MULTIMODE AUDIO REPRODUCTION DEVICE

Field of the Invention

This invention relates to a multimode audio reproduction device and refers particularly, though not exclusively to an audio reproduction device that can be used both as a headphone and a loudspeaker.

Background of the Invention

The reproduction of audio requires a reproduction device such as, for example, earphones, headphones or one or more loud speakers.

Many people now have one or more of: portable music players, portable media players, portable game consoles and players; portable computers with games, multimedia players including movies, and audio; and the like. This often requires the use of external, attachable speakers for audio reproduction and/or headphones for audio reproduction. Many have both headphones for use when traveling, and speakers for use in offices, hotel rooms, and the like.

Summary of the Invention

In accordance with a first preferred aspect there is provided an audio reproduction device. The audio reproduction device comprises a first audio driver module and a second audio driver module, as well as a support structure coupling the first and second audio driver modules. The first and second audio driver modules are movable relative to one another between a first configuration in which they are positioned to be used as headphones and a second configuration in which they are positioned to be used as loudspeakers.

The first and second audio driver modules may each include a headphone audio driver and a loudspeaker audio driver. The headphone audio drivers may face generally towards each other and the loudspeaker audio drivers may face generally away from each other when the audio reproduction device is in the first configuration. The first and second audio driver modules may be movable towards each other to assume the second configuration.

The loudspeaker audio drivers of the first and second audio modules may be positioned to project sound in the same general direction when the first and second

audio modules are in the second configuration. The loudspeaker audio drivers of the first and second audio modules may be positioned to project sound in the same general direction when the first and second audio modules are in the second configuration.

The audio reproduction device may further comprise a switch to disable the loudspeaker audio drivers when the audio reproduction device is in the first configuration and to disable the headphone audio drivers when the audio reproduction device is in the second configuration. The switch may operate automatically as the first and second audio modules are moved between configurations.

The first and second audio modules may engage each other in the second configuration so that they maintain their relative position. The support structure may serve to prop up the first and second audio modules when in the second configuration and as a headband for the first and second audio driver modules when in the first configuration.

The audio reproduction device may further comprise circuitry for wireless reception of audio. The circuitry may include a processor for decompressing compressed audio data.

The first and second audio driver modules may each comprise an enclosure. Each enclosure may comprise a front face and a rear face. The loudspeaker audio drivers may be mounted in the front faces, and the headphone audio drivers may be mounted in the rear faces.

The loudspeaker audio drivers may be operative when the first and second audio driver modules are in the second configuration but may not be operative when the first and second audio driver modules are in the first configuration. The headphone audio drivers may be operative when the first and second audio driver modules are in the first configuration. Preferably, the headphone audio drivers are not operative when the first and second audio driver modules are in the second configuration.

At least one of the enclosures may further comprise a detector for detecting whether the first and second audio driver modules are in the first configuration or the second configuration. The support structure may be pivotally connected to the enclosure of both the first and second audio driver modules.

Each enclosure may further comprise an end, and each end may comprise a retainer for releasably retaining the end of the first audio driver module with the end of the second audio driver module when the first and second audio driver modules are in the second configuration. The retainer may be a tongue and a complementary groove, or a pin and a complementary hole. Also, there may be an ear pad mounted to the rear face co-axial with the headphone audio driver.

There may be at least one internal baffle within each enclosure located between the headphone audio driver and the loudspeaker audio driver. The at least one baffle may divide each enclosure into two sub-enclosures: a first sub-enclosure for the headphone audio driver, and a second sub-enclosure for the loudspeaker audio driver.

According to a second preferred aspect there is provided an audio reproduction device comprising a first audio driver module and a second audio driver module with the first and second audio driver modules being movable relative to one another between a first configuration and a second configuration. At least one of the first and second audio driver modules comprises audio processing circuitry for processing audio supplied to the device. The audio processing circuitry comprising an amplifier, the amplifier being for responding to an input to automatically limit an output of the amplifier when the device is in the first configuration.

Each of the first and second audio driver modules may comprise an enclosure with each enclosure having an end. The input may be from a detector mounted on the end of at least one of the enclosures. The audio processing circuitry may further comprise a switch for receiving an output from the detector and providing the input.

Brief Description of the Drawings

In order that the invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative example only a preferred embodiment of the present invention, the description being with reference to the accompanying illustrative drawings.

In the drawings:

Figure 1 is a front perspective view of a first embodiment of the audio reproduction device during use in a first mode;

Figure 2 is a front perspective view of the first embodiment during use in a second mode;

Figure 3 is a view corresponding to Figure 1;

Figure 4 is a side view of the first embodiment in a third mode;

Figure 5 is a side view corresponding to Figure 2;

Figure 6 is a partial cross-sectional view along the lines and in the direction of arrows 6-6 in Figure 3;

Figure 6(a) is a view corresponding to Figure 6 but of an alternative embodiment;

Figure 7 is an illustration of a preferred form of circuit;

Figure 8 is a top perspective rear view of a second embodiment when in the first mode;

Figure 9 is an underneath perspective corresponding to Figure 6;

Figure 10 is an underneath view corresponding to Figures 6 and 7;

Figure 11 is a front view corresponding to Figures 6 to 8;

Figure 12 is a side view corresponding to Figures 6 to 9;

Figure 13 is a front perspective view of the second embodiment in the second mode;

Figure 14 is a rear perspective view corresponding to Figure 11;

Figure 15 is a front perspective view of a second embodiment of the audio reproduction device during use in a first mode;

Figure 16 is a front perspective view of the second embodiment during use in a second mode;

Figure 17 is a front perspective view of a second embodiment of the head band used in the second embodiment of the audio reproduction device; and.

Figure 18 is an enlargement of the circled portion in Figure 17.

Detailed Description of the Preferred Embodiments

To refer to Figures 1 and 3, there is shown a multimode audio reproduction device able to be used in two modes: a first mode or configuration in which it is usable as

a headphone, and a second mode or configuration in which it is usable as a loudspeaker.

Figure 1 shows the audio reproduction device in a first configuration in which it functions as a headphone. The audio reproduction device 10 includes a head band 12 extending between and pivotally connected to a first audio reproduction module 14 and a second audio reproduction module 16. At each end 18 of the head band 12 there is a pivotal or hinged connection 20 between the head band 12 and the respective audio reproduction module 14, 16.

The head band 12 has a first portion 22 and a second portion 24 that are slidable relative to each other to enable the effective length of the head band 12 to be varied. This enables the head band 12 to be adjusted to suit a user's head. The first portion 22 and second portion 24 may engage each other telescopically.

Each audio reproduction module 14, 16 comprises an enclosure 30 having a front face 32, a rear face 34, an end face 36 and a top 38. The pivotal connection 20 is preferably on rear face 34 at or adjacent the top 38.

Mounted in and/or to front face 32 is at least one loudspeaker driver 40. Although a single driver 40 is shown, there may be more than one driver 40 in front face 32.

To protect the driver 40, a removable cover 42 is provided to cover at least that part of front face 32 in which the driver 40 is located. The cover 42 may be removably attached using any known, suitable retainer such as, for example, Velcro™ , bayonet fittings, clips, snap fittings, or the like. As shown, the cover 42 has a rim 44 that is a snap fit over peripheral edge 46 of front face 32.

Mounted to rear face 34 is an ear pad 50. The ear pad 50 may be of the "rest on the ear" style (as shown) or may be of the type than encompasses the ear. Ear pad 50 may be releasably attached to rear face 34 by a mount 52. The mount 52 may be in a form of a short hollow cylinder to which ear pad 50 is attached. Mounted in and/or to rear face 34 and substantially co-axial with ear pad 50 as well as mount 52 is a headphone driver 54. Audio as reproduced by headphone driver 54 can pass through mount 52 and ear pad 50 and be heard by a user. Headphone driver 54 may be mounted in or to the enclosure 30 so that the enclosed volume of enclosure 30 provides an improved acoustic response, for example in lower frequencies.

The end 36 of each audio reproduction module 14, 16 has a retainer 56. As shown in Figures 4 and 6, this comprises complementary tongues 58 and grooves 60 engaging in the manner of a snap or sliding fit. In this way the two ends 36 can be brought together and the tongues 58 engaged in grooves 60 for the two audio reproducing modules 14, 16 to be releasably secured together with rear faces 34 being generally co-planar, and ends 36 being adjacent each other or even in contact with each other.

In this situation, the audio reproduction device 10 is in now in the second mode or configuration in which it serves as a loudspeaker. This is shown in Figures 2 and 5. Here, the headband 12 acts as a support or prop so that the audio reproducing modules 14, 16 can be placed on a surface 62 at an angle relative to surface 62 that provides for projection of sound from the drivers 40.

In Figure 4, the support 12 is used as a carry handle.

Either or both of the ends 36 may have a detector 64 for determining when the ends 36 are engaged and disengaged so that the audio reproduction modules 14, 16 will switch automatically between headphone mode and speaker mode. The detector 64 may be a pressure switch, proximity switch, cams, contacts or the like that automatically connect or disconnect the relevant audio drivers when the audio reproduction modules pivot between the headphone and speaker configurations.

The drivers 40, 54 are shown in more detail in Figure 6. They may be opposite each other or may be vertically or laterally spaced apart. If desired, a divider or baffle 82 [Figure 6(a)] may be provided between the drivers 40, 54 to improve the acoustic response, and/or to separate or isolate drivers 40, 54 into separate compartments by dividing the enclosure into two sub-enclosures – one for the first driver 40 and one for the headphone driver 54. The baffle or divider 82 may be perforated if desired.

The audio reproduction modules 14, 16 are joined by a cable 76 (Figure 7) located within headband support 12 in the usual manner. The audio reproduction device 10 receives the audio from an external source, or from an inbuilt MP3, FM radio or like player. If from an external source, it may be by:-

(i) a direct connection using relevant connections such as, for example, an USB connection, IEEE 1394 connection, or using RCA or like connections;

(ii) a cable connection using a suitable connector at a remote end, such as a conventional or mini headphone plug. The cable connection may be permanently connected to the audio reproduction device 10 or may be removable by use of an appropriate connector; or

(iii) wirelessly using, for example, Bluetooth, Wi-Fi, infrared or magnetic induction. If Bluetooth it may be the A2DP profile for audio.

The audio reproduction device 10 may have appropriate audio processing circuitry 66, as illustrated in Figure 7. The circuitry is usually provided in one of the audio reproduction modules 14, 16. Included is an antenna 70 for receiving the audio wirelessly and a decoder 71 for decoding the received audio if in an encoded format such as, for example, MP3. A processor 72 controls controls the overall functionality. A spatializer 73 or other audio processor may be used to enhance the user experience. A clipper 74 may be used to prevent overload of the audio drivers. The audio reproduction modules 14, 16 may be powered using an external or internal amplifier, or an internal amplifier. When onboard circuitry is used for wireless audio reception and/or decoding, an onboard amplifier 75 is used to amplify the audio.

The detector(s) 64 is operatively connected to a switch 77 that may be separate to or integral with processor 72. The switch 77 is to enable the processor 72 to determine whether the audio reproduction modules 14, 16 are separate and thus in headphone mode, or are joined and thus in speaker mode. If in headphone mode, the output from amplifier 75 may be limited to protect the hearing of a user. Also, with driver 54 is use as headphones the loudspeaker drivers 40 may be disabled to prevent audio from being reproduced by drivers 40. When in the speaker mode and thus loudspeaker drivers 40 are operative, the headphone drivers 54 may be disabled. Alternatively, when in the speaker mode, the headphone drivers 54 may remain enabled to provide an improved acoustic response from the audio reproduction module 14, 16.

The loudspeaker driver 40 and the headphone driver 54 may be the same but, as their functions are different, they typically have different audio reproduction characteristics. It is normal for the loudspeaker driver 40 to be physically larger, to have a larger power rating, and a relatively wider frequency response than the headphone driver 54. However, the loudspeaker driver 40 may be small physically, and have a frequency response that is better in the higher frequencies than the headphone driver, but may have a lesser frequency response in the lower frequencies. In this way the headphone driver 54 may be also used when in the

speaker mode so that the rear-facing headphone driver can reproduce the audio with a better lower frequency response. The reflection of such reproduced audio may have an enhanced low frequency response.

A battery 78 is used to provide the necessary power if required. In one embodiment, the audio reproduction device 10 receives an amplified analog signal directly via a cable (i.e. in conventional headphone manner), and no further power is required. If additional power is required for wireless audio reception, decoding of audio data, or amplification, this may be provided by an external power source (e.g. a battery pack or AC power supply) or an onboard power source such as the battery 78.

Controls 79 for volume and/or balance and/or tone and/or treble and/or bass response may also be provided, if required or desired. Alternatively or additionally, the control of the external source of audio may be used. A noise cancellation feature 80 may also be included.

Figures 9 to 14 illustrate a second embodiment that is the same as the first embodiment except that the pivotal connection 20 is of a slightly different form, and the enclosures 30 are of a different shape. Also, the mount 52 is a hollow cylinder of relatively small diameter. In all other respects it is the same as the embodiment of Figures 1 to 8.

A second embodiment of the present invention is shown in Figures 15 and 16. There is also shown a multimode audio reproduction device that is able to be used in two modes, namely a first mode in which it is usable as a headset and a second mode in which it is usable as a loudspeaker.

Figure 15 shows the audio reproduction module 16 in use in a first mode as a headset. The module 16 is detachable from the head band 12 of the audio reproduction device described in the first embodiment. The module 16 may be independently powered when it is used as a headset. For example, a battery 1 may be incorporated into the module 16 to power the module 16 or it may be powered by a solar cell. The module 16 may have a ear latch (not shown) for hooking onto a ear of the user. Having modules 16 and 14 with ear latches may enable the first embodiment of the audio reproduction device to be used as a neckphone, where the head band 12 rests towards a rear portion of a user's head. The head band 12 may contain a power source that charges the power source of the module 16 (and/or module 14) when the module 16 (and/or module 14) is connected to the

head band 12. Module 16 with a battery 1 may also provide power to module 14 when the modules 16 and 14 are connected with the head band 12 as depicted in Figure 17. A first receptor 2 and a second receptor 4 on module 16 may be for the reception of power and functional connectors respectively of a head band or neck band. As such, when modules 16 and 14 are connected with the head band 12, controlling the functionalities of each individual module may allow for the concurrent control of both modules.

Referring to Figure 17, a first connector 3 and a second connector 5 on the head band 12 connects to the first receptor 2 and a second receptor 4 respectively. The connectors 3, 5 may be connectors that secure the head band 12 to the modules 16 and 14 using click-lock pins 9 (as shown in Figure 18) that fit into receptors 2, 4.

The module 16 may receive audio from an external source, or from an in-built media file source, FM radio, mobile telephone or the like. If from an external source, it may be by:-

1. a direct connection using relevant connections such as, for example, an USB connection, IEEE 1394 connection, or using RCA or like connections;
2. a cable connection using a suitable connector at a remote end, such as a conventional or mini headphone plug. The cable connection may be permanently connected to the module 16 or may be removable by use of an appropriate connector; or
3. wirelessly using, for example, Bluetooth, Wi-Fi, infrared or magnetic induction. If Bluetooth it may be the A2DP profile for audio.

The module 16 may independently have appropriate audio processing circuitry as illustrated in Figure 7 as per the first embodiment of the present invention. The module 16 may include an antenna 70 for receiving the audio wirelessly and a decoder 71 for decoding the received audio if in an encoded format such as, for example, MP3. A processor 72 controls the overall functionality. A spatializer 73 or other audio processor may be used to enhance the user experience. A clipper 74 may be used to prevent overload of the audio driver. The second embodiment of the present invention may also have a microphone for the user 98 to speak into for transmission of audio signals such as speech back to the external source. The audio signals may be recorded at the external source or it may be transmitted as per usage as a mobile phone headset. The microphone 10 may be a boom that is integrated with module 16.

Referring to Figure 16, there is shown the module 16 placed on a surface 62 used in a second mode as a loudspeaker where the projection of sound is from the driver 40. The module 16 may have a switch to toggle between the first and second mode. The ear pad 50 may act as a support or prop so that the module 16 can be placed on a surface 62 at an angle relative to surface 62 to provide for projection of sound from the driver 40.

Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology that many variations or modifications in details of design or construction or operation may be made without departing from the present invention.

The Claims

1. An audio reproduction device, comprising:

a first audio driver module;

a second audio driver module; and

a support structure coupling the first and second audio driver modules,

the first and second audio driver modules being movable relative to one another between a first configuration in which they are positioned to be used as headphones and a second configuration in which they are positioned to be used as loudspeakers.

2. The audio reproduction device of claim 1, wherein the first and second audio driver modules each include an headphone audio driver and a loudspeaker audio driver, the headphone audio drivers facing generally towards each other and the loudspeaker audio drivers facing generally away from each other when the audio reproduction device is in the first configuration.

3. The audio reproduction device of claim 2, wherein the first and second audio driver modules are movable towards each other to assume the second configuration.

4. The audio reproduction device of claim 3, wherein the loudspeaker audio drivers of the first and second audio modules are positioned to project sound in the same general direction when the first and second audio modules are in the second configuration.

5. The audio reproduction device of claim 2, wherein the loudspeaker audio drivers of the first and second audio modules are positioned to project sound in the same general direction when the first and second audio modules are in the second configuration.

6. The audio reproduction device of claim 2, further comprising a switch to disable the loudspeaker audio drivers when the audio reproduction device is in the

first configuration and to disable the headphone audio drivers when the audio reproduction device is in the second configuration.

7. The audio reproduction device of claim 1, wherein the first and second audio modules engage each other in the second configuration so that they maintain their relative position.

8. The audio reproduction device of claim 4, wherein the support structure serves to prop up the first and second audio modules when in the second configuration.

9. The audio reproduction device of claim 1 further comprising circuitry for wireless reception of audio.

10. The audio reproduction device of claim 9, wherein the circuitry includes a processor for decompressing compressed audio data.

11. The audio reproduction device of claim 6, wherein the switch operates automatically as the first and second audio modules are moved between configurations.

12. The audio reproduction device is claimed in claim 2, wherein the support structure serves as a headband for the first and second audio driver modules when in the first configuration.

13. The audio reproduction device as claimed in claim 2, wherein the first audio driver module and the second audio driver module each comprises an enclosure; each enclosure comprising a front face and a rear face; the loudspeaker audio drivers being mounted in the front faces, and the headphone audio drivers being mounted in the rear faces.

14. The audio reproduction device as claimed in claim 2, wherein the loudspeaker audio drivers are operative when the first and second audio driver

modules are in the second configuration but are not operative when the first and second audio driver modules are in the first configuration; and the headphone audio drivers are operative when the first and second audio driver modules are in the first configuration.

15. The audio reproduction device as claimed in claim 14, wherein the headphone audio drivers are not operative when the first and second audio driver modules are in the second configuration.

16. The audio reproduction device as claimed in claim 13 wherein at least one of the enclosures further comprises a detector for detecting whether the first and second audio driver modules are in the first configuration or the second configuration.

17. The audio reproduction device as claimed in claim 13, wherein each enclosure further comprises an end, each end comprising a retainer for releasably retaining the end of the first audio driver module with the end of the second audio driver module when the first and second audio driver modules are in the second configuration.

18. The audio reproduction device as claimed in claim 17, wherein the retainer comprises at least one selected from the group consisting of: a tongue and a complementary groove, and a pin and a complementary hole.

19. The audio reproduction device as claimed in claim 13, wherein the support structure is pivotally connected to the enclosure of both the first and second audio driver modules.

20. The audio reproduction device as claimed in claim 13 further comprising an ear pad mounted to the rear face and being co-axial with the headphone audio driver.

21. The audio reproduction device as claimed in claim 13 further comprising at least one internal baffle within each enclosure located between the headphone audio driver and the loudspeaker audio driver.

22. The audio reproduction device as claimed in claim 21, wherein the at least one baffle divides each enclosure into two sub-enclosures; a first sub-enclosure

being for the headphone audio driver, and a second sub-enclosure for the loudspeaker audio driver.

23. An audio reproduction device comprising:

(a) a first audio driver module;

(b) a second audio driver module;

the first and second audio driver modules being movable relative to one another between a first configuration and a second configuration; at least one of the first and second audio driver modules comprising audio processing circuitry for processing audio supplied to the device; the audio processing circuitry comprising an amplifier, the amplifier being for responding to an input to automatically limit an output of the amplifier when the device is in the first configuration.

24. The audio reproduction device as claimed in claim 23, wherein each of the first and second audio driver modules comprises an enclosure, each enclosure having an end, the input is from a detector mounted on the end of at least one of the enclosures.

25. The audio reproduction device as claimed in claim 24, wherein the audio processing circuitry further comprises a switch for receiving an output from the detector and providing the input.