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(54) **HEADSET AUDIO BYPASS APPARATUS AND METHOD**

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(57) **ABSTRACT**

An apparatus and method provides control over the relative level of audio and background sound for an audio device such as a headset or headphones. An input sound transducer can be provided and configured to convert ambient acoustical pressure into an electrical background signal representing the background sound. Noise cancellation circuitry create a cancellation signal that is the inverse of the electrical background signal. A summing component is coupled to the noise cancellation component and combines the cancellation signal with an audio signal representing audio program content and provides the combined electrical signal to an output sound transducer. A controller is coupled to the noise cancellation component and is configured to control the level of a cancellation signal relative to the audio signal, thereby controlling the mix of cancellation signal and audio signal reaching the output sound transducer.

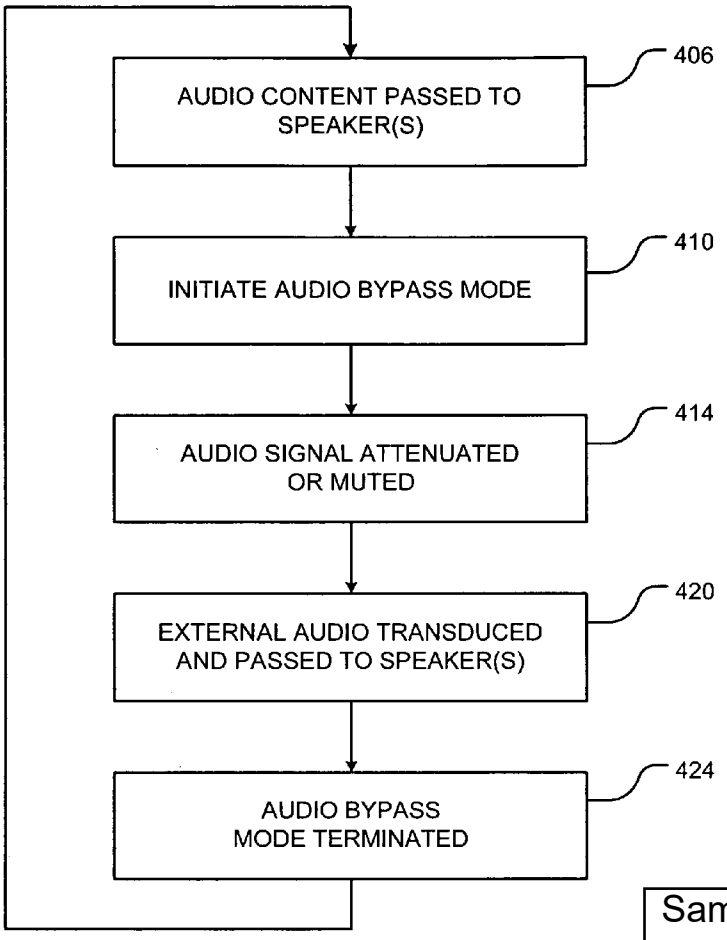

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Exhibit 1016

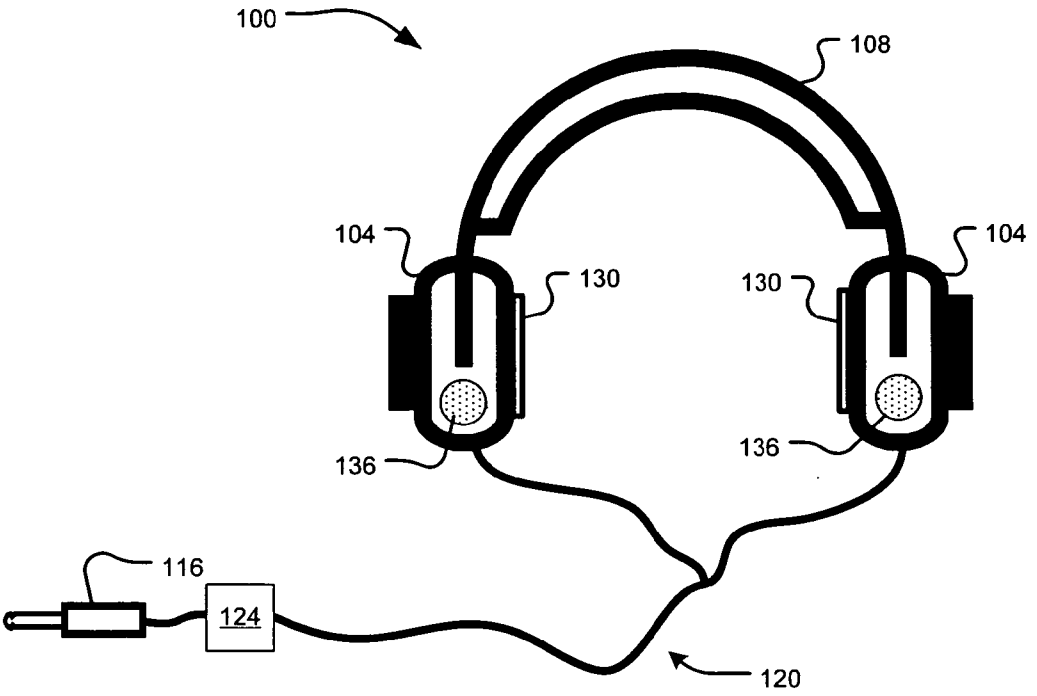
100
108
104
130
130
104
136
136
116
124
120

Fig. 1

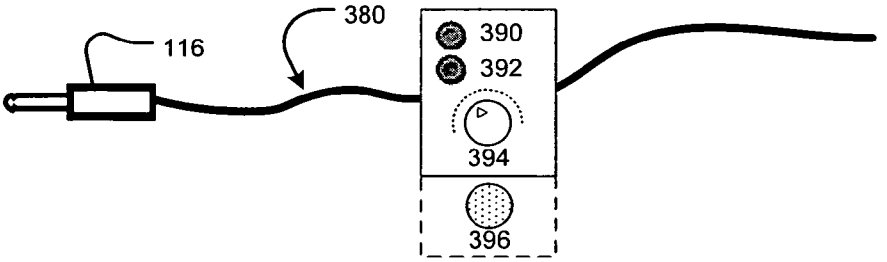
380
116
390
392
394
396

Fig. 11

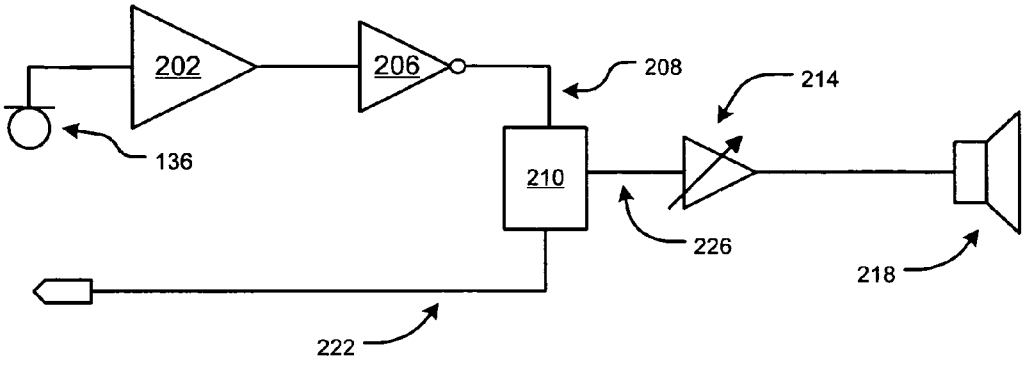
202
206
208
214
136
210
226
218
222

Fig. 2

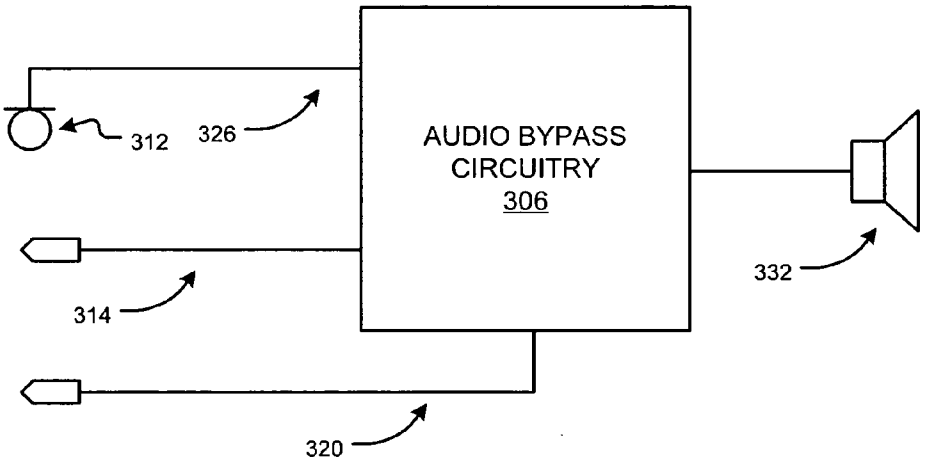
AUDIO BYPASS
CIRCUITRY
306
312
326
314
320
332

Fig. 3

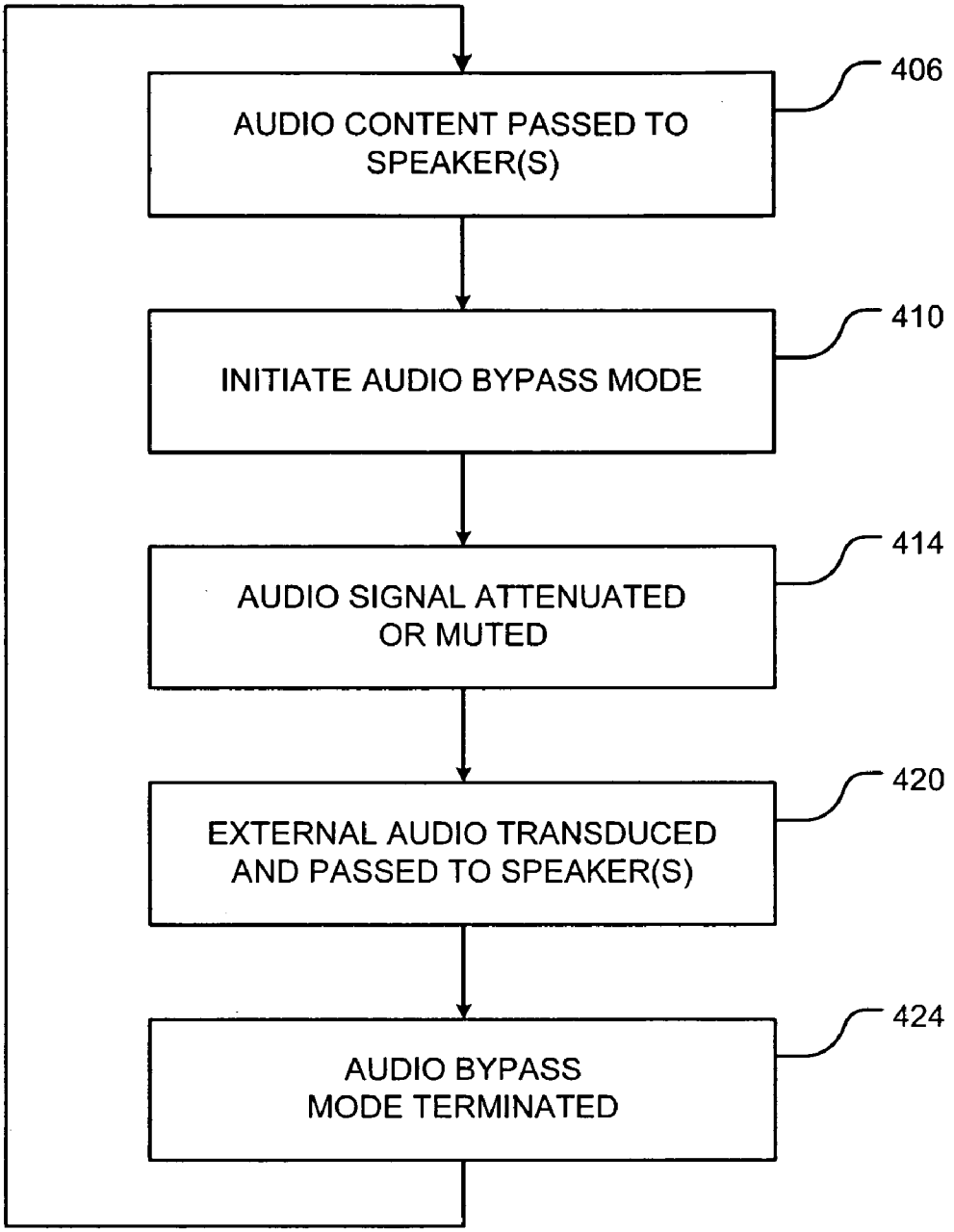
AUDIO CONTENT PASSED TO SPEAKER(S)
406
INITIATE AUDIO BYPASS MODE
410
AUDIO SIGNAL ATTENUATED OR MUTED
414
EXTERNAL AUDIO TRANSDUCED AND PASSED TO SPEAKER(S)
420
AUDIO BYPASS MODE TERMINATED
424

Fig. 4

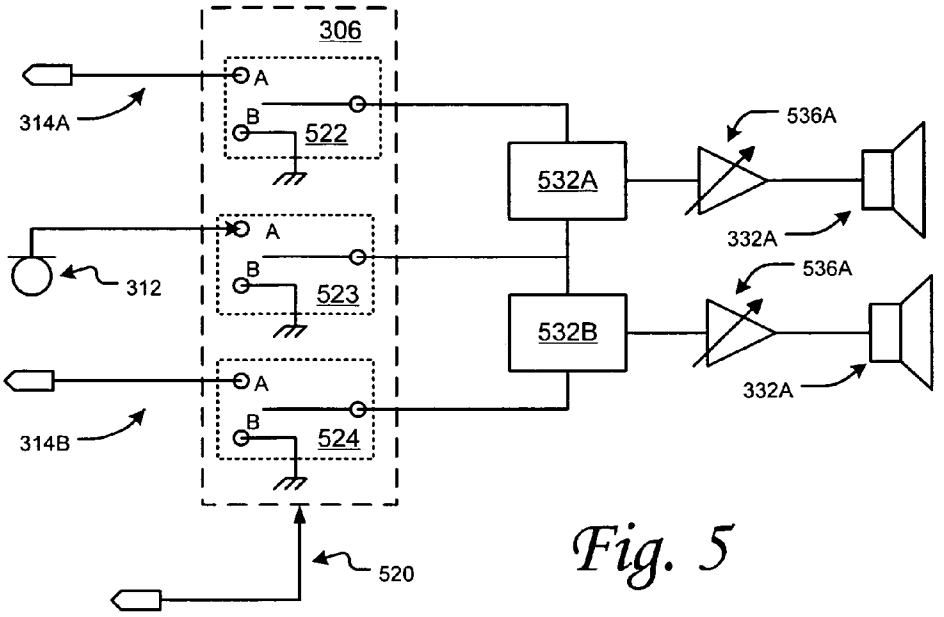
306
A
B
522
314A
536A
532A
332A
A
B
523
312
536A
532B
332A
A
B
524
314B
520

Fig. 5

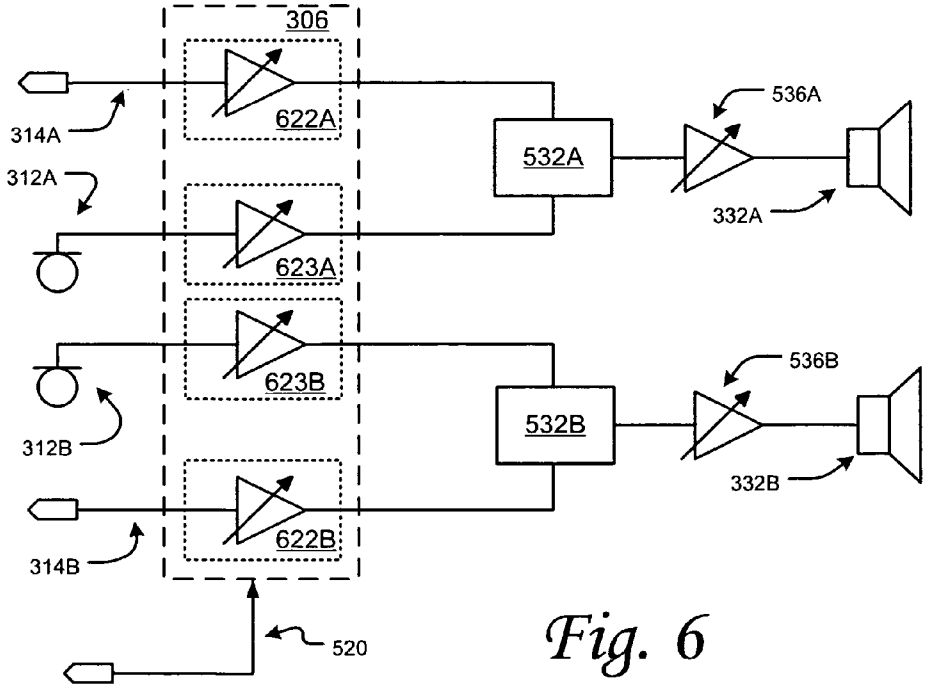
306
622A
314A
536A
532A
332A
312A
623A
623B
536B
532B
312B
332B
622B
314B
520

Fig. 6

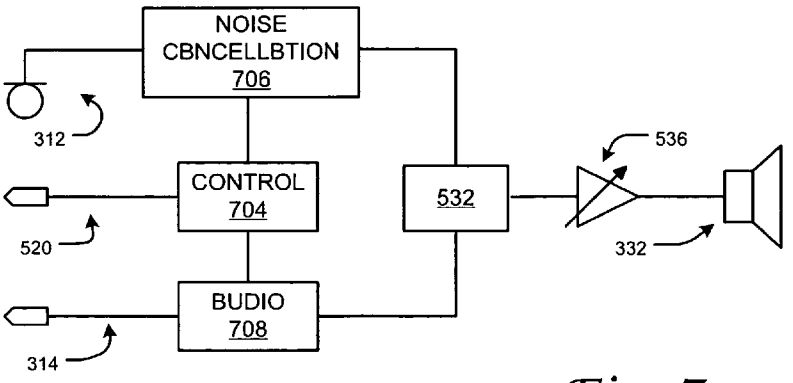
NOISE
CBNCELLBTION
706
312
CONTROL
704
520
BUDIO
708
314
532
536
332

Fig. 7

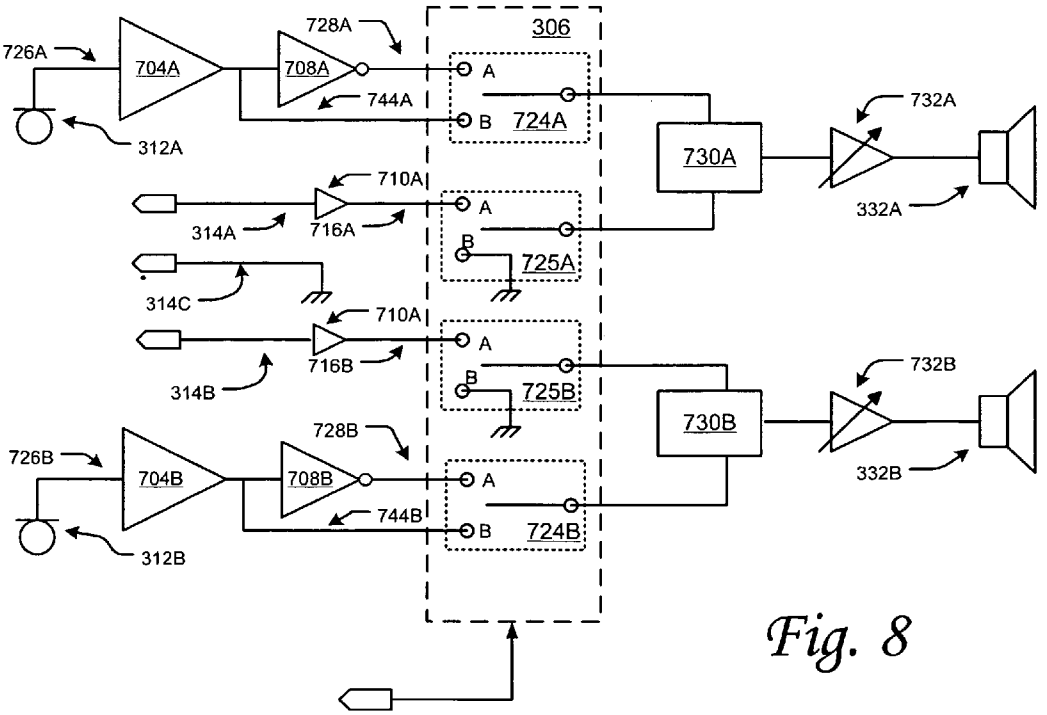
306
726A
704A
728A
708A
744A
312A
A
B
724A
730A
732A
332A
710A
314A
716A
725A
314C
710A
716B
725B
314B
730B
732B
332B
728B
726B
704B
708B
744B
312B
724B

Fig. 8

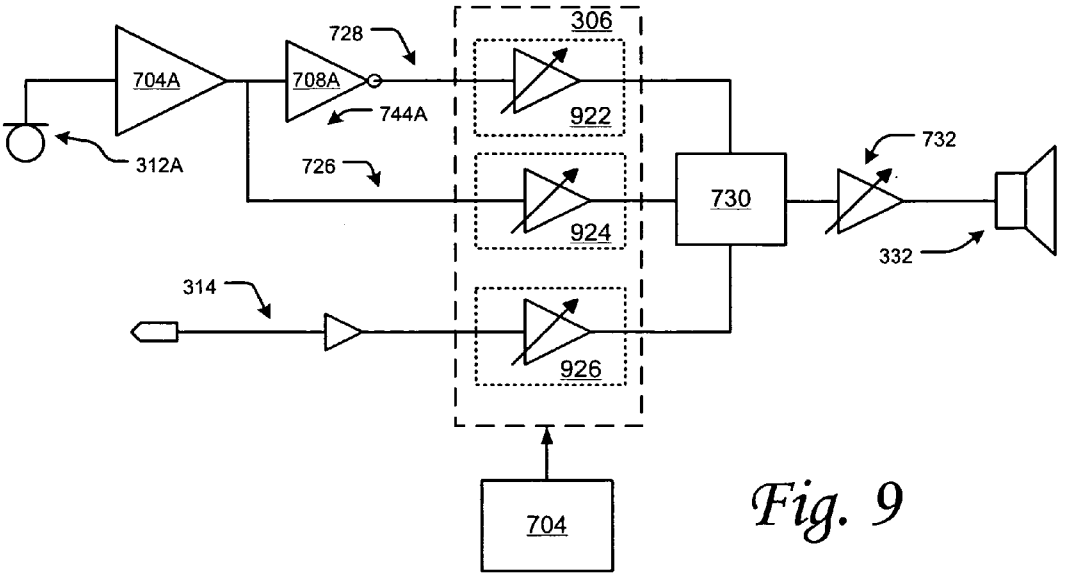
306
728
704A
708A
744A
922
312A
726
730
732
924
332
314
926
704

Fig. 9

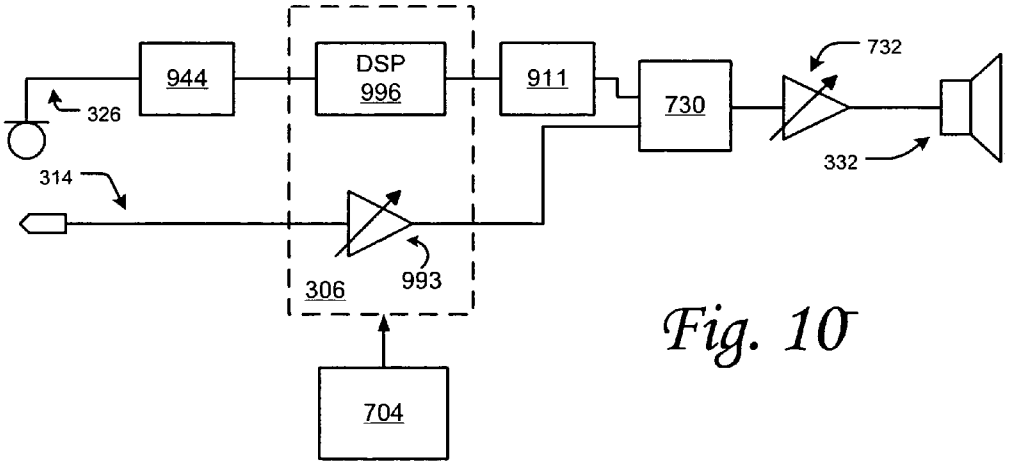
944
DSP
996
911
730
732
326
332
314
306
993
704

Fig. 10

HEADSET AUDIO BYPASS APPARATUS AND METHOD

[0001] This application claims priority to U.S. Patent Provisional Application Ser. No. 60/642,842, filed on Jan. 10, 2005, the disclosures of which are herein incorporated by reference in their entirety.

BACKGROUND OF INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to audio headsets, and more particularly to an apparatus and method to facilitate enhanced usability thereof.

[0004] 2. Description of Related Art

[0005] Our contemporary society enjoys numerous electronic devices that help to make our lives more productive, more comfortable and more efficient. One such device is the audio headset, which is a listening device that allows a user to hear audio material. Early examples of an audio headset included the monaural earpiece that was often seen accompanying the early transistor radio. Modern examples of an audio headset include stereo headphones used by casual listeners and audiophiles alike to enable a personal listening experience even in a public setting.

[0006] With the proliferation of portable audio and video players, the headset market has also exploded. People on the go or at home use an audio headset to allow them to listen to their electronic devices without external interruptions and without disturbing others. For example, on any given airline flight, one will see numerous passengers with his or her own audio or audio/video source such as, for example, a DVD player, MP3 player or the like. Headsets used with these and other devices allow the user to not only play the source material without disturbing others nearby, but also allow the user to at least partially screen out unwanted noises or audible distractions.

[0007] In fact, many contemporary headsets offer active or passive noise rejection or noise cancellation features to provide an enhanced listening experience. For example, passive systems may utilize a relatively tight seal around the perimeter of the ear or around the circumference of the ear canal to insulate the listener from unwanted noises. Active systems, on the other hand, may utilize electronic cancellation of undesirable background audio or noise.

[0008] Unfortunately, the advantages offered by many headsets also result in a disadvantage as well. That is, when listening to audio program content via a headset the user often experiences difficulty participating in a conversation with others around him or her or otherwise hearing certain background audible content that may be of interest. This is especially true with passive noise insulating or active noise cancellation devices, which make it particularly difficult for the user to hear a conversation, listen to someone speaking to them or otherwise hear outside audio information that may be of interest.

SUMMARY OF THE INVENTION

[0009] In accordance with one embodiment, an apparatus to provide control over the relative level of audio and background sound includes: an input sound transducer configured to convert ambient acoustical pressure into an electrical background signal representing the background sound; noise cancellation circuitry coupled to the input sound transducer and configured to create a cancellation signal that is the inverse of the electrical background signal; a summing component coupled to the noise cancellation component and configured to combine the cancellation signal with an audio signal representing audio program content and for providing the combined electrical signal to an output sound transducer; and a controller coupled to the noise cancellation component and configured to control the level of a cancellation signal relative to the audio signal, thereby controlling the mix of cancellation signal and audio signal reaching the output sound transducer.

[0010] In accordance with another embodiment, an apparatus to provide control over the relative level of audio and background sound includes: an input sound transducer configured to convert ambient acoustical pressure into an background audio signal representing the background sound; an audio input line configured to accept an audio content signal representing audio program content; and audio bypass circuitry coupled to the input sound transducer and the audio input line and configured to adjust the level of electrical background signal relative to the audio signal. The audio bypass circuitry can be implemented, for example, using at least one of a switch, an amplifier, and a processor. A summer can also be included to combine the audio content signal with the background audio signal.

[0011] Additionally, cancellation circuitry can be provided to adjust the electrical background signal such that it provides a level of cancellation of the background sound when played through an output audio transducer. The cancellation circuitry can include at least one of an inverter, a compensation filter, and a digital signal processor.

[0012] In accordance with yet another embodiment, an audio headset can be provided that includes: an input sound transducer configured to convert ambient acoustical pressure into an background audio signal representing the background sound; an audio input line configured to accept an audio content signal representing audio program content; audio bypass circuitry coupled to the input sound transducer and the audio input line and configured to adjust the level of electrical background signal relative to the audio signal; a summer configured to combine the audio content signal with the background audio signal to create a combined output signal; and an output transducer configured to convert the combined output signal into an audible signal.

[0013] The audio headset can include cancellation circuitry to adjust the electrical background signal such that it provides a level of cancellation of the background sound when played through the output transducer.

[0014] In accordance with yet another embodiment, a method for controlling the level of audible program content relative to a background sound is provided. The method converts a background sound into a background audio signal representing the background sound; receives an audio content signal representing audio program content; adjusts the level of electrical background signal relative to the audio content signal; combines the audio content signal and the electrical background signal into a combined output signal; and provides the combined signal to a speaker or other audio driver.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The present invention, in accordance with one or more various embodiments, is described in detail with reference to the following figures. The drawings are provided for purposes of illustration only and merely depict typical or example embodiments of the invention. These drawings are provided to facilitate the reader's understanding of the invention and shall not be considered limiting of the breadth, scope, or applicability of the invention. It should be noted that for clarity and ease of illustration these drawings are not necessarily made to scale.

[0016] **FIG. 1** is a diagram illustrating an example environment in which the invention can be implemented.

[0017] **FIG. 2** is a diagram illustrating an example implementation for noise cancellation circuitry that can be implemented in accordance with one embodiment of the invention.

[0018] **FIG. 3** is a diagram illustrating an example implementation of audio bypass circuitry in accordance with one embodiment of the invention.

[0019] **FIG. 4** is a diagram illustrating an example operation of an audio bypass feature in accordance with one embodiment of the invention.

[0020] **FIG. 5** is a diagram illustrating an example implementation of audio bypass circuitry in accordance with one embodiment of the invention.

[0021] **FIG. 6** is a diagram illustrating an example implementation of audio bypass circuitry in accordance with one embodiment of the invention.

[0022] **FIG. 7** is a diagram illustrating an example implementation of audio bypass in accordance with one embodiment of the invention.

[0023] **FIG. 8** is a diagram illustrating an example implementation of audio bypass circuitry in accordance with one embodiment of the invention.

[0024] **FIG. 9** is a diagram illustrating an example implementation of audio bypass in accordance with one embodiment of the invention.

[0025] **FIG. 10** is a diagram illustrating an example implementation of audio bypass in accordance with one embodiment of the invention.

[0026] **FIG. 11** is a diagram illustrating an example controller in accordance with one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] The present invention is directed toward a system and method for providing an audio bypass feature for various headset applications that allow outside sounds or other background audio information to pass through the headset to the user's ears. In one embodiment, this audio bypass feature is enabled selectively by the user, but in other embodiments, user intervention is not utilized. The present invention is described herein in terms of an example application in a set of noise-canceling audio headphones. As will become apparent to one of ordinary skill in the art after reading this description, the present invention can be implemented in other headset applications where it may be useful or desirable for a user to allow outside audio information such as, for example, a conversation to pass through the headset so this information can be heard by the user.

[0028] Thus, before describing the invention in detail, this example application of a noise-canceling audio headset is first described. **FIG. 1** is a diagram illustrating one embodiment of a noise-canceling audio headset, which forms an example application for the present invention. Referring now to **FIG. 1**, this example noise-canceling audio headset **100** includes two ear pieces **104**, a headband **108**, an audio jack **116**, audio cables **120**, and optionally a switch or other control device **124**. Typically contained within ear pieces **104** are speakers or other audio drivers, (not illustrated in **FIG. 1**) which can be used to translate electrical representations of an audio signal into an audible audio content that is capable of being heard by the human ear. Ear pieces **104** may also include insulating structure **130** (for example, padded rings around the perimeter) to provide more effective sound insulation, thus helping to better shield the user from background audio or other unwanted background noise originating outside the headset that may detract from the desired audio content being played through the audio headset **100**.

[0029] Control device **124** may include controls such as, for example, a volume control, an on/off switch, a mute button, or other controls that allow the user to customize his or her listening experience. Control device **124** also provides a convenient location in which a battery, batteries, or other power source may be included to provide power to noise-cancellation headset **100**. Alternatively one or more of these items can be included elsewhere in audio headset **100** including, for example, on or within ear pieces **104**, headband **108** and so on.

[0030] In audio headsets **100** utilizing active noise-cancellation techniques, an input transducer **136**, such as for example a microphone or other device, can be included in either or both earpieces **104** for transducing acoustic pressure outside of ear pieces **104** (e.g., audible background noise) to a corresponding audio signal, which is used by the noise-cancellation system to filter out or otherwise cancel the background noise.

[0031] **FIG. 2** is a simplified block diagram illustrating an example implementation for noise cancellation circuitry that can be included with noise-canceling headset **100**. Referring now to **FIG. 2**, microphone **136** transduces the acoustical pressure generated by the unwanted background noise into an electrical signal that is enhanced by an amplifier such as pre-amp **202**. The electrical signal is inverted by an inverter **206** to create an inverse of the original signal representing the background noise, thus creating a cancellation signal **208**. Cancellation signal **208** can then be amplified via an amplifier **214**, which is preferably a variable gain amplifier, and provided to drive a speaker **218** to cancel the external noise that may penetrate the ear piece **104**. In the embodiment illustrated in **FIG. 2**, cancellation signal **208** is summed with the audio signal **222** via summer **210** to create a composite signal **226** to amplifier **214** to drive speaker **218** with an audio signal that includes the cancellation signal **208**, thus canceling, at least partially, the unwanted noise.

[0032] Cancellation signal **208** can be generated using an inverter **206**, a compensation filter, a DSP, or other circuitry, devices or techniques to create a signal that when provided

to speaker **218** cancels all or part of the background noise transduced by microphone **136**. The example application illustrated in **FIG. 2** shows the use of an inverter **206**. However, it will become apparent to one of ordinary skill in the art after reading this discussion how alternative techniques such as those provided in the foregoing examples can be implemented.

[**0033**] Having thus described an example environment in which the present invention can be applied, the present invention will now be described in greater detail in terms of this example environment. After reading this description, it will become apparent to one of ordinary skill in the art how to implement the invention in its various forms and embodiments in this or alternative environments in which it may be desirable to utilize the features and aspects of the present invention. **FIG. 3** is a high-level block diagram illustrating an example implementation of the audio bypass feature according to one embodiment of the invention. Referring now to **FIG. 3**, the present invention includes audio bypass module **306**, which is implemented to allow background sounds originating outside the headset to more readily be heard by the user of an audio headset. More particularly, in accordance with one embodiment of the invention, audio bypass module **306** can be implemented to allow a user to selectively engage or disengage the audio bypass feature to thereby allow selected background sounds to be heard by the user while the user is wearing an audio headset. In alternative embodiments, audio bypass module **306** can be implemented to automatically engage or disengage the audio bypass feature. Audio bypass module **306** in this and the other embodiments described herein can be implemented utilizing hardware, firmware, software, or a combination thereof, as may be desirable based on the given application.

[**0034**] An audio input is provided to accept the traditional audio signal **314** for the audio program content a user may desire to hear via a speaker **332**, such as, for example, the audio stream from a CD player, MP3 player, radio, DVD player or other audio source. The audio input may be implemented using a jack, banana plug or any other wired connector, and could alternatively be implemented utilizing a wireless interface.

[**0035**] A control signal **320**, typically generated by user interaction, can be utilized by audio bypass module **306** to allow an external audio signal transduced by a microphone **312** to pass through to speaker **332** such that that external audio signal **326** can be heard by the user without removing the audio headset. As discussed in the various embodiments presented herein, one or more control signals **320** can be generated by user interaction (e.g., via a control panel or other user interface) or generated automatically depending on the implementation.

[**0036**] **FIG. 4** is an operational flow diagram illustrating an example process for implementing audio bypass in accordance with one embodiment of the invention. Referring now to **FIGS. 3 and 4**, in a step **406**, in conventional operation, audio content is passed to speaker **332** by audio bypass module **306**. That is, for example, an audio signal **314** representing audio content from an electronic device can be heard via the ear pieces **104** in a user's noise-cancellation headset **100**.

[**0037**] In a step **410**, the audio bypass mode is initiated. In one embodiment, this can be accomplished by user interaction such as, for example, the user depressing a button or operating a switch to activate audio bypass module **306**. In other embodiments, this may be accomplished, for example, by automated means such as, for example, voice or speech recognition, background audio level threshold detection or other techniques.

[**0038**] In a step **414**, with audio bypass mode initiated, the audio signal **314** can be either attenuated or muted such that the audio program content is either softened before it reaches speaker **332** or is prevented from actually reaching speaker **332** so that it is diminished or not heard by the user during audio bypass mode.

[**0039**] In a step **420**, the external audio transduced by a microphone **312** (which can be implemented as, for example, microphone **136** in the example environment) is passed to speaker **332**, which converts the electrical signal into an audible signal that can be heard by the user via the headset speaker or speakers. In an environment of a noise cancellation headset **100**, it may be desirable to diminish or inhibit the noise cancellation functionality so that the background audio can be better heard by the user.

[**0040**] In a step **424**, when the audio bypass mode is terminated, audio signal **314** is returned to normal levels and the original audio content is once again passed to speaker **332** such that the user can resume listening to the audio content. Similar to initiating audio bypass mode, termination of the audio bypass mode can be accomplished by a manual means (e.g., via a button or switch etc.) or through automatic means (e.g., voice or speech recognition or audio level threshold detection and so on).

[**0041**] As will become apparent to one of ordinary skill in the art after reading this description, audio bypass module **306** can be implemented utilizing a number of different techniques. A few example embodiments for implementing audio bypass module **306** are now described. **FIG. 5** is a diagram illustrating one example implementation of audio bypass module **306** in accordance with one embodiment of the invention. In the example illustrated in **FIG. 5**, audio signal **314** is a stereo signal and is thus provided as a left audio signal **314**A and a right audio signal **314**B. A microphone **312** transduces the acoustical pressure generated by the background noise (e.g., the background audio) thereby generating a background audio signal **526**. In this example embodiment, audio bypass module **306** is illustrated as being implemented utilizing switches **522**, **523**, and **524**. Switches **522**, **523**, and **524** can be implemented utilizing various technologies including, for example, FET switches or other switching techniques. Because various audio signals are being switched through switches **522**, **523**, and **524**, it is desirable to utilize technologies that exhibit the appropriate frequency response characteristics for handling such audio signals. It is also often desirable that low cost means be used when implementing switches **522**, **523**, and **524**. Additionally, it is important to consider isolation of the various signals in the device.

[**0042**] One or more control signals **520**, as illustrated, are utilized to provide control information to configure switches **522**, **523**, and **524** to initiate and/or terminate the audio bypass mode. For example, to initiate the audio bypass mode, switches **522** and **524** would be set to the B position and switch **523** set to the A position. In this configuration, background audio signal **526** is passed through audio bypass

module **306** and on to speakers **332**A and **332**B. Alternatively, when not in audio bypass mode, switches **522** and **524** are set to position A and switch **523** is set to position B, thus allowing audio signal **314**A and audio signal **314**B to pass to its respective speaker **332**A and **332**B.

[**0043**] Summers **532**A and **532**B can be used to combine the respective audio signals **314**A and **314**B with the background audio signal **526**. Variable gain amplifiers **536**A (or fixed gain amplifiers) can be utilized to provide amplification of the resultant signal prior to driving speakers **332**A and **332**B.

[**0044**] In the embodiment illustrated in **FIG. 5**, a single microphone **312** is illustrated as providing a background audio signal from a single source (i.e., microphone **312**) to both speakers **332**A, **332**B in a stereo headset. As will become apparent to one of ordinary skill in the art after reading this description, a second microphone (not illustrated) and a second switch (not illustrated) can be provided in addition to microphone **312** and switch **523** to provide a separate background audio signal for each of the left and right channels.

[**0045**] **FIG. 6** is a simplified schematic diagram illustrating another example implementation of audio bypass module **306** in accordance with one embodiment of the invention. Referring now to **FIG. 6**, in the embodiment illustrated, switches **522**, **523**, and **524** have been replaced by amplifiers **622** and **623**. More specifically, in the embodiment illustrated in **FIG. 6**, these amplifiers are illustrated as variable gain amplifiers. Note, however, that the embodiment illustrated in **FIG. 6** includes two microphones **312**A and **312**B for left and right channel operation.

[**0046**] The operation of this embodiment is similar to the operation of **FIG. 5**, wherein one or more control signals **520** are utilized to provide input to audio bypass module **306** to selectively allow a background audio signal to pass through audio bypass module **306** to be heard by the user via speakers **332**. Thus, when the audio bypass mode is initiated, control signal **520** can be utilized to cause audio signals **314**A and **314**B to be attenuated by variable gain amplifiers **622**A and **622**B, and background or outside audio signals **312**A and **312**B to be amplified by variable gain amplifiers **623**A and **623**B. Thus, in this embodiment, the signal level, and thus ultimate volume, of background audio signal **312** is increased relative to that of audio signal **314**, thus enabling the user to better hear the background audio signal **312** over the audio program content **314** from the audio source of the electronic device. Also illustrated in the example provided in **FIG. 6** are summers **532**A, **532**B and output amplifiers **536**A, **536**B. In the configuration illustrated in **FIG. 6**, two microphones **312**A and **312**B are provided such that a separate background audio signal can be provided for each channel of the headset. However, as would be apparent to one of ordinary skill in the art after reading this description, the embodiment can be implemented using a single microphone **312** and a single amplifier **623** to transduce and provide a single background audio signal to both channels of the listening device.

[**0047**] The embodiments described above with reference to **FIGS. 5 and 6** illustrate example applications in which audio bypass module **306** is used in conjunction with headset devices having no noise-cancellation circuitry or utilizing passive noise attenuation techniques to filter out unwanted background noise from the listening environment. Now described are a plurality of embodiments that can be utilized in applications such as, for example, the example environment of a noise-cancellation headset **100** utilizing active noise-cancellation techniques. **FIG. 7** is a simplified block diagram illustrating at a high level the implementation of an audio bypass mode with a noise-cancellation headset. Referring now to **FIG. 7**, the example implementation includes controller **704** that can be utilized to control a noise cancellation component **706** and an audio component **708** of the noise-canceling headset. In this example embodiment, when the audio bypass mode is initiated, controller **704** attenuates or mutes audio signal **314** and allows the background noise signal to pass through noise cancellation portion **706**. This can be accomplished by bypassing or inhibiting the noise cancellation circuitry, allowing the external signal transduced by microphone **312** to be passed to speakers **332**. Alternatively, this can also be accomplished by allowing noise cancellation portion **706** to continue unaltered or unadjusted. This is true especially, for example, in configurations where noise cancellation portion **706** is utilized to filter out only low frequency noises and does not affect, at least not to a great extent, noise in the frequency ranges of ordinary human speech. Also illustrated in the embodiment shown in **FIG. 7** are a summer **532**, amplifier **536** and speaker **332** to provide the selected audio content to the user. Although one audio channel is illustrated, it will become apparent to one of ordinary skill in the art how to implement the invention utilizing multiple channels.

[**0048**] **FIG. 8** is a simplified schematic diagram illustrating an example implementation of the audio bypass feature in a noise-cancellation headset in accordance with one embodiment of the invention. Referring now to **FIG. 8**, the example implementation illustrated herein is that of a stereo or other dual-channel headset in which first and second audio signals **314**A, **314**B (e.g., left and right audio signals) are received and played via speakers **332**. After reading this description, it will be apparent to one of ordinary skill in the art how to implement this embodiment in a monaural application or in applications having an alternative number of channels.

[**0049**] In normal operation, audio signals **314**A and **314**B are received from the audio source and can be conditioned utilizing buffer amps **710**A and **710**B, respectively. Audio signals **314**A and **314**B are typically received from the audio source via an audio jack such as, for example, an eighth inch stereo plug or other audio connecter. However, other input techniques, both hardwire and wireless, can be utilized. Conditioned audio signals **716**A and **716**B are switched by audio bypass module **306** to drivers **732**A and **732**B via mixers **730**A and **730**B such that they can be heard by the user on speakers **332**A and **332**B.

[**0050**] With the noise cancellation feature turned on, acoustical pressure generated by background noise is transduced by microphones **312**A and **312**B to create a background noise signals **726**A and **726**B that can be conditioned by optional driver/pre-amp **704**A and **704**B and ultimately inverted via inverters **708**A and **708**B to create noise-cancellation signals **728**A and **728**C. Noise-cancellation signals **728**A and **728**C are summed with conditioned audio signal **716**A and **716**B via summer **730** and amplified by driver **732** to provide an audio signal to the user that includes both the original audio program content and a component

representative of the inverse of the background noise. Thus, when the background noise is combined with its inverse and this signal is used to drive speaker **332**, the background noise is canceled such that it is not heard by the user (or it is at least diminished).

[**0051**] In the embodiment illustrated in **FIG. 8**, audio bypass module **306** comprises a plurality of switches similar to those utilized in the embodiment illustrated in **FIG. 5**. Thus, when the audio bypass mode is initiated, switches **724**A and **724**B are placed in the B position, as are switches **725**A and **725**B. Thus, in the audio bypass mode, the input audio signals **314**A and **314**B are muted and the inverters **708**A and **708**B utilized to create the cancellation signal are bypassed, thus allowing the background noise signals **726**A and **726**B to pass through to speakers **332**A and **332**B. In one example embodiment of this configuration, the gain of amplifiers **704** or amplifier **732** (or both) can be increased in the audio bypass mode to allow the background audio signal to be amplified to a greater extent so that it can be heard by the user. Thus, in this configuration, in the audio bypass mode, the background audio signal (for example, a conversation within earshot of the headset user) can be picked up by microphones **312**A and **312**B, amplified by the circuitry, and readily heard by the user via speakers **332**A and **332**B. When the audio bypass mode is terminated, switches **724**A, **724**B, **725**A, and **725**B can be returned to the A position such that background noise cancellation once again commences and the audio signals **314**A, **314**B can be passed through the respective componentry to speakers **332**A, **332**B. As discussed above, an inverter **708** can be implemented utilizing a number of different techniques to provide an inverse or complementary audio signal utilized to cancel out the background audio noise. This can be accomplished using inverters, compensation filters, and other known techniques.

[**0052**] Additionally, in this and other embodiments instead of an inverter **708**, a band pass or other filter can be utilized to filter out unwanted background noise. For example, in the environment of an aircraft cabin, the unwanted background noise is often predominantly made up of low frequency components resulting from the roar of the aircraft engines. Thus, for applications utilized in such environments, it is possible to implement the noise-cancellation function a band pass filter to filter out low frequency sounds, thus allowing only higher frequency sounds to pass. Thus, in this embodiment, in addition to or in place of inverters **708**, band pass filters can be utilized to limit audio at certain frequencies. Additionally, circuitry components or instrumentality can be utilized in signal paths **744**A and **744**B to enhance or amplify signals falling within the frequency range of normal human speech. Thus, for example, an amplifier and a band pass filter can be included where the transfer response of the band pass filter is tuned to allow frequency components within the range of human speech to be transferred to the speakers **332**A, **332**B for playback to the listener. Thus, in this embodiment, amplifying the range of frequencies covered by human speech can enhance the ability of the user to hear a conversation that is occurring outside the ear pieces and, thus, allow the user to participate in or listen to that conversation without necessarily removing the headphones.

[**0053**] **FIG. 9** is a simplified schematic diagram illustrating yet another application of the invention in the environment of a noise-canceling headset in accordance with one embodiment of the invention. **FIG. 9** illustrates one audio channel; however, as described above, this embodiment can be implemented in applications utilizing a plurality of audio channels including, for example, a stereo headset. Referring now to **FIG. 9**, bypass module **306** is implemented using a plurality of amplifiers, which in the illustrated embodiment are variable gain amplifiers **922**, **924**, and **926**. Variable gain amplifiers **922**, **924**, and **926** can be implemented in place of switches **724** and **725** illustrated in **FIG. 8**. More particularly, in this embodiment, controller **704** can be utilized to control the gain of amplifiers **922**, **924**, and **926** to selectively pass cancellation signal **728**, background audio signal **726**, or the audio signal **314**. Preferably, when the audio bypass mode is initiated, the gain of variable gain amplifiers **922** and **926** is attenuated such that noise cancellation signal **728** and audio signal **314** are attenuated and the gain of variable gain amplifier **924** is increased such that the background audio signal **726** is amplified and readily heard by the user through speaker **332**. Conversely, when the bypass mode is terminated, the gain of variable gain amplifier **924** is turned down such that the background audio signal **726** is no longer amplified (or is attenuated to some extent). Additionally, the gain of variable gain amplifier **926** is increased such that audio signal **314** is amplified and can be readily heard by the user via speaker **332**. Also, the gain on variable gain amplifier **922** can be increased such that noise cancellation signal **728** is amplified and can be utilized in conjunction with audio signal **314** to minimize the amount of background noise heard by the user.

[**0054**] In yet another alternative embodiment, audio bypass module **306** can be implemented utilizing DSP technology. For example, in this embodiment, one or more analog/digital converters (ADC) can be utilized to digitize either or both of background noise signal **326** and audio signal **314**. Once digitized, these signals can be processed utilizing a digital signal processor to, for example, amplify the speech signal, diminish the background noise, and inhibit the audio signal **314** from passing through to speaker **332**. One example implementation utilizing DSP technology is illustrated in **FIG. 10** in accordance with one embodiment of the invention. Referring now to **FIG. 10**, A/D converter **944** is utilized to digitize background noise signal **326**. A digital signal processor **996** can be utilized to provide the noise-cancellation functions desired to diminish or eliminate undesirable background noise from the content heard by the user. D/A converter **911** is used to perform a digital to analog conversion such that the resultant noise cancellation signal can be converted to an audible signal via speaker **332**. Additionally, a variable gain amplifier (or, alternatively, a switch or other component or instrumentality) **993** can be included to attenuate or amplify audio signal **314**. Thus, when the audio bypass mode is initiated, the gain of variable gain amplifier **993** can be decreased to minimize the level of audio signal **314** while the operation of DSP **996** occurs such that the noise cancellation features are inhibited and the background audio signal **314** is allowed to pass through to speaker **332**. More particularly, in one embodiment, the DSP **996** can be utilized to actually enhance the background audio signal such that the conversation or other audio that the user desires to hear in the bypass mode is better heard via speaker **332**.

[**0055**] The above description provides details on a plurality of embodiments that utilize some form of audio bypass

module **306** that optionally attenuates an audio signal **314** such that a background signal **326** can be heard by the user via speaker **332**. In the illustrated embodiments, a microphone **312** (or **136** in the example application) is included to detect and transduce the acoustical pressure generated by the background noise that the user wishes to hear. In the example environment illustrated in **FIG. 1**, microphone **136** is provided in ear piece **104**. In fact, in the embodiment illustrated in **FIG. 1**, there are two microphones **136**, one in each ear piece **104**. This is often the configuration found with noise-cancellation headsets **100** with which the invention can be implemented. Alternatively, microphones **312** can be implemented internal to ear piece **104** as opposed to externally, as illustrated in **FIG. 1**. In this embodiment, it may be more difficult to detect background sounds that are external to the ear pieces, as the ear pieces **104** may provide insulative properties shielding an internal microphone from such conversations. However, in such an environment, various combinations of filtering and amplification as discussed above may be utilized to further enhance the audibility of background audio picked up by internal microphones. Although not illustrated, in yet another embodiment, one or more microphones can be provided in other locations such as, for example, on or in proximity to headband **108**, somewhere along cord **120**, or integrated with control device **124**. Although not required, it is anticipated that in noise cancellation applications, microphones **136** will be positioned somewhere in the proximity of ear pieces **104** such that, when they are performing the noise-cancellation function, they do a better job of approximating the sound that is to be canceled from the ultimate signal.

[**0056**] Although some of the above embodiments discuss utilizing as microphones **312** existing microphones **136** that are also utilized for noise cancellation, it is also possible to implement the invention utilizing one or more additional microphones **312** rather than utilizing the existing microphones **136** provided for noise-cancellation purposes. For example, it may be desirable to provide one or more microphones **312** on or near control device **124**, headband **108**, cord **120** or jack **116**. One advantage, depending on the alternative placement, is that it may allow the microphone(s) **312** to be directed toward the source of the background audio for better pickup.

[**0057**] A user interface device can be included to allow the user to control one or more features of the audio bypass function. **FIG. 11** is a diagram illustrating an example implementation of such a control device in accordance with one embodiment of the invention. Referring now to **FIG. 11**, illustrated is a control device **372** that is utilized to provide manual control of one or more of the features of the invention. The control device **372** illustrated in **FIG. 11** is illustrated as being positioned along audio cables **380**; however, other locations are possible, including on either or both ear pieces **104** or on headband **108** or in conjunction with jack **116**. In one embodiment, control device **372** is hardwired in with the headset; however, wireless control devices **372** are also contemplated.

[**0058**] The features included with control device **372** in the illustrated example can include a mute button **390**, an audio bypass button **392**, a volume control **394**, and a speaker **396**, although each of these need not be present with a control device **372** and alternatives are possible, depending on the desired implementation. Mute button **390** can be utilized to mute the audio signal sent to the headset, thereby silencing in its entirety the audio content provided by the speakers. Alternatively, or in addition, a mute button can be provided that mutes only the original audio program content such that background audio can be heard without having to be heard above the audio signal (or vice versa). An audio bypass button **392** can be provided to allow the user to manually enter the audio bypass mode. Thus, depressing this button (or flicking the switch, etc.) allows the user to manually enter the audio bypass mode and utilize the features discussed above.

[**0059**] Volume control **394** can be included and utilized to adjust the audio volume presented by the headset. In one embodiment, this can adjust the volume for all features; however, one or more volume knobs **394** can be included to adjust individually if desired the audio content playback level, the background audio level, the noise cancellation level, and so forth.

[**0060**] As discussed above, a microphone **396** can also be included on the control device which can be used in addition to or as an alternative to other microphones that may be positioned elsewhere such as, for example, on ear pieces **104**. Although jack **116** in this embodiment is illustrated as a standard stereo plug, it is contemplated that other connection devices can be utilized to receive the audio playback signal such as, for example, USB connectors, wireless communication ports, and so on.

[**0061**] In addition to utilizing a manual control to enter or exit the audio bypass mode, an automatic mode can be included wherein the audio bypass mode is controlled automatically based on the occurrence of one or more events. For example, in one embodiment, voice or speech recognition techniques can be utilized to allow the headset to enter the audio bypass mode in response to a command that is spoken by the user. Thus, for example, the user can program the device to enter the audio bypass mode when a particular word or phrase is spoken. For example, the headset in this embodiment could be programmed to respond to a phrase such as "Could you repeat that?" Thereby enabling the audio bypass mode when the user asks another person to repeat what they have just said. As another example, the device may be programmed to enter automatically the audio bypass mode when a background audio level is sensed that is louder or at a higher level than the ambient background noise or, for example, when a particular threshold is reached. Thus, for example, in this application, when the device senses that the user has spoken (as words spoken by the user may be sensed by the device at a level louder than the background noise), the device could automatically enter the audio bypass mode.

[**0062**] Additionally, timeout features can be provided to allow the device to automatically terminate the audio bypass mode upon the passage of a specified amount of time. This could be preprogrammed or user selected and controlled, depending on the implementation.

[**0063**] Various embodiments of the invention and implementation examples have been described above. However, it is understood that these various embodiments and examples are exemplary only and should not serve to limit the scope of the invention. It is also readily understood by those of ordinary skill in the art how to design and implement the disclosed embodiments using alternative architectures, processes, functionality, structures, and implementations. In

sum, after reading this description, various modifications of and alternatives to the preferred embodiments described above can be implemented by those of ordinary skill in the art, without undue experimentation. These various modifications and alternatives are contemplated to be within the spirit and scope of the invention.

[0064] As an example of such modifications and alternatives and without limiting the generality of the foregoing, the example embodiments described herein illustrate a configuration utilizing a particular configuration of amplifiers and summers for combining and driving the various signals. As will be apparent to one of ordinary skill in the art after reading this disclosure, amplifiers could be provided elsewhere in the chain and summers can be provided as summing amplifiers. Also as would be apparent to one of ordinary skill in the art after reading this description, the circuitry can also include appropriate drivers, pre-amps, buffer amps, or other components or instrumentalities, as desired or appropriate to further condition the various audio signals. Furthermore, the schematic diagrams are provided to illustrate example implementations of various embodiments of the functionality of the audio bypass feature, and one of ordinary skill in the art after reading this description will understand how to implement these features and functions utilizing alternative configurations of hardware, software, firmware or combinations thereof. Likewise, particular implementations of switching functionality are disclosed herein in terms of FET switches and variable gain amplifiers. It would be apparent to one of ordinary skill in the art after reading this description how to implement the functionality of selecting and deselecting, or amplifying and attenuating selected audio signals to achieve the desired effects.

[0065] Terms and phrases used in this document, and variations thereof, unless otherwise expressly stated, should be construed as open ended as opposed to limiting. As examples of the foregoing: the term "including" should be read as mean "including, without limitation" or the like; the term "example" is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof; and adjectives like "conventional,""traditional, ""normal,""standard," and terms of similar meaning should not be construed as limiting the item described to a given time period or to an item available as of a given time, but instead should be read to encompass conventional, traditional, normal, or standard technologies that may be available now or at any time in the future. Likewise, a group of items linked with the conjunction "and" should not be read as requiring that each and every one of those items be present in the grouping, but rather should be read as "and/or" unless expressly stated otherwise.

What is claimed is:

1. An apparatus to provide control over the relative level of audio and background sound, comprising:

an input sound transducer configured to convert ambient acoustical pressure into an electrical background signal representing the background sound;

noise cancellation circuitry coupled to the input sound transducer and configured to create a cancellation signal that is the inverse of the electrical background signal;

a summer coupled to the noise cancellation circuitry and configured to combine the cancellation signal with an audio signal representing audio program content and for providing the combined electrical signal to an output sound transducer; and

a controller coupled to the noise cancellation circuitry and configured to control the level of a cancellation signal relative to the audio signal, thereby controlling the mix of cancellation signal and audio signal reaching the output sound transducer.

2. The apparatus of claim 1, wherein the cancellation circuitry comprises at least one of an inverter, a compensation filter, and a digital signal processor.

3. The apparatus of claim 1, wherein the controller is configured to attenuate or mute the audio signal.

4. The apparatus of claim 1, wherein the controller is configured to attenuate or mute the cancellation signal.

5. The apparatus of claim 1, wherein the controller is configured to inhibit or diminish functionality of the noise cancellation circuitry.

6. The apparatus of claim 1, wherein the controller is configured to cause the electrical background signal to bypass the noise cancellation circuitry.

7. An apparatus to provide control over the relative level of audio and background sound, comprising:

an input sound transducer configured to convert ambient acoustical pressure into an background audio signal representing the background sound;

an audio input line configured to accept an audio content signal representing audio program content; and

audio bypass circuitry coupled to the input sound transducer and the audio input line and configured to adjust the level of electrical background signal relative to the audio signal.

8. The apparatus of claim 7, wherein the audio bypass circuitry comprises at least one of a switch, an amplifier, and a processor.

9. The apparatus of claim 7, further comprising a summer configured to combine the audio content signal with the background audio signal.

10. The apparatus of claim 7, further comprising cancellation circuitry coupled to the input sound transducer and configured to adjust the electrical background signal such that it provides a level of cancellation of the background sound when played through an output audio transducer.

11. The apparatus of claim 10, wherein the cancellation circuitry comprises at least one of an inverter, a compensation filter, and a digital signal processor.

12. The apparatus of claim 10, wherein the audio bypass circuitry is configured to cause the electrical background signal to bypass the noise cancellation circuitry.

13. The apparatus of claim 7, wherein the audio bypass circuitry is configured to attenuate or mute the audio signal.

14. The apparatus of claim 7, wherein the audio bypass circuitry is configured to attenuate or mute the cancellation signal.

15. The apparatus of claim 7, wherein the audio bypass circuitry is configured to inhibit or diminish functionality of the noise cancellation circuitry.

16. The apparatus of claim 7, wherein engagement of the audio bypass circuitry is controlled by at least one of voice recognition, speech recognition, and background audio level threshold detection.

17. The apparatus of claim 7, further comprising a user interface device configured to allow a user to control the audio bypass circuitry.

18. The apparatus of claim 7, further comprising means for automatically engaging the audio bypass circuitry.

19. The apparatus of claim 18, wherein the means for automatically engaging comprises voice recognition, speech recognition, and background audio level threshold detection.

20. An audio headset, comprising:

an input sound transducer configured to convert ambient acoustical pressure into an background audio signal representing the background sound;

an audio input line configured to accept an audio content signal representing audio program content;

audio bypass circuitry coupled to the input sound transducer and the audio input line and configured to adjust the level of electrical background signal relative to the audio signal;

a summer configured to combine the audio content signal with the background audio signal to create a combined output signal; and

an output transducer configured to convert the combined output signal into an audible signal.

21. The audio headset of claim 20, wherein the audio bypass circuitry comprises at least one of a switch, an amplifier, and a processor.

22. The audio headset of claim 20, further comprising cancellation circuitry coupled to the input sound transducer and configured to adjust the electrical background signal such that it provides a level of cancellation of the background sound when played through the output transducer.

23. The audio headset of claim 22, wherein the cancellation circuitry comprises at least one of an inverter, a compensation filter, and a digital signal processor.

24. The audio headset of claim 20, wherein the audio bypass circuitry is configured to cause the electrical background signal to bypass the noise cancellation circuitry.

25. The audio headset of claim 20, wherein the audio bypass circuitry is configured to attenuate or mute the audio signal.

26. The audio headset of claim 20, wherein the audio bypass circuitry is configured to attenuate or mute the cancellation signal.

27. The audio headset of claim 20, wherein the audio bypass circuitry is configured to inhibit or diminish functionality of the noise cancellation circuitry.

28. The audio headset of claim 20, wherein engagement of the audio bypass circuitry is controlled by at least one of voice recognition, speech recognition, and background audio level threshold detection.

29. The audio headset of claim 20, further comprising a user interface device configured to allow a user to control the audio bypass circuitry.

30. The audio headset of claim 20, further comprising means for automatically engaging the audio bypass circuitry.

31. The audio headset of claim 30, wherein the means for automatically engaging comprises voice recognition, speech recognition, and background audio level threshold detection.

32. A method for controlling the level of audible program content relative to a background sound, the method comprising the steps of:

converting a background sound into a background audio signal representing the background sound;

receiving an audio content signal representing audio program content;

adjusting the level of electrical background signal relative to the audio content signal;

combining the audio content signal and the electrical background signal into a combined output signal; and

providing the combined signal to a speaker or other audio driver.

33. The method of claim 32, wherein the step of adjusting causes the electrical background signal to bypass the noise cancellation circuitry.

34. The method of claim 32, wherein the step of adjusting attenuates or mutes the audio signal.

35. The method of claim 32, wherein the step of adjusting attenuates or mutes the cancellation signal.

36. The method of claim 32, wherein the step of adjusting inhibits or diminishes functionality of the noise cancellation circuitry.

37. The method of claim 32, wherein the step of adjusting is controlled by at least one of voice recognition, speech recognition, and background audio level threshold detection.

38. The method of claim 32, wherein the step of adjusting is controlled by a user.

39. An apparatus for controlling a relative level of audio and background sound in an audio playback device, comprising:

means for converting ambient acoustical pressure into an electrical background signal representing background sound;

means for controlling the signal level of an electrical background signal relative to the level of an electrical audio signal representing audio program content;

means for receiving an electrical audio signal representing audio program content;

means for combining an electrical background signal with an electrical audio signal and The method of claim 32, wherein the step of adjusting is controlled by providing the combined electrical background and audio signal to an output sound transducer.

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