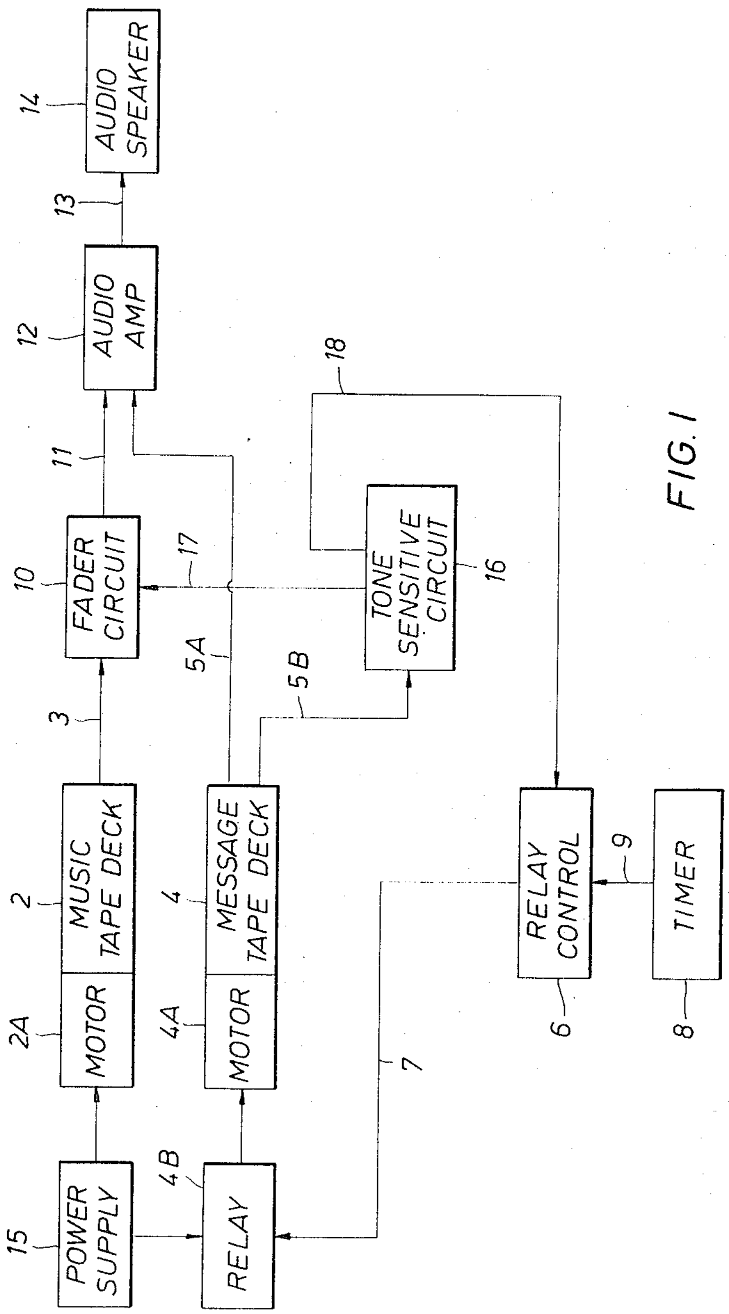


FIG. 1

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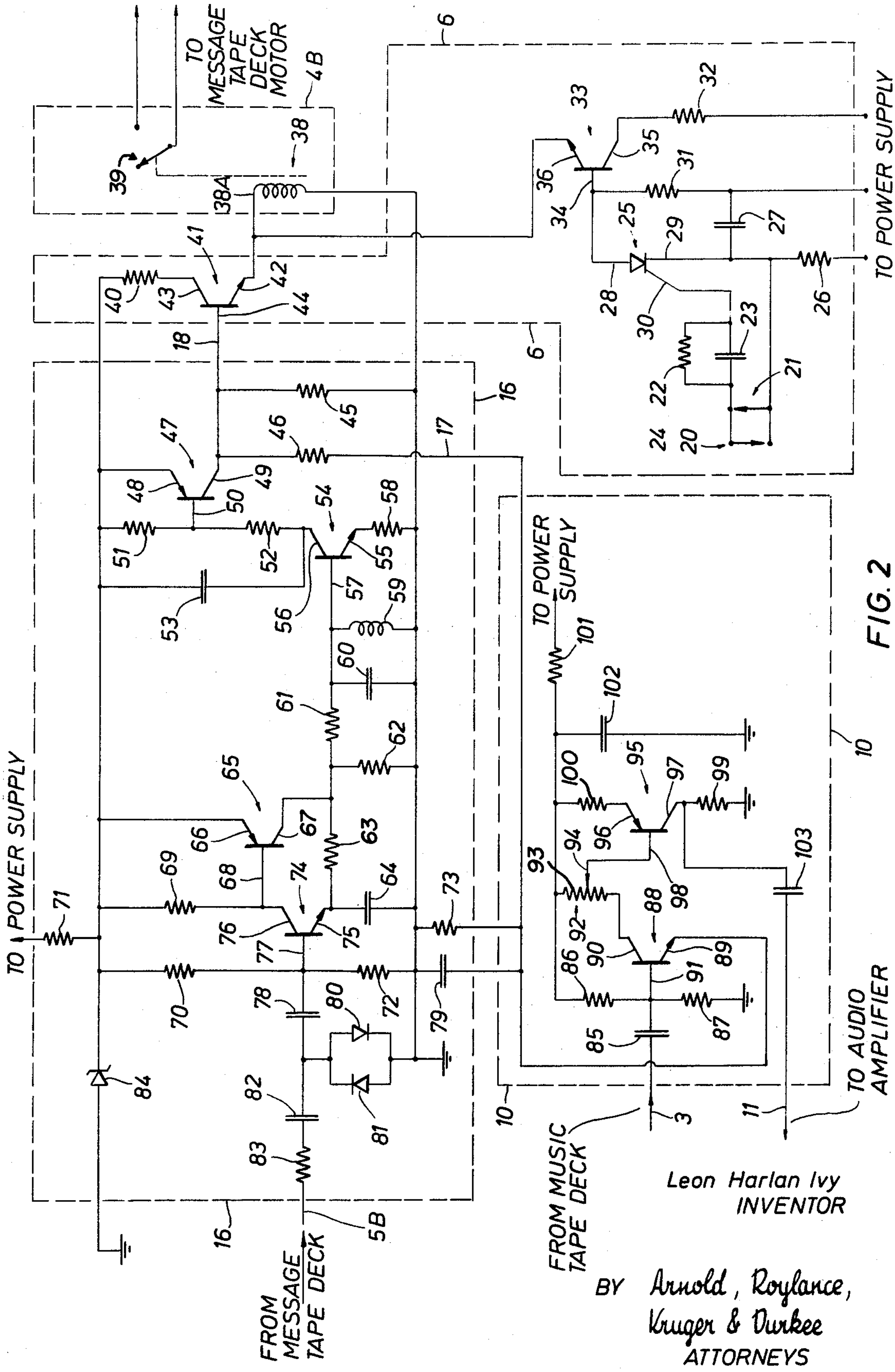

FIG. 2

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METHOD AND APPARATUS FOR SUPPRESSING AND SUBSTITUTING SIGNALS

BACKGROUND OF INVENTION

This invention relates to methods and apparatus for switching between a plurality of electronic signals, and more particularly relates to methods and apparatus for fading out one of a plurality of signal inputs while simultaneously fading in another signal input to a common receiving circuit.

There are many suitable applications for the present invention. However, a particularly suitable use is in the production of music and the like from tape recordings, wherein it is sought to introduce a different input signal to the audio amplifier at selected intervals.

It is well known to provide what is commonly known as "-background music" in public places such as airport terminals, bus depots, hotel lobbies and rooms, and the like. It is also common practice to interrupt such music from time-to-time, for the purpose of substituting another different signal into the audio amplifier, such as an announcement of departure schedules, the availability of commercial products and services, or the like. What is further well known, is that the interruption is unpleasantly abrupt, when performed by the techniques of the prior art, and that this frequently produces a reaction on the part of the listener which is far different from that which was sought to be achieved.

The present invention overcomes the disadvantages of the prior art techniques, and novel switching and selection means and methods are provided for selectively and gradually fading out the music or other primary signal before introducing a different secondary or alternate signal.

SUMMARY OF INVENTION

In its broader sense, a blocking circuit is provided which generates an output signal for blocking the primary signal input to the audio amplifier in response to a tone control signal which accompanies the alternate or secondary signal. The tone control signal is initially generated at a low frequency and only gradually increases to its optimum frequency. The blocking or "fading" circuit includes a resonance circuit tuned to the tone control signal and generating a control bias signal functionally related to the frequency of the tone control signal. Accordingly, as the frequency of the tone control signal gradually increases to optimum, the bias signal increases in a like manner to increase the amplitude of the blocking signal. The secondary signal is preferably not started until after the tone control signal has reached its optimum frequency, and the blocking signal has reached an optimum amplitude sufficient to completely block the primary signal.

In a particularly suitable embodiment of the present invention, a conventional motor-driven tape deck circuit or assembly is employed to provide a generally continuous primary audio input signal to a conventional audio amplifier and speaker, and the alternate or secondary signal is similarly provided by a conventional motor-driven tape deck preferably having an endless tape or other suitable signalling means. The secondary tape deck may be actuated either manually or by any suitable electrical or mechanical means. In those instances wherein the secondary signal is a short recorded announcement of commercial import, it may be desirable to provide a timer circuit for actuating the secondary tape deck at preselected discrete time intervals of sufficient duration to play through the entire tape.

In all forms of the present invention, a fader circuit as hereinbefore described is provided between the input side of the audio amplifier and the two tape deck outputs. As will hereinafter be explained in detail, the fader circuit will normally pass the primary signal into the audio amplifier. However, the fader circuit is responsive to a command input from a tone control circuit which, in turn, is sensitive or responsive to the tone of an output signal which is generated by the secondary tape deck along with the secondary or message signal.

As will be apparent to those having ordinary familiarity with this art, there will be an interval before the motor of the secondary tape deck reaches its normal operating velocity after it is energized, and thus the frequency of the tone control signal which is preferably carried on the tape along with the secondary "message" signal will increase from an initially low frequency to a higher optimum when the motor achieves its full or normal operating velocity.

The tone control circuit preferably includes a stage for generating an output signal having an amplitude proportional to the bias voltage on the stage, and further including a resonance circuit tuned to the tone control signal for generating the bias voltage. Thus, the bias voltage is initially low, since the frequency of the tone control signal is initially low. As the motor increases its velocity, the frequency of the tone control signal increases to thereby increase the amplitude of the bias voltage in a corresponding manner. As the bias voltage increases, this increases the magnitude of the command signal generated by the tone control circuit and applied to the fader circuit.

In a particularly suitable embodiment of the present invention, the timer circuit may be arranged to momentarily actuate a conventional relay control circuit to connect power to the motor of the secondary tape deck. However, the relay control circuit will thereafter be held in an actuated condition by the command signal generated by the tone sensitive circuit and applied to the fader circuit. When the secondary tape deck has revolved far enough to complete the message, the tone control signal will terminate at the same time the message signal terminates. Thus, termination of the tone control signal causes the tone sensitive circuit to discontinue generating the command signal applied to the fader circuit and to the relay control circuit. Accordingly, the relay control circuit will now revert to its normally de-energized condition, and power will now be disconnected from the motor of the secondary tape deck at the same instant the fader circuit begins to gradually revert to its original normal condition.

These and other features of the invention will become apparent from the following detailed description wherein reference is made to the figures in the accompanying drawings.

DRAWINGS

FIG. 1 depicts a functional representation of the basic components of an exemplary system embodying the present invention.

FIG. 2 is a schematic diagram providing a more detailed illustration of selected portions of the system depicted generally in FIG. 1.

DETAILED DESCRIPTION

Referring now to FIG. 1, there may be seen a functional representation of a system for continuously reproducing a primary audio signal such as music, and including one embodiment of the present invention for periodically fading out the primary signal and substituting a secondary audio signal such as a commercial announcement. In particular, there may be seen a functional representation of a source of the primary signal, such as a conventional tape deck **2** driven by a motor **2A**, and also a similar signal source for providing the secondary signal, such an another tape deck **4** of conventional design which is also driven by a motor **4A**. As further indicated, the primary or music signal **3** normally passes through a fader circuit **10** to a conventional audio amplifier **12**, and thereafter to one or more conventional speakers **14** in the form of an amplified audio signal **13**.

Both motors **2A** and **4A** are depicted as energized by a suitable source of power **15**. A relay **4B** is illustrated as interconnected between the power supply **15** and the motor **4A** for the purpose of selectively energizing the secondary or message tape deck **4**. A similar component may also be provided for the first motor **2A**, but it has not been specifically depicted since it is immaterial to the purpose of the present invention.

The secondary tape deck 4 may be provided with an endless tape, whereby it will automatically be arranged to repeat its output each time it has been rotated through its entire length. In addition to the message signal 5A recorded thereon, however, the tape is preferably provided with a message control signal 5B which is preferably a constant preselected tone frequency, and which has been recorded so as to begin a little prior to the commencement of the message signal 5A, and so as to run concurrently with the recorded message 5A throughout its duration.

The secondary tape deck 4 may be adapted to be manually actuated so that the recorded message 5A may be delivered at any time. As depicted in FIG. 1, however, the system may include a timer 8 of any suitable design which is adapted to generate a clock or timer pulse 9 of preselected duration at preselected times such as at the start of each half-hour interval. The timer pulse 9 is applied to a relay control circuit 6 which reacts by generating an actuating signal 7 closing the relay 4B, and thereby connecting the power supply 15 to the driving motor 4A of the message tape deck 4.

When the secondary or message tape deck 4 is actuated in this or any other manner, the motor 4A begins to rotate the tape (not depicted) on the message tape deck 4. The first signal to the produced will be the message control signal 5B, and after a preselected time interval determined by the speed of the tape, the message signal 5A will commence. Since the motor 4A of the secondary tape deck 4 will increase its rotational velocity until it reaches a predetermined maximum constant speed, the tone of the message control signal 5B will also increase during this initial "start up" period until it reaches its constant frequency which is a function of the normal operating velocity of the motor 4A of the secondary tape deck 4.

As may be seen in FIG. 1, the message signal 5A is applied directly to the audio amplifier 12. However, the message control signal 5B (which appears prior to the message signal 5A) is applied to a tone sensitive circuit 16 which, in turn, produces a fader control signal 17 having a magnitude functionally related to the tone of the message control signal 5B.

The output pulse 9 from the timer 8 is preferably of only a limited duration, and the relay control 6 will ordinarily revert to its inactive condition when the timer pulse 9 disappears. This, in turn, will disconnect the power supply 15 from the motor 4A of the secondary tape deck 4, and will interrupt or discontinue the message signal 5A before the recorded message has been completed. Accordingly, the tone sensitive circuit 16 is preferably adapted to provide a relay control holding signal 18 which keeps the relay control 6 energized after the timer pulse 9 has disappeared. Thus, the motor 4A will continue to drive the secondary tape deck 4 as long as it produces the message control signal 5B without interruption.

As will hereinafter be explained in detail, the function of the fader circuit 10 is to suppress the primary or music signal 3 in response to the occurrence or arrival of the fader control signal 17. However, the fader circuit 10 is also responsive in this respect to the magnitude of the fader control signal 17 which, in turn, is functionally related in magnitude to the tone of the message control signal 5B. Accordingly, actuation of the message tape deck 2 by the timer 8 or other means does not cause the fader circuit 10 to instantly suppress or eliminate the audio signal 11 which corresponds to the input music signal 3 from the music tape deck 2. Instead, the degree of such suppression or "damping" is directly dependent on the tone of the message control signal 5B. Hence the fader circuit 10 tends to gradually fade out the audio signal 11, as the motor 4A of the message tape deck 4 increases its speed, and as the message control signal 5B correspondingly increases in frequency. Therefore, it is for this reason that the message signal 5B is preferably timed to begin only after the message control signal has reached its optimum frequency and the fader control signal 17 has attained a maximum magnitude to fully damp out the audio signal 11 applied to the audio amplifier 12 before the message signal 5A commences.

After the message signal 5A has been completed, the message control signal 5B will then terminate. The tone sensitive circuit 16 will then discontinue both the fader control signal 17 (preferably letting it die away gradually rather than abruptly interrupting it) and also the relay control holding signal 18. The message tape deck 4 will stop with the termination of the relay control holding signal 18, and the audio signal 11 will "fade up" to its normal maximum amplitude as the fader control signal 17 disappears.

As hereinbefore stated, the tape (not depicted) in the message tape deck 4 is an endless belt having a length dependent on the duration of the message signal 5A. Thus the tape in the message tape deck 4 preferably stops in a position such that it is positioned to repeat the cycle when the timer 8 produces the next succeeding timer pulse 9. Accordingly, this eliminates the necessity for any complex rewinding mechanisms for the message tape deck 4.

Referring now to FIG. 2, there may be seen a simplified schematic illustration of circuitry which is suitable for the relay control 6, the fader circuit 10, and the tone sensitive circuit 16, represented more generally in FIG. 1. More particularly, the relay control circuit 6 may be seen to include a functional representation of a suitable time switch 20 which is preferably actuated by the timer 8, according to a predetermined sequence and when closed, operates to charge a capacitor 23. As depicted, a conventional push button switch 21 may be included for accomplishing the same result. When either switch is closed, charging the capacitor 23 develops a potential on the trigger electrode 30 of the silicon controlled rectifier 25. Accordingly, current will pass between the cathode 29 and the anode 28 of this component to "turn on" the NPN transistor 33, and to thereby draw current through the winding or solenoid 38A of the relay 38. The relay 38, thereupon closes the relay switch 39 to connect power to the motor of the message tape deck 4 which then begins generating signals 5A and 5B.

It will be noted that the capacitor 23 is connected in parallel with a resistor 22 to form a pulse and time delay circuit 24. It is the purpose of this delay circuit 24 to prevent the relay 38 from being tripped more than once during the time the switch 20 is closed.

It will be noted that the NPN transistor 33 is arranged with its base 34 connected between the anode 28 of the silicon controlled rectifier 25 and a resistor 31 which, in turn, is connected to the power supply (not depicted). The collector 35 of the NPN transistor 33 is also connected to a resistor 32 leading to the power supply, and the emitter 36 is connected to the non-grounded end of the winding 38A of the relay 38. Power is supplied to the silicon controlled rectifier 25 through a resistor 26 connected between the power supply and the cathode 29 of the silicon controlled rectifier 25. A suitable capacitor 27 is also preferably connected between resistors 31 and 26.

As hereinbefore explained, it is preferable that the relay control circuit 6 function to keep the message tape deck 4 operating until its driving motor (not depicted) reaches its optimum speed. In the circuitry depicted in FIG. 2, this is achieved by means of resistors 26 and 31 in conjunction with capacitance 27, which provide a preselected delay factor for keeping the winding 38A of the relay 38 energized. More particularly, the silicon controlled rectifier 25 is maintained in a conducting condition until the capacitance 27 has been fully charged.

As may further be seen in FIG. 2, the so-called fader circuit 10 may include a capacitance 85 arranged between the incoming music signal 3 provided the the music tap deck 2, and the junction between resistors 86 and 87. A suitable NPN transistor 88 is preferably connected with its base 91 coupled to the junction of resistors 86 and 87, its collector 90 coupled to one end of the variable resistance provided by the potentiometer 92, and the emitter 89 coupled to receive the fader control signal 17 which is generated by the tone sensitive circuit 16 as will hereinafter be explained. As will be apparent, the magnitude of this resistance will depend on the position of the wiper 94 on the load resistor 93.

The fader circuit 10 may also include a PNP transistor 95 having its base electrode 98 connected to the wiper 94 of the potentiometer 92, its collector 97 coupled to the junction between the ground resistor 99 and a capacitance 103 which, in turn, is coupled to the audio amplifier 12, and with its emitter 96 connected to one end of a resistor 100. The resistor 100, in turn, is coupled between the opposite end of the load resistance 93 of the potentiometer 92 and resistor 86. Power is received by the fader circuit 10 by way of a conventional filter circuit composed of resistor 101 and a grounded capacitance 102, to the emitter 96 of the PNP transistor 95.

Referring now to the tone control circuit 16 depicted in FIG. 2, there may be seen a load resistor 83 having one end coupled to receive the message control signal 5B, and having its other end connected to one side of a suitable capacitance 82. As may be further seen, a pair of oppositely arranged diodes 80 and 81 are connected in parallel between ground and the junction between capacitances 82 and 78 to provide a voltage limiting circuit. A fader time-delay circuit is provided which may include a capacitance 79 and resistor 73 connected in parallel between ground and the incoming fader control signal 17 hereinbefore described. A limiter circuit is preferably included which may be composed of a PNP transistor 65 arranged with its collector 67 coupled through a resistance 63 to the emitter 75 of the NPN transistor 74. The base 68 of transistor 65 is preferably coupled to the junction between the collector 76 of the transistor 74 and a load resistance 69 which, in turn, is coupled to receive power by means of resistor 71. The emitter 66 of the transistor 65 is preferably connected to the junction between resistor 69 and resistor 71, and the base 77 of transistor 74 coupled to receive power by way of resistors 70 and 71.

Amplification of the message control signal 5B is provided by the NPN transistor 54, which has its emitter 55 connected through resistance 58 to the junction between resistor 73 and the lower end of the winding 38A of the relay 38. The base of the transistor 54 is connected to the junction between a suitable coil 59 and capacitor 60 which, as will be apparent from FIG. 2, operate to provide a resonance circuit responsive only to an incoming message control signal 5B of a preselected frequency. Resistor 62 may be included to provide a bias for the collector 67 of the transistor 65.

It will be apparent that the coil 59 has a very low resistance except while conducting. Accordingly, the resistance 61 is preferably included for the purpose of preventing the PNP transistor 65 from conducting heavily during periods when the coil 59 is not conducting.

Referring again to the tone sensitive circuit 16 depicted in FIG. 2, an NPN transistor 54 may be provided therein with its base 57 connected to the upper end of the coil 59, and with its emitter 55 connected through the resistor 58 to the grounded end of the winding 38A of the relay 38. The collector 56 of the transistor 54 is connected to the junction between resistor 52 and capacitor 53.

The PNP transistor 47 is arranged with its base 50 connected to receive the amplified message control signal 5B from the junction between resistors 52 and 51. Accordingly, the emitter 48 of transistor 47 is preferably connected to the junction between resistor 51 and the opposite end of the capacitor 53, and the collector 49 is connected to the junction between resistors 45 and 46, and the base 44 of NPN transistor 41. Thus, the amplified signal 5B is further amplified for energizing the winding 38A of the relay 38, as well as for actuating the fader circuit 10.

In other words, it is a function of the transistor 41 to control the flow of current through the winding, of the relay 38. Accordingly, the emitter 42 is preferably connected to provide current flow through the winding 38A, and the collector 43 is connected through resistance 40 to the emitter 48 of the amplifying transistor 47 to regulate such flow. As will be apparent, it is a function of the resistor 45 to maintain the transistor 41 in a non-conducting state except when a voltage appears on the collector 49 of the transistor 47. It is also a function of resistor 45 to restore a biasing voltage to the PNP transistor 47 after the NPN transistor 54 ceases to conduct. Thus, the capacitor 53 stabilizes the voltage on the collector 56 of the NPN transistor 54.

During the normal condition of the system, the fader circuit 10 is inactive, and the music signal 3 will be amplified by the NPN transistor 88 and conducted through the potentiometer 92 to the PNP transistor 95. Accordingly, the position of the wiper 94 of the potentiometer 92 determines the magnitude of the audio signal 11 which passes through the coupling capacitor 103 to the input terminals (not depicted) of the audio amplifier 12. Furthermore, it may be noted that the capacitor 79 and resistor 73 will function with the transistor 88 as part of the first audio amplification stage (not depicted) of the audio amplifier 12.

During normal operation of the system depicted in the drawings, it will be noted that the PNP transistor 47 in the tone control circuit 16 is nonconducting. Accordingly, there will be no voltage drop across resistor 46, and thus the fader control signal 17 will not be produced. However, when the message control signal 5B is applied to the tone sensitive circuit 16, as will hereinafter be explained in detail, a voltage will develop across the resistor 46, which will constitute the fader control signal 17, and when this voltage 17 is applied to the emitter 89 of the NPN transistor 88, a charge will be developed on the capacitor 79.

The resistor 73 functions to establish the charge rate of the capacitor 79, and also to apply a biasing voltage to the transistor 88 to thereby limit conduction of the music signal 3 across transistor 88. Accordingly, the voltage developed across the resistor 73 is functionally related to the magnitude of the amount of charge on the capacitor 79, and since the capacitor 79 is charged gradually, the voltage across resistor 73 will also be developed gradually in a like manner. Therefore, the biasing voltage which is applied to the emitter 89 of the NPN transistor 88 is also developed in a correspondingly gradual manner, and it is this effect which "fades" out the music signal 3 being conducted across the NPN transistor 88.

As hereinbefore stated, the message control signal 5B renders transistors 54 and 47 conductive, when it enters the tone sensitive circuit 16, to thereby develop the voltage across resistor 46 which constitutes the fader control signal 17. The transistor 41 will then conduct current through the winding 38A and the relay 38 will then keep the relay switch 39 closed to maintain the message tape deck 4 motor operating even though the transistor 33 in the relay control circuit 6 has ceased to conduct. Accordingly, it is necessary for this purpose that the transistor 41 begin conducting before the transistor 33 ceases to conduct.

The message tape deck 4 preferably utilizes an endless tape to avoid the need for rewinding circuitry. Accordingly, both the message signal 5A and the message control signal 5B terminate at the same instant, to thereby deactivate the tone control circuit 16 upon completion of the message signal 5A. This, in turn, terminates the activating signal from the winding 38A of the relay 38, and the relay 38 will accordingly open the relay switch 39. The fader control signal 17 is now discontinued from the fader circuit 10. However, it should be noted that the capacitor 79 will discharge at substantially the same gradual manner and rate as which it was charged. Accordingly, the back-biasing voltage then being applied to the emitter 89 of the NPN transistor 88 will decline and disappear in the same gradual manner as it was originally generated, and the fader circuit 10 will thereupon fade the music signal 3 back into the audio amplifier 12 in the same gradual manner that it was gradually faded out.

Although the concept of the invention has been described with respect to a music and advertising system, it will be apparent that the advantages of the invention will be available in many different applications, since the basic purpose is to suppress a primary signal and to substitute a secondary signal for the suppressed primary signal. Thus, both the primary and secondary signals may be generated by any suitable means, although a motor controlled tape deck is particularly suitable for this purpose.

Many other modifications may be made in the techniques and structures depicted and described herein without departing from the central concept of the present invention. Accordingly, the techniques and structures depicted and described herein are intended only as examples and not as limitations on the scope of the invention.

What is claimed is:

1. A method of suppressing a primary signal and of substituting a secondary signal for said suppressed primary signal, comprising

generating a primary signal during an indeterminate time interval,

generating a tone control signal at an increasing frequency during a first preselected discrete portion of said indeterminate interval and at a constant preselected frequency during a subsequent second preselected discrete portion of said indeterminate interval,

gradually suppressing said primary signal according to said increasing frequency during said first preselected portion of said indeterminate interval,

generating a secondary signal during said second discrete portion beginning with and during such suppression of said primary signal, and

substituting said secondary signal for said primary signal.

2. The method described in claim 1, including the steps of

terminating said secondary signal at the expiration of said second time portion

reducing the frequency of said tone control signal upon said termination of said secondary signal, and

replacing said terminated signal with said primary signal.

3. The method described in claim 2, wherein said primary signal is gradually restored following discontinuance of said tone control frequency.

4. A system for suppressing a primary signal in favor of a secondary signal, comprising

primary signalling means for continually generating a primary signal,

tape deck means for generating a secondary signal during a first discrete time interval and a tone control frequency during a second discrete time interval commencing prior to and extending through said first interval,

power means for producing a supply of power to said primary signalling means,

rotatable motor means for driving said tape deck means,

normally-open relay means for connecting said motor means to said power means,

timer means for providing an actuating pulse to close said relay means for the duration of said actuating pulse,

tone sensitive means responsive to said tone control frequency for generating a first control voltage signal functionally related in magnitude to the frequency of said tone control frequency and a second control signal for keeping said relay means closed after expiration of said actuating pulse, and

fader means responsive to said first control voltage for opposing said primary signal generated by said primary signalling means.

5. The system described in claim 4, wherein said tone control frequency is functionally dependent on the rotational velocity of said motor means, and wherein said first control voltage is functionally dependent in magnitude on said tone control frequency.

6. The system described in claim 5, wherein said system further includes

utilization means interconnected to receive said primary signal from said fader means and said secondary signal from said tape deck means.

7. The system described in claim 6, wherein said fader means includes

first circuit means for receiving said primary signal from said primary signalling means,

second circuit means for transmitting said received primary signal to said utilization means, and

third circuit means for receiving and putting said first control voltage into opposition to said primary signal at a magnitude great enough to block said primary signal from said utilization means when said motor means attains a predetermined rotational velocity.

8. The system described in claim 7, wherein said first time interval commences after said motor means has attained said predetermined rotational velocity.

9. A switching system for suppressing a primary signal in favor of a secondary signal, comprising

a primary signal means for generating a primary signal,

a secondary signal means for generating a tone control signal during a first discrete time interval and a secondary signal during a second discrete time interval commencing after the beginning of said first time interval, said secondary signal means further generating said tone control signal at an increased frequency during the period between said first and second discrete intervals and at a constant preselected frequency throughout said second discrete time interval, and

a control means responsive to said tone control signal for gradually suppressing said primary signal as a function of said increasing frequency of said tone control signal and for thereafter substituting said secondary signal for said suppressed primary signal during said second time interval.

10. The system as described in claim 9 wherein said control means further includes

tone sensitive means for generating a control voltage having an amplitude functionally related to the frequency of said tone control signal, and

fading means for receiving and suppressing said primary signal as a function of said control voltage.

11. The system as described in claim 10 wherein said fading means includes

a stage for receiving and transmitting said primary signal, and

suppression means responsive to said control voltage provided by said tone sensitive means for providing a blocking voltage to said stage having an amplitude functionally related to the amplitude of said control voltage from said tone sensitive means.

12. The system as described in claim 11 wherein said suppression means includes

resonance means responsive to said tone control signal for providing an actuating voltage,

biasing means for producing said blocking voltage with a magnitude functionally related to the magnitude of said actuating voltage and for applying said blocking voltage to said receiving and transmitting stage in opposition to said primary signal, and

storage means for regulating the magnitude of said actuating voltage.

13. The system as described in claim 12 wherein said storage means accumulates a charge from said actuating voltage and wherein said storage means discharges said accumulated charge in opposition to said primary signal upon termination of said blocking voltage by said biasing circuit.

14. The system described in claim 13, wherein said suppression means further includes means for generating an energizing voltage for maintaining said secondary signal source energized during generation of said tone control signal.

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