US 20030028273A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2003/0028273 A1

Lydecker et al. (43) Pub. Date: Feb. 6, 2003

(54) RECORDING AND PLAYBACK CONTROL SYSTEM

(76) Inventors: **George Lydecker**, Burbank, CA (US); **Alan J. McPherson**, Burbank, CA (US); **Edwin Outwater III**, Santa Monica, CA (US); **Gregory Thagard**, Encino, CA (US)

Correspondence Address:
GOTTLIEB RACKMAN & REISMAN PC
270 MADISON AVENUE
8TH FLOOR
NEW YORK, NY 100160601

(21) Appl. No.: **10/263,979**

(22) Filed: **Oct. 3, 2002**

Related U.S. Application Data

(62) Division of application No. 08/850,996, filed on May 5, 1997.

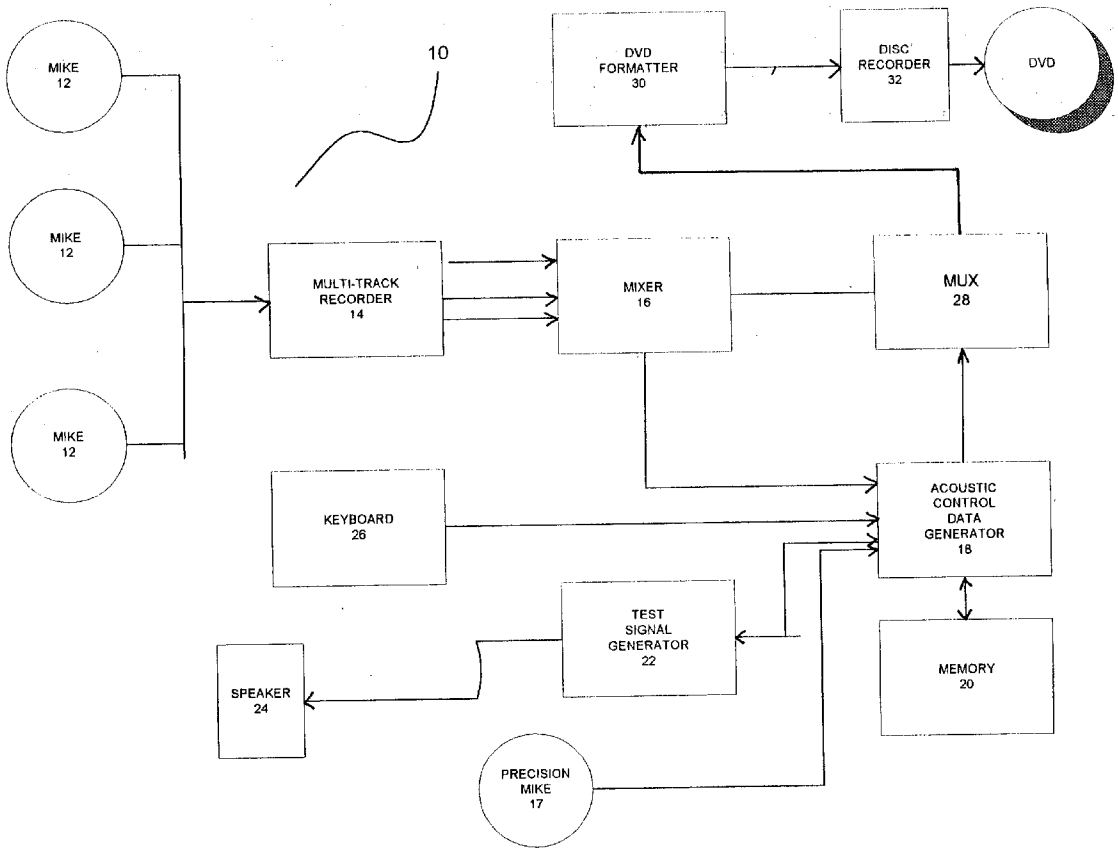
Publication Classification

(51) **Int. Cl.**[7] **G06F 17/00**

(52) **U.S. Cl.** **700/94**

(57) **ABSTRACT**

The invention is a system for recording and reading both program data and acoustical control data and playing back the data to optimize performance of audio reproduction and recreate the effect of an original acoustic environment. The system has a recording apparatus, a playback apparatus and a recording media. The recording apparatus produces recording media having both acoustic control information and audio data. The playback apparatus gives the user some ability to override otherwise automatic parameter adjustments. Optionally, a metadata display system takes information about the physical arrangement of instruments and other characteristics of the recording session and the recording studio and makes that visually available to the listener. A player type register identifies the characteristics of the playback device to cause an adjustment of the characteristics of the playback system.



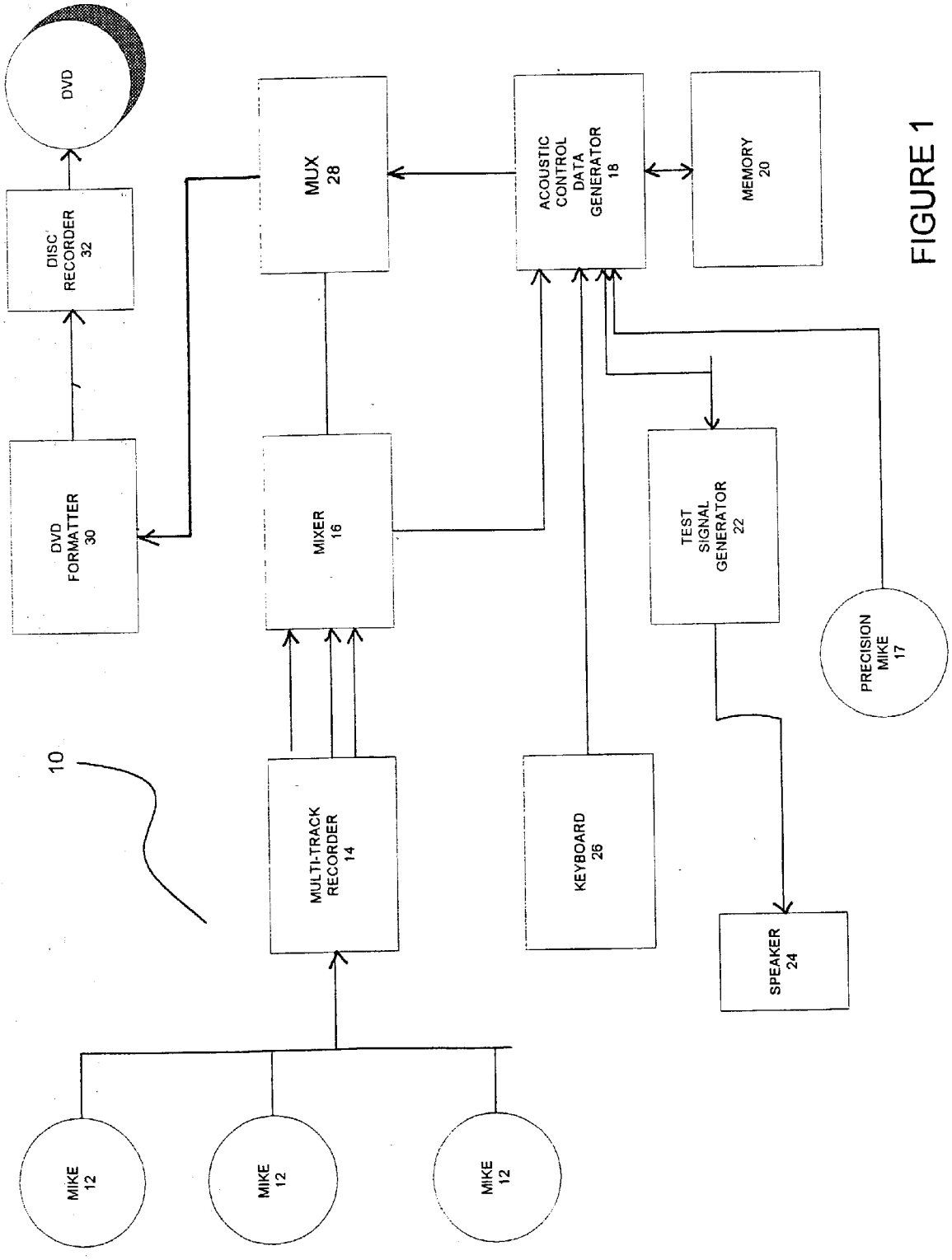

DVD
DISC RECORDER 32
DVD FORMATTER 30
MUX 28
MIXER 16
ACOUSTIC CONTROL DATA GENERATOR 18
MEMORY 20
TEST SIGNAL GENERATOR 22
PRECISION MIKE 17
SPEAKER 24
KEYBOARD 26
MULTI-TRACK RECORDER 14
10
MIKE 12
MIKE 12
MIKE 12

FIGURE 1

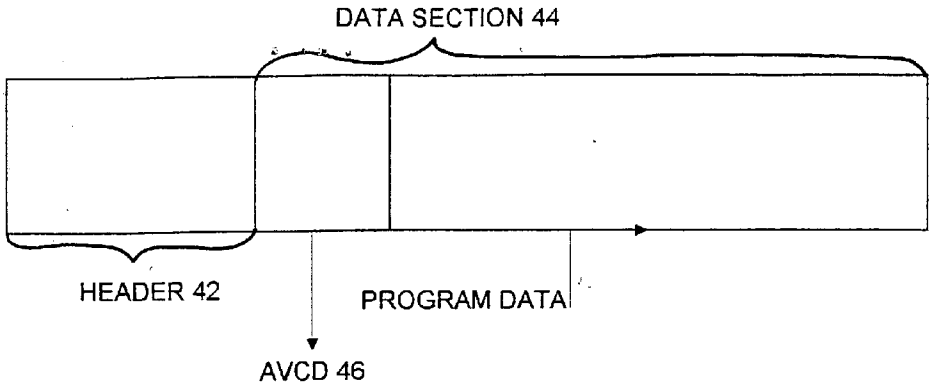


FIGURE 2

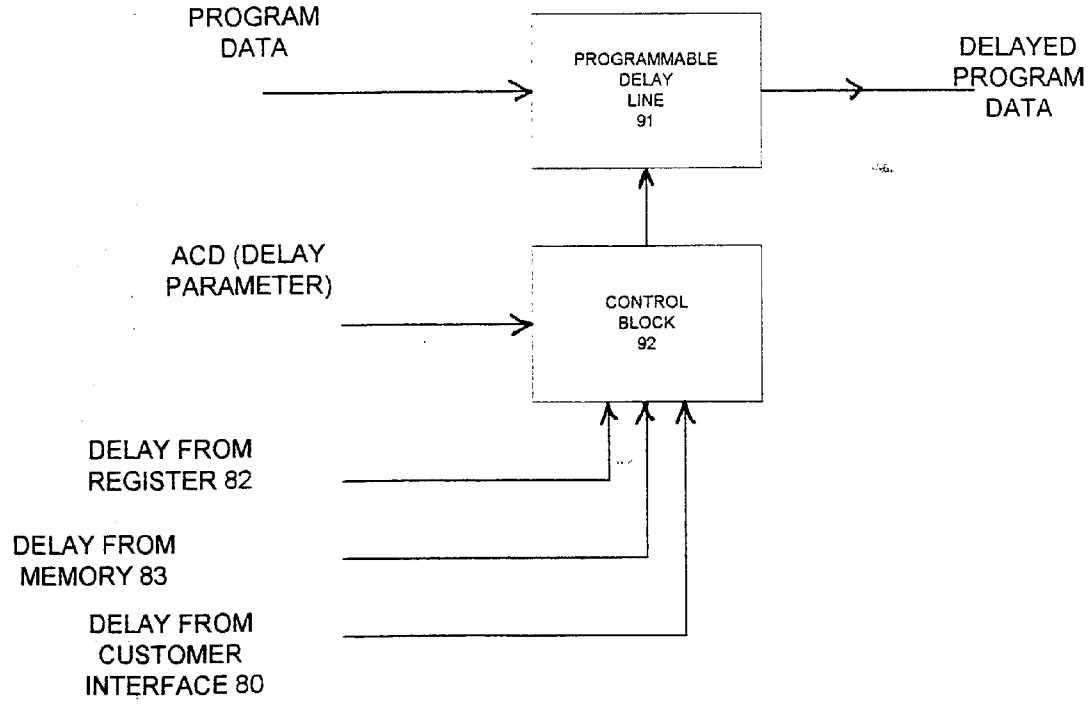


FIGURE 4

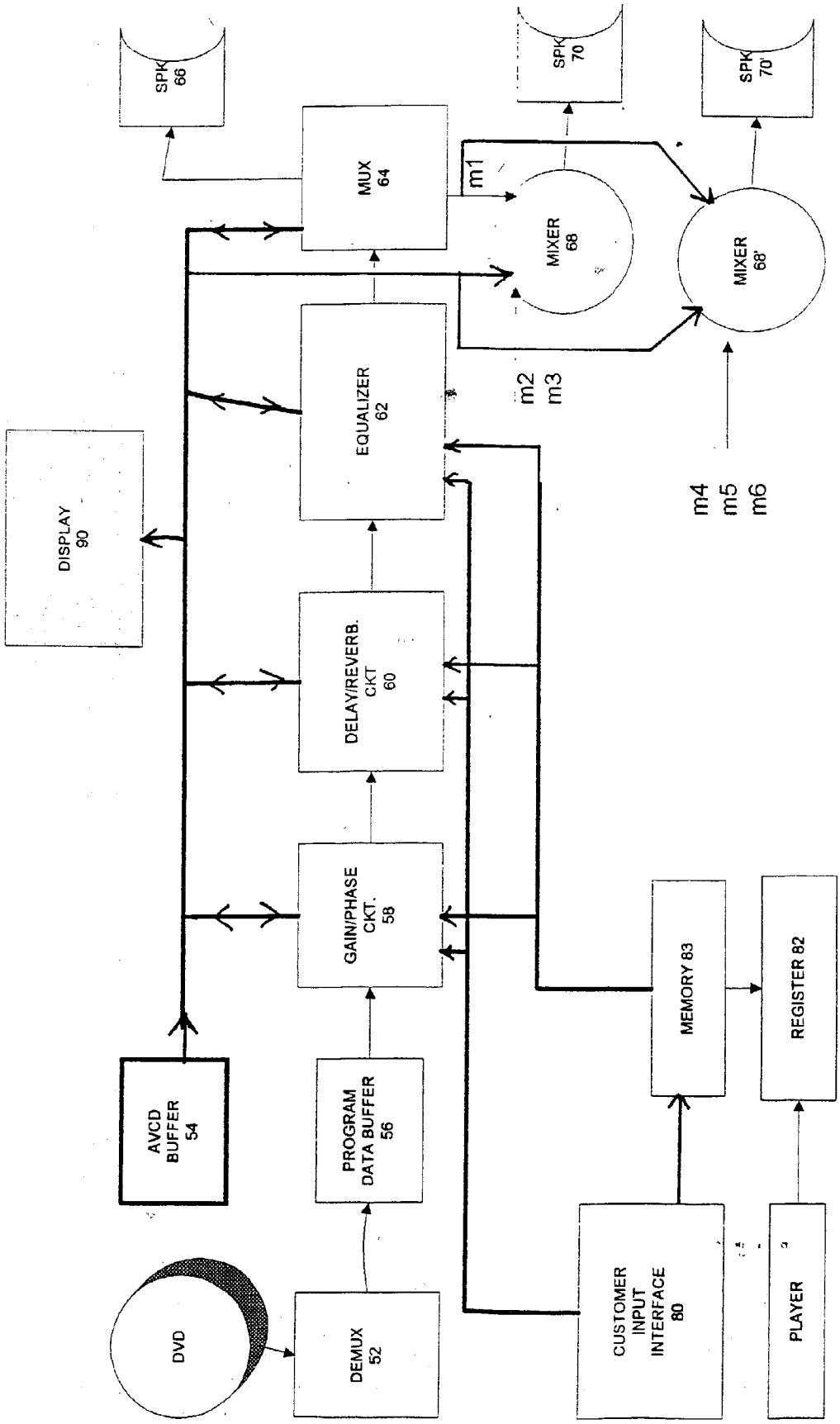

SPK 66
SPK 70
SPK 70'
MUX 64
m1
MIXER 68
MIXER 68'
EQUALIZER 62
m2
m3
m4
m5
m6
DISPLAY 90
DELAY/REVERB. CKT 60
GAIN/PHASE CKT. 58
AVCD BUFFER 54
PROGRAM DATA BUFFER 56
MEMORY 83
REGISTER 82
DVD
DEMUX 52
CUSTOMER INPUT INTERFACE 80
PLAYER

FIGURE 3

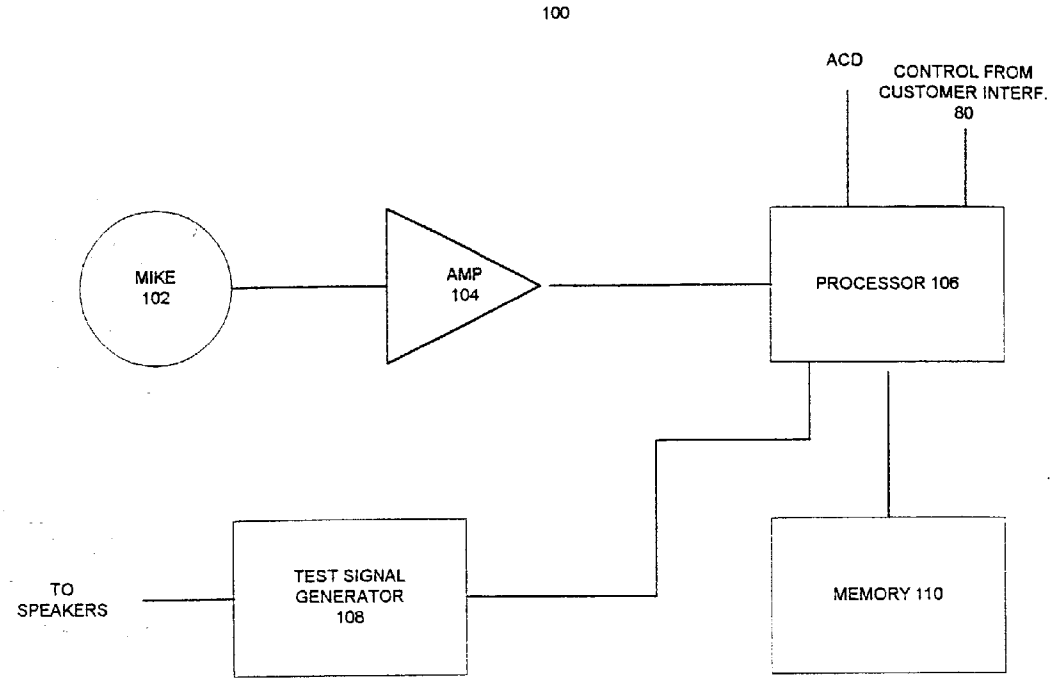


FIGURE 5

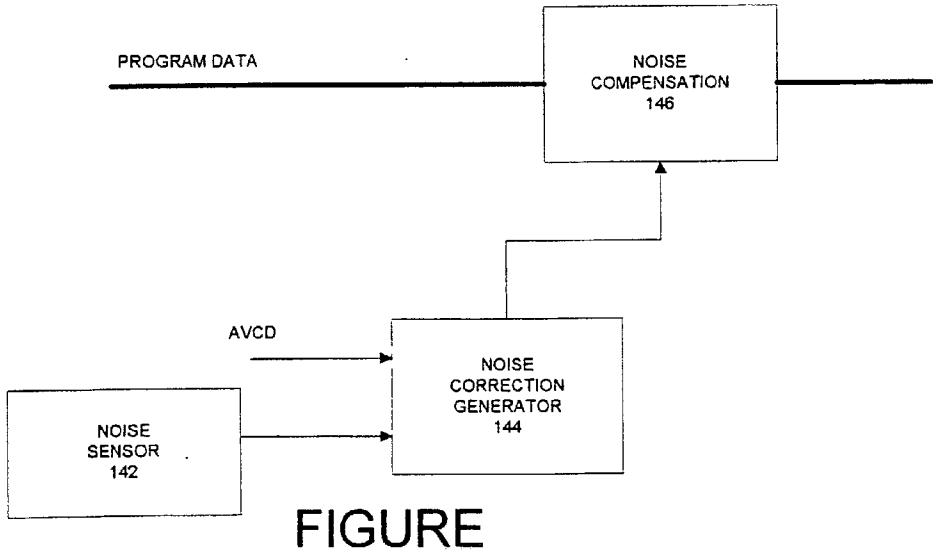


FIGURE 6

RECORDING AND PLAYBACK CONTROL SYSTEM

FIELD OF THE INVENTION

[0001] This invention relates to systems for recording and playing back audio information on optical recording media. In particular, it relates to such systems that compensate for the differences between the characteristics of the recording and playback sites.

BACKGROUND OF THE INVENTION

[0002] The present invention is concerned with apparatus and methods for playing back recorded material from media, particularly, but not strictly limited to high density optical recording media such as DVD discs containing acoustic data, e.g., music. For purposes of this disclosure, the term "music" is to be understood throughout to include the possibility of video. A serious limitation of the present systems is that they record music in a studio or a concert hall and leave it to the listener/viewer (herein termed the "listener") to adjust the playback apparatus to attempt to reproduce the artist's intended sound in a different playback site, i.e., his home, or car. However, because the recording and playback sites almost always have different acoustic characteristics, it is not feasible for the listener satisfactorily to manage the adjustment of the playback equipment.

SUMMARY OF THE INVENTION

[0003] The present invention provides a system for recording and reading audio visual control data (herein termed "acoustic control data"), together with the musical program data, and playing back the program data in accordance with the acoustical control data to optimize performance of audio reproduction and recreate the original acoustic environment. Basically, it provides a system for incorporating the acoustic control data into the information stored on the media and, during playback, provides components responsive to the control data during the playing back of the musical program. The acoustic control data includes several parameters and may be used to adjust the operation of the playback system as accurately and as often as desired, down to millisecond intervals.

[0004] The system of the invention comprises a recording apparatus, a playback apparatus and a high density digital recording media, such as DVD. The recording apparatus comprises in addition to the standard equipment, a precision microphone, a controller, a test signal generator and a data multiplexer to produce recording media having both the acoustic control information and the audio data.

[0005] The playback system comprises a demultiplexer, a customer input interface giving the user some ability to override the otherwise automatic parameter adjustments, optionally a metadata display system that takes information about the physical arrangement of instruments in the recording studio and makes that information visually available to the listener, and a register that identifies the characteristics of the playback apparatus. The playback apparatus further includes data processing components for processing the acoustic program data, these components being dynamically controlled using the acoustic control data.

[0006] An open and closed loop control scheme is also provided. In the open loop scheme, the acoustic characteristics of local playback site are provided to the playback apparatus by the listener at the playback apparatus.

[0007] In the closed loop control scheme, the acoustic parameters of the playback site are automatically determined, by generating acoustical test signals and sensing the responses. In either case, the characteristics of the recording and playback sites are compared and used to control the operation of the playback components.

[0008] The playback apparatus may also include a noise cancellation circuit which receives special information of the acoustic program data from the recording site.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] **FIG. 1** shows a block diagram for the recording apparatus;

[0010] **FIG. 2** shows a typical sector on a recording media in accordance with the invention;

[0011] **FIG. 3** shows a block diagram of the playback apparatus;

[0012] **FIG. 4** shows details of the delay circuit;

[0013] **FIG. 5** shows a block diagram for the closed loop control configuration; and

[0014] **FIG. 6** shows a block diagram for a noise cancellation circuit in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] The invention shall now be described for a particular preferred embodiment in conjunction with the drawings. This preferred embodiment of the present system concerns the generation and replaying of audio data recorded on a pure audio DVD (digital versatile disk). The DVD is an optical recording disc medium having very high data density and MPEG compression of the audio data. The system consists, in addition to the DVD, of a recording apparatus, which herein shall refer to collectively all the equipment involved in generating a DVD media having data representative of a live performance of music or other similar performing activity, and a playback apparatus in which the data from the DVD is reproduced for the listening pleasure of a customer.

[0016] Referring to **FIG. 1**, the recording apparatus **10** is disposed at a recording site or venue. It includes a plurality of primary microphones **12** used for picking up sounds generated during the performing activity. The signals generated by these microphones **12** are fed to a multichannel recorder **14**. The signals may be stored in the recorder **14**, for later processing or may be fed immediately to a mixer **16**. The mixer **16** combines these signals into a multi-channel and stereo stream of audio data, which for the sake of simplicity, shall be referred to as the program data.

[0017] An important feature of the present invention is that prior to the performance being recorded, a data generator **18** determines the acoustic conditions of the recording venue and/or control room for the performance and stores the same in a memory **20**. In order to determine these conditions, the generator **18** activates a test signal generator **22** which in response generates a predetermined test signal to an auxiliary speaker **24**. A precision microphone **17** senses

the response at the recording locale to the test signal and sends the same to generator **18** and stores it in memory **20**. The recording locale (or venue) is the actual zone where the performance takes place. In addition, the data generator **18** also receives mixing information from the mixer **16** and stores the same in memory **20** as well. Additionally, the producer of the performance may enter specific data regarding the reproduction of the performance to memory **20** via a keyboard **26**. All of this information shall be referred to collectively as acoustical control data.

[**0018**] The acoustical control data stored in memory **20** is interleaved with the audio information on the DVD as described more fully below and is used during the playing of the DVD, either to recreate the conditions under which the recording was made and/or other conditions selected by the producer. More particularly, the memory **20** contains information descriptive of the acoustic characteristic of the room where the recording occurs. Of course these characteristics are dependent on the size of the room, the composition of the wall coverings, the height, etc, all of which affect how the sounds are recorded. These characteristics in turn affect certain acoustical properties such as delay, reverberation, and so on, and are determined by data generator **18** from the response to the test signal from generator **22**.

[**0019**] In addition, the manner in which the sounds from the different microphones **12** are mixed, i.e. the various proportions or ratios are important when the performance is replayed, especially in a multichannel system since, for most accurate reproduction, the sounds should be replayed by speakers in proportions corresponding to these mixing ratios as described below. Accordingly, this information is also recorded in memory **20**.

[**0020**] Finally, the producer may desire to change some of these characteristics. This is especially desirable if when multichannel signals are folded down to generate two-channel stereo sounds. The producer has the ability to define the fold down characteristics using keyboard **26**.

[**0021**] The producer may optionally also provide to the data generator various other parameters. Alternatively, this information may be provided automatically from the mixer **16**, the recording equipment or another microphone. Some of these parameters are:

[**0022**] instrumental placement;

[**0023**] instrument separation partition placement;

[**0024**] peak or RMS limiting in the mixer **16**;

[**0025**] equalization, compression and other similar recording information;

[**0026**] studio and/or control room dynamic data such as reverb time, delay time, standing waves, ambient noise;

[**0027**] room frequency response, room dynamic information; etc.

[**0028**] The acoustical visual control data, or AVCD, is fed to multiplexer **28** which combines the program data with this AVCD and feeds the same to a formatter **30**. Formatter **30** partitions the combined data and, if necessary, adds additional data including for example parity codes, error correction codes, etc., in conformance with a particular DVD standard used. The resulting data is recorded on a DVD by a recording device **32**.

[**0029**] A typical data sector **40** shown in **FIG. 2** and consists of a header portion **42** and a data portion **44**. In a typical DVD scheme, the data portion **44**, which normally is reserved to the actual program data is 2048 bytes and the header portion **42**, which carries other types of signals and contains 156 bytes. In the present invention, a small section **46** is carved out, preferably of the data portion **44**, as shown, and dedicated for the AVCD signals. In **FIG. 2**, section **46** is shown at the beginning of the data portion **44**, however it may be disposed at other locations as well.

[**0030**] While in **FIG. 2**, AVCD is shown as being provided in a sector **40**, it should be understood that this data need not be repeated in every sector. Instead, the AVCD may be provided in every sector on the DVD or, in an ultimate case, once for each DVD.

[**0031**] The other portion of the subject system is the playback apparatus. As shown in **FIG. 3**, this playback apparatus **50** includes a demultiplexer **52**, an AVCD buffer **54** for the AVCD signal and a buffer **56** for the program data. The demultiplexer **52** separates the AVCD and the program data for the respective buffers **54**, **56** from the incoming data as it is read off the DVD. It also reads the header information and performs other control functions, such as error correction, which do not form a part of this invention. A DVD player which shows details of such a demultiplexer is disclosed in U.S. Pat. No. 5,463,565, incorporated herein by reference.

[**0032**] Preferably player **50** is a multichannel audio DVD player capable of generating six channels. (Such players are commonly referred to as generating 5.1 channels, the last channel being dedicated to a low frequency subwoofer.)

[**0033**] The program data from buffer **56** is fed via six lines L1-L6, to six processing channels. Typical processing circuits are shown in **FIG. 3** for one channel, it being understood that the elements for the other channels are substantially identical.

[**0034**] The program on L1 is fed first to a gain/phase circuit **58** for amplification, gain adjustment and phase correction in accordance with certain control signals as described below.

[**0035**] The adjusted signals are sent to a delay/reverberation circuit **60** where the delay of the signals for appropriate reverberation are adjusted. The signals are next sent to an equalizer **62**. After equalization, the signals are sent to a multiplexer **64**.

[**0036**] The operation of the multiplexer **64** is dependent on the number and arrangement of speakers that the costumer wants to use. For a full 5.1 channel surround sound, the multiplexer sends the signals to an appropriate speaker **66**, it being understood that similar speakers are provided for each of the other channels.

[**0037**] To achieve two channel 'stereo sound', the multiplexer **64** first sends the sounds for channel **1** to a mixer **68** on line m**1**. This mixer **68** also receives signals on lines m**2**, m**3** for signals from other channels. The signals from these channels are mixed at certain ratios described more fully below, to generate a 'left' signal for a speaker **70**. Similarly signals from lines m**3**, m**4**, m**5** generated by other channels (not shown) are fed to a second mixer **68'** where they are combined to generate a so-called 'right' signal for a speaker

70'. Thus, in effect, the two mixers **68**, **68'** fold the signals from six channels into a standard two-channel stereo signals.

[**0038**] In addition, the playback apparatus **50** further includes a customer input interface **80** and a register **82**. The customer input interface **80** is used by the customer to input his preferences, and, if so desired, to override the AVCD as described more fully below. The register **82** is used by the manufacturer to store certain device specific information, such as whether the player is an automobile player, a home player, a personal or portable player, a studio player, and so on.

[**0039**] The goal of any sound player is to reproduce a recorded performance as accurately as possible by recreating the conditions under which it was recorded. Of course, the acoustic characteristics of the playback site play an important role in the accuracy of the reproduction. These characteristics include the physical dimensions of the room where the playback apparatus is to be used, including characteristics of the walls, the location of the speakers, etc. For best reproduction quality, the playback apparatus **50** should have information descriptive of all these characteristics.

[**0040**] Two configurations are envisioned for providing these local characteristics to the playback apparatus **50**. In one configuration, an open loop control is used. In this configuration, the customer provides the descriptive information to the playback apparatus **50**. For example, in response to prompts, the customer may enter the size of the room, the location of the speakers, etc. This information is then stored in memory **83**. In addition, related acoustic parameters, are also determined and stored in memory **83**.

[**0041**] The information from memory **83** and register **82** is used by each of the elements **58**, **60**, **62**, **64** in conjunction with the ACD information from buffer **54** to perform their respective functions. This feature of the invention is best explained in conjunction with a specific element. **FIG. 4** shows details of the delay circuit **60**. The delay circuit **60** includes a programmable delay line **91** and a control block **92**. The control block receives a reference delay parameter which is one of the parameters of the AVCD and is determined at the recording site **10**. The control block also receives an input from register **82**, or memory **83**.

[**0042**] Control block **92** may be for example a look-up table which uses the information received to generate an appropriate delay for the signals of channel **1**, by comparing for example the delay characteristic of the room with the optimal delay indicated by the reference delay parameter. This delay control signal is then fed to programmable delay line **91**. For example, the original performance may have been recorded in a concert hall having a delay time of 2 seconds. On the other hand the customer may be keeping his player in relatively small room with a delay of 0.5 seconds. Therefore for optimum playing a delay of 1.5 sec is required. This delay is developed by delay line **91** as defined by the control block **92**.

[**0043**] Of course, the customer may desire to have the sounds played with different characteristics. He may chose these characteristics using the customer interface **80**. When the customer makes his choice, rather then having the system generate the delay automatically, the customer choice is fed to the controller block **92** from memory **80** and is used to override any previous decisions.

[**0044**] Thus the operation of each of the elements **58**, **60**, **62**, **64** is adjusted using information from the AVCD, the register **82**, memory **83** and the customer input interface **80**.

[**0045**] Of particular importance are the mixing ratios used by mixer **68**. As discussed above, these ratios can be set using information from the ACD which is derived from information on how the mixer **16** is set, and, optionally, the ratios set by the producer using keyboard **26**.

[**0046**] In the second configuration of the invention a closed loop control system is used. In this configuration, a control circuit **100** is provided which includes (**FIG. 5**) a microphone **102**, an amplifier **104**, a processor **106**, and test generator **108**. The test generator is used to generate on command a test signal. For example, the test generator may be used to generate pink noise, or a particular test sound defined by the AVCD. This test signal is transmitted to the speakers of the player **50**. The test may be identical to the test signal from generator **22**.

[**0047**] Preferably the microphone **102** is located, at least temporarily, at a central location within the room wherever the customer prefers to listen to the player. The microphone **102** is connected via the amplifier **104** to the processor **106** either by direct wiring or by an indirect coupling such as RF, IR, or other similar means.

[**0048**] In any event, the processor **106** routes the test signals from generator **108** to each of the speakers **66** serially and/or simultaneously to allow the processor to analyze the acoustic characteristics of the customer's listening room, including its size, wall covering, speaker locations, and so on. Thus, instead of having the customer enter information and calculating these characteristics, the characteristics are obtained directly. These characteristics may have to be adjusted to compensate for changes in the room.

[**0049**] After the characteristics are obtained as described, they are stored in a memory **110**. The information from this memory is then used in the same manner as the information from memory **83**. Register **82** is still used to store player specific information.

[**0050**] The AVCD may be used for other important information as well. For instance, many high quality players, especially players designed to be used in automobiles, may include a noise cancellation circuit for canceling road noise. Noise cancellation may be advantageously incorporated into the present system as follows.

[**0051**] Referring to **FIG. 6, a** noise cancellation circuit **140** includes a noise sensor **142**, a noise correction generator **144** and a mixer **146**. Sensor **142** is used to sense ambient sounds and it may be for example a local microphone. The noise signals thus sensed are fed to the noise correction generator **144**. The noise correction signal also receives from the AVCD information describing the spectral content of the program data on the corresponding channel, for example channel **1**. The noise correction generator **144** analyzes the sensed noise signals and generates noise compensation signals. In this manner, the noise correction generator **144** does not have to perform its own analysis to differentiate between the desirable sound signals and the undesirable noise signals. These compensation signals are added to the program signals by mixer **146**. Mixer **146** in turn mixes the channel **1** signals and the noise correction signals to thereby compensate for noise.

[0052] As previously mentioned, the AVCD may include metadata descriptive of the locations of the instruments, vocalists and/or recording microphones. This information is captured and displayed by a display **90** at the playback apparatus to give the customer a more accurate information about how the performance was recorded.

[0053] Although the invention has been described in terms of specific embodiments, it is intended that the patent cover equivalent substitutions for any of the elements of these embodiments, and that the protection afforded by this patent be determined by the legitimate scope of the following claims.

What is claimed is:

1. A playback system for reproducing audio data and reading acoustic control data comprising

a demultiplexer for retrieving audio data and acoustic control data

said acoustic control data providing a predetermined number N of inputs to

gain and phase circuits,

delay and reverberation circuits,

equalizer circuits, and

gain/attenuation circuits,

said gain/attenuation circuits connected to output to a second predetermined number M of summation channels,

said audio data feeding serially through said

gain and phase circuits,

delay and reverberation circuits, and

equalizer circuits.

2. The playback system for reproducing audio data and reading acoustic control data of claim 1 further comprising a listener input circuit connected to provide signals, said listener input signals adapted to alter default data from said media and to interact dynamically with bias information in said default data.

3. The playback system for reproducing audio data and reading acoustic control data of claim 1 further comprising a player type register providing a signal indicative of parameters of the playback medium to said gain and phase circuits, delay and reverberation circuits, and equalizer circuits to provide information indicative of the characteristics of a player for the media.

4. The playback system for reproducing audio data and reading acoustic control data of claim 2 further comprising a player type register providing a signal indicative of parameters of the playback medium to said gain and phase circuits, delay and reverberation circuits, and equalizer circuits to provide information indicative of the characteristics of a player for the media.

5. The playback system for reproducing audio data and reading acoustic control data of claim 3 wherein said player type register is adapted to provide information to active noise cancellation apparatus.

6. The playback system for reproducing audio data and reading acoustic control data of claim 4 wherein said player type register is adapted to provide information to active noise cancellation apparatus.

7. The playback system for reproducing audio data and reading acoustic control data of claim 1, further comprising, a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

8. The playback system for reproducing audio data and reading acoustic control data of claim 2, further comprising, a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

9. The playback system for reproducing audio data and reading acoustic control data of claim 3, further comprising, a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

10. The playback system for reproducing audio data and reading acoustic control data of claim 4, further comprising, a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

11. The playback system for reproducing audio data and reading acoustic control data of claim 5, further comprising, a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

12. The playback system for reproducing audio data and reading acoustic control data of claim 6, further comprising, a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

13. The playback system for reproducing audio data and reading acoustic control data of claim 1, wherein said playback system further comprises a metadata display system.

14. The playback system for reproducing audio data and reading acoustic control data of claim 7, wherein said playback system further comprises a metadata display system

15. A system for recording acoustical control data to optimize performance of audio reproduction and provide data for the recreation of an original acoustic environment comprising

a recording system comprising

a precision microphone to provide signals to an authoring system and test signal generator,

said authoring system generating and recording acoustic control information comprising acoustic venue information and control room venue information,

said acoustic venue information comprising

studio dynamic data comprising data selected from the group concerning

reverb time,

delay time,

standing waves,

ambient noise,

room frequency response, and

room dynamics information

said control room venue information comprising data concerning

reverb time,

delay time,

standing waves, and

ambient noise

said test signal generator adapted to output preprogrammed test signals for a predetermined time and to detect received returned signals to determine recording acoustic information,

a data multiplexer to bring together as multiplexed data said acoustic control information and audio information,

recording apparatus for fixing said multiplexed data in a medium capable of mass reproduction.

16. The system for recording acoustical control data to optimize performance of audio reproduction and provide data for the recreation of an original acoustic environment of claim 15 wherein said acoustic venue information further comprises

meta data comprising data selected from the group concerning

instrument placement,

instrument separation and partitioning

peak or RMS limiting

console recorded information comprising

equalization

compression.

17. A system for recording and reading acoustical control data and playing back acoustical information controlled by such data to optimize performance of audio reproduction and recreate an original acoustic environment comprising

a recording system comprising

a precision microphone to provide signals to an authoring system and test signal generator,

said authoring system generating and recording acoustic control information comprising acoustic venue information and control room venue information,

said acoustic venue information comprising

meta data comprising data selected from the group concerning

instrument placement,

instrument separation and partitioning placement,

peak or RMS limiting

console recorded information comprising

equalization

compression

studio dynamic data comprising data selected from the group concerning

reverb time,

delay time,

standing waves,

ambient noise,

room frequency response, and

room dynamics information

said control room venue information comprising data selected from the group concerning

reverb time,

delay time,

standing waves, and

ambient noise

said test signal generator adapted to output preprogrammed test signals for a predetermined time and to detect received returned signals to determine recording acoustic information,

a data multiplexer to bring together as multiplexed data said acoustic control information and audio information,

recording apparatus for fixing said multiplexed data in a medium capable of mass reproduction,

media produced from said mass reproduction medium,

a playback system for reproducing audio data and reading acoustic control data comprising

a demultiplexer for retrieving audio data and acoustic control data

said acoustic control data providing a predetermined number N of inputs to gain and

metadata display systems, and

a player type register providing a signal indicative of parameters of the playback medium to said gain and phase circuits, delay and reverberation circuits, and equalizer circuits to provide information indicative of the characteristics of a player for the media,

said player type register adapted to provide information to active noise cancellation apparatus,

a loop closing subsystem interfaced to said playback system comprising

a programmable delay,

a second generator for test signals,

precision microphones to receive returned information from said test signals,

connections to provide parameter corrections to parameters of said playback system.

* * * * *