Technical Disclosure Commons

Defensive Publications Series

October 26, 2017

Wearable Open-Ear Audio Device System With Weighted Pendant

N/A

Follow this and additional works at: http://www.tdcommons.org/dpubs_series

Recommended Citation
N/A, "Wearable Open-Ear Audio Device System With Weighted Pendant", Technical Disclosure Commons, (October 26, 2017)
http://www.tdcommons.org/dpubs_series/773

This work is licensed under a Creative Commons Attribution 4.0 License.
This Article is brought to you for free and open access by Technical Disclosure Commons. It has been accepted for inclusion in Defensive Publications Series by an authorized administrator of Technical Disclosure Commons.
WEARABLE OPEN-EAR AUDIO DEVICE SYSTEM WITH WEIGHTED PENDANT

ABSTRACT OF THE DISCLOSURE

Aspects of the disclosure provide an audio device system. The audio device system includes an ear hook at one end. A bone conduction transducer (BCT) is attached to the ear hook such that a contact force is exerted against a user’s head when the ear hook is worn by the user on his or her ear. A cable extends from the BCT, connecting to a pendant at the other end of the audio device system. The pendant has a weight that provides additional contact force between the BCT and the user's head.

BACKGROUND

Headphones producing bone conducting audio cause vibrations in a user’s bone or cartilage. The transducers vibrate the user's inner ear indirectly via vibrations in the user's skull or other bones or cartilage in the user's head proximate to where the transducers are positioned. Sound is perceived by the user primarily via the cochlea in the user's inner ear while bypassing the user's ear drum. If the bone conducting transducer does not make adequate contact with the user's skull, sound quality is lost.

BRIEF SUMMARY

Aspects of the disclosure provide an audio device system. The audio device comprising a first ear hook at a first end; a first bone conduction transducer (BCT) attached to the first ear hook and exerting a first contact force against a user’s head when the first ear hook is worn by the user on a first ear; a first cable extending from the first BCT; and a pendant connected to the first cable at a second end, the pendant having a weight that provides additional contact force between the first BCT and the user's head. In this disclosure, the bone conduction transducer is not limited to transmitting sound through bone, but further includes transmission of sound through cartilage, such as the auricle, or pinna, of the ear of a user, as
well as transmission of sound through a combination of bone and cartilage. However, for ease of discussion, the transducer will continue to be referred to as a BCT.

In one example, the audio device system also includes a second ear hook at a first end; a second BCT attached to the second ear hook and exerting a second contact force against the user’s head when the second ear hook is worn by the user on a second ear; and a second cable extending from the second BCT; wherein the second cable is connected to the pendant at the second end, the weight of the pendant providing additional contact force between the second BCT and the user’s head. In this example, the first cable and the second cable join together at a point between the first end and the second end, forming a Y-shape.

In another example, the first BCT is enclosed in a pod, the pod being inserted through an opening in the first ear hook and holding the enclosed BCT against the user’s head. In this example, the pod is sealed such that the pod is water-proof or sweat-proof. Also in this example, the pod includes one or more sensors, the one or more sensors including at least one of an accelerometer, a heat sensor, a gyroscope.

In yet another example, the first BCT is connected to one or more components including at least one of one or more processors, a circuitry board, a battery, a memory, one or more sensors, a microphone, and an amp. In this example, the one or more components are located in the pendant.

In a further example, the pendant weighs between 10 and 20 grams. In yet another example, the pendant has a first surface, a second surface parallel with the first surface, and one or more side surfaces spanning a distance between the first and second surfaces and intersect the first and second surfaces, the first surface and the second surface being oval in shape. In this example, the distance between the first surface and the second surface is between one and two centimeters. Also in this example, the second surface of the pendant is magnetic. In yet
another example, the pendant includes a wireless transceiver to connect wirelessly to other devices.

Other aspects of the disclosure provide for a pendant for increasing a contact force between a bone conduction transducer (BCT) and a user’s head, comprising a first surface; a second surface parallel with the first surface; one or more side surfaces spanning a distance between the first and second surfaces, thereby forming a cavity; and one or more electronic components located in the cavity and configured to send audio information to the BCT; wherein the pendant is attachable to a BCT via a cable, a weight of the pendant increasing a contact force between the BCT and the user's head.

In one example, the weight of the pendant is between 10 and 20 grams. In another example, the electronic components comprise at least one of one or more processors, a circuitry board, a battery, a memory, one or more sensors, a microphone, and an amp in the cavity. In yet another example, the pendant also includes at least one of a charging input and a user control on one of the first, second, and side surfaces of the pendant. In a further example, the distance between the first surface and the second surface is between one and two centimeters.

Further aspects of the disclosure provide for a device for bone conduction comprising a first ear hook and a second ear hook at a first end; a first bone conduction transducer (BCT) and a second BCT attached to the first ear hook and the second ear hook, respectively, each BCT having a contact force against a user’s head; a first cable extending from the first BCT and a second cable extending from the second BCT, the first cable and the second cable joining together at a point toward a second end to form a Y-shape; and a pendant connected to the first cable at a second end, the pendant having a first surface, a second surface parallel with the first surface, and one or more side surfaces spanning a distance between the first and
second surfaces; wherein a weight of the pendant provides additional contact force between
the BCTs and the user's head.

In one example, the weight of the pendant is between 10 and 20 grams.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of an audio device according to aspects of the disclosure.

FIGURE 2 is a pictorial diagram of the audio device positioned in relation to a user according
to aspects of the disclosure.

FIGURE 3 is an enlarged side view of a portion of the audio device according to aspects of
the disclosure.

FIGURE 4 is pictorial diagram of a portion of the audio device positioned in relation to a
user's ear according to aspects of the disclosure.

FIGURE 5 is an exploded side view of a portion of the audio device according to aspects of
the disclosure.

FIGURES 6A-6C are pictorial diagrams illustrating example positioning of a BCT in the
audio device according to aspects of the disclosure.

FIGURE 7 is an enlarged side view of a pod in the audio device according to aspects of the
disclosure.

DETAILED DESCRIPTION

OVERVIEW

The technology relates to a wearable open-ear audio device system with weighted pendant.
The open-ear audio device system may be one with a bone conduction transducer for bone
conducting audio capabilities. Bone conducting audio typically requires a decent contact
force to the body in order to get good quality audio. The bone conduction transducer (BCT)
needs to be coupled to the body in order to transmit the necessary vibrations. In an over the
ear BCT design, it is difficult to provide an adequate contact force in a comfortable and easy
to wear way.

The audio device system may include first and second ear hooks at a first end, with each ear
hook supporting a BCT. A cable extends from each BCT, with the two cables joining
together towards a second end, thereby forming a “Y” shape. The cables are attached to a
pendant at the second end, a weight of the pendant supplying a contact force between the
BCT and the user's cartilage, skull, or both. The audio device system may alternatively have
only one ear hook and one BCT. In this design, only one cable may connect the BCT to the
pendant.

The first ear hook and the second ear hook of the audio device system may be designed to
ergonomically fit on the user’s ears. When worn, the ear hooks may rest on the top of the
user’s ears and maintain substantially the same positions while worn. Along a portion of the
first ear hook is an opening wherein a first BCT may be attached. There may also be an
opening in a portion of the second ear hook for attaching a second BCT. The openings may
be in the shape of the BCTs and be located where the ear hooks contact the back of the user’s
ears or a higher or lower portion of the ears.

The BCTs provide audio to the user by vibrating against the user’s cartilage, skull, or both.
Bone conduction requires an amount of contact force against the user in order for the
vibration of the BCTs to reliably cause a same or similar vibration of the user’s cartilage
and/or skull and, ultimately, the user’s inner ear, thereby providing clear audio output.

In the audio device system, the BCTs may be enclosed in pods, which may be shaped to fit a
user’s ears. A first portion of the pod may be configured to fit through the opening of an ear
hook and contact the user’s ears. A second portion of the pod may be configured to house
components of a BCT that may generate a vibration in response to received audio
information. The vibration may be translated to the user’s ear through the contact between
the first pod and the user’s ear. The pods may also be sealed off in order to be water-proof or
sweat-proof. The second portion of one or both pods may also include sensors.
The BCTs may be connected to one or more processors, a circuitry board, a battery, a
memory, one or more sensors, a microphone, an amp, and/or other components. These
components may be located remotely from the BCT, such as in the pendant. The cables
attached to the BCTs may be designed to provide a torque to the ear hooks and the BCTs
such that the BCTs are pressed firmly against the user’s cartilage and/or skull. The cables
may protrude from the BCTs or portions of the ear hooks at a particular angle with respect to
a direction of gravity. The cable may extend straight for a predetermined distance at the
particular angle. When the cable is weighted, for example by the gravitational force of a
pendant coupled thereto, the angle at which the cable protrudes from the BCT may cause a
torque to be applied to the BCT, the torque in turn increasing a contact force between the
BCT and the user's skull and/or cartilage. Strain relief may be provided in the cables at a
point where the straight portion begins to curve. In this regard, when compressive forces are
applied to the cable, it will also prevent the ear hook from becoming unseated on the user's
ear. For example, when the user turns his head or when the pendant is resting on a surface
and no longer applying a tensile force on the cable, the cable may return to its resting angled
position as opposed to translating the compressive force to the ear hook or BCT. The first
cable and the second cable may join together at a point such that the cables form a “Y” shape.
The point at which the cables join may be adjustable for the comfort of the user. After the
point at which the cables are joined, the pendant may be attached at the second end of the
device.
The pendant at the second end of the device may have some mass, thereby increasing the contact force between the BCTs and the user’s cartilage and/or skull. As mentioned above, the pendant may include components such as one or more processors, a circuitry board, a battery, a memory, one or more sensors, a microphone, and/or an amp. The components in the pendant may be connected to the BCTs or other components in the pods via wires running through the cables. When the audio device system is worn, the pendant may rest more or less at the center of the user’s chest. The gravitational pull on the pendant therefore may provide a downward force on the cables, which translates the same force to the ear hooks and the BCTs, thereby pushing the BCTs more firmly onto the user’s cartilage or skull behind the user’s ears. The amount of force provided is enough to provide the contact necessary for clear audio output, but not an amount that would be uncomfortable to the user.

EXAMPLE SYSTEMS

As shown in FIGURE 1, the audio device system may include first and second ear hooks 110, 112 at a first end. Each ear hook may support BCTs 120, 122, respectively. Cables 130, 132 may extend from BCTs 120, 122, respectively. The two cables 130, 132 may join together at a point 140 towards a second end of the audio device system, thereby forming a “Y” shape. The point 140 at which cables 130, 132 are joined may be adjustable to any other point along the cables for the comfort of the user. The point 140 may be closer to the BCTs 120, 122 at the first end of the audio device system, thereby creating a smaller opening in the “Y” shape. The point 140 may be closer to the pendant 150 at the second end of the audio device system, thereby creating a bigger opening in the “Y” shape. The cables 130, 132 are attached to a pendant 150 at the second end, a weight of the pendant 150 supplying a contact force between the BCT and the user's cartilage and/or skull. The pendant 150 may have a first surface 152, a second surface 154 generally parallel with the
first surface 152, and one or more side surfaces connecting the first surface 152 and the second surface 154. The first surface and the second surface may be oval, as shown in FIGURE 1, or any other shape. The surfaces 152, 154 may be relatively flat, or the first surface, the second surface, or both may be slightly convex in shape. The side surface may wrap around the first surface and the second surface, spanning the distance between the first and second surfaces and intersect the first and second surfaces at approximately 90 degrees, or more or less. The distance between the first surface and the second surface, and the width of the side surface, by implication, may be small, giving the pendant an overall slim profile. For example, the distance may be between one and two centimeters. The pendant may be made from plastic, metal, or a combination of plastics and metals.

The pendant may have some mass, thereby increasing the contact force between the BCTs and the user’s cartilage and/or skull. For example, the pendant may weigh between 10 and 20 grams.

The pendant may include components such as one or more processors, a circuitry board, a battery, a memory, one or more sensors, a wireless transceiver, a microphone, and/or an amp. Such components may provide audio to the BCTs, control how such audio is provided, or provide other functionality to the audio device system. For example, the pendant may have the capability to connect wirelessly to other devices via a wireless transceiver or a pairing mechanism. The wireless connection may be between the pendant and a device that outputs audio information, such as an mp3 player. The pendant may receive audio information wireless from the device outputting audio information, and the audio device may produce bone conduction audio via the BCTs. In other examples, the pendant may be connected to the device outputting audio information via wires.
The components may be located on any portion of the pendant. For example, a microphone may be located close to where the cables attach to the pendant. In other examples, the microphone may be positioned on the cable by the user’s mouth when the audio device is worn, with a weight of the pendant at the end of the cable helping to maintain the microphone in generally a same position with respect to the user.

The pendant may also include input controls. For example, volume and play/pause controls may be disposed on the side surface of the pendant, or on the first or second surface of the pendant. Other examples of user controls may include a power input, a device pairing/synching control, or any other type of control for a mobile computing device. The input controls may be, for example, buttons, dials, switches, fingerprint readers, or any other type of control.

The pendant may also include one or more sensors. The sensors may include, for example, step counters, gyroscopes, accelerometers, light sensors, temperature sensors, motion sensors, or any other type of sensor. In one example, the sensors may be activated or deactivated by one of the input controls mentioned above, or by a voice command received through the microphone.

In some examples, the pendant may further include a charging input. The charging input may be positioned, for example, on the side surface at an end of the pendant opposite where the cables are attached, or on any other portion of the pendant. The charging input may be an input for a USB Type-C connector, or any other type of connector for charging the battery in the pendant or the audio device.

Including one or more components in the pendant not only may allow for a sleeker design, but may also provide the mass to the pendant to provide the needed contact force for the
BCTs. The components in the pendant may be connected to the BCTs or other components in the pods via wires running through the cables.

When the audio device system 100 is worn, the pendant may rest on a user’s chest as shown in FIGURE 2. The first surface 152 may face forward and the second surface 154 may lie against the user’s chest. The cables 130, 132, from the point 140 where they are joined to where the pendant 150 is connected, may be vertical or nearly vertical. The pendant 150 may be more or less at the center of the user’s chest. In some examples, the pendant may be secured in a position on the user’s chest. For example, the pendant may include a magnet or the second surface of the pendant may be made from a magnetic material that may be coupled with another magnet to attach the pendant to a user’s clothing. As another example, another mechanism for securing the pendant, such as a clip, pin, etc. may be attached to the second surface 154 or to another portion of the pendant 150 or the cable.

The gravitational pull on the pendant may provide a downward force on the cables, which translates the same force to the ear hooks and the BCTs, thereby pushing the BCTs more firmly onto the user’s cartilage or skull behind the user’s ears. Returning to FIGURE 1, the weight of the pendant 150 may apply a force 160, 162 downward on cables 130, 132.

As shown in FIGURE 3, the cable 130 may be attached at the back of the BCT 120 at a surface opposite the surface contacting the user’s head. The cable 130 may extend away from the opening of the “C” of the ear hook 110 when the ear hook 110 is attached to BCT 120. In other examples, the cables may be attached to the pods enclosing the BCTs at a surface on the second portions of the pods. The force 160 on the cable 130 from the pendant 150 may be translated to the BCT 120 and the ear hook 110 such that the BCT 120 and the ear hook 110 are pushed into the user’s head when worn, providing a force 310. The amount of force provided is enough to provide the contact necessary for clear audio output, but not an
amount that would be uncomfortable to the user. It is therefore unnecessary to clamp or clip the audio device to the user’s head or ear. It is therefore also unnecessary to use adhesive to maintain contact of the BCT and/or the cable to the user or otherwise adhere the BCT and/or the cable to the user’s head.

The first ear hook and the second ear hook of the audio device system may be designed to ergonomically fit on the user’s ears as shown in FIGURE 4. For example, the first ear hook 110 may be C-shaped and worn such that the ear hook curves along the back of the user’s ears. For example, the first ear hook 110 may contact the crease where the auricle, or pinna, of the user’s ear connects to the user’s head. The first ear hook 110 may contact at least the user’s zygomatic process and the user’s mastoid process and/or other nearby portions of the temporal bone. The first ear hook may also contact the cartilage of the user’s auricle. The first ear hook 110 may therefore be tucked behind the helix 410, antihelix 420, and lobule 430 of the user’s ear. Furthermore, the surface of the first ear hook 110 may be shaped to accommodate the shape of the portions of the temporal bone and ear that it contacts. The opening of the “C” may then open toward the front of the user’s ears, such as near the tragus 440 and the lobule 430. When worn, the first ear hook 110 may rest primarily on the top of the user’s ears and maintain substantially the same positions while worn.

The second ear hook 112 may be the same shape as the first ear hook or may be a different shape. In some examples, the audio device may be configured to be worn on only one ear of the user. For example, the device may have only one ear hook and one BCT. In this design, only one cable may connect the BCT to the pendant.

The ear hooks may be designed to be detachable from the audio device system and interchangeable with ear hooks having different sizes and/or shapes. For example, along a portion of the first ear hook 110 may be an opening 510. The first ear hook may be attached
to a first BCT 120 of the audio device system by placing the opening 510 over the first BCT 120, as shown in FIGURE 5. The opening 510 and the BCT 120 may have a snap-fit configuration or another type of configuration to securely attach the first ear hook to the first BCT. The first ear hook may be detached from the BCT by pulling the first ear hook 110 away from the BCT 120 with a degree of force. Pulling the first ear hook may also include deforming the first ear hook in order to warp the shape of the opening in the first ear hook.

There may also be an opening in a portion of the second ear hook, which may be similarly configured for attaching and detaching the second ear hook to and from a second BCT. The openings may be in the shape of the BCTs and be located where the ear hooks contact the back of the user’s ears or a higher or lower portion of the ears. For example, the openings may be anywhere within a range from the top of a user’s ears to 180 degrees down from the top of the user’s ears. When a BCT is fitted in an opening, the BCT may be maintained in a fixed position in contact with the back of a user’s ear. For example, the BCT extending through the ear hook may contact the crease where the auricle, or pinna, of the user’s ear connects to the user’s head. In other examples, the BCT may directly contact the cartilage of the auricle of the user’s ear, or may be secured against the skull of the user.

As shown in FIGURE 6A, an opening in the ear hook configured to accept BCT 120 may be approximately 90 degrees down from a top 610 of the user’s ear. Accordingly, when the device is worn, the BCT 120 may contact a portion of the user's cartilage and/or skull behind a midportion of the user's ear.

As shown in FIGURE 6B, the opening for the BCT 120 may be closer to the top 610 of the ear hook. Accordingly, when worn, the BCT 120 of the device may contact a portion of the user's cartilage and/or skull near a portion of the ear hook that is less than 90 degrees down from the top portion of the ear hook.
As shown in FIGURE 6C, the opening for the BCT 120 may be further from the top 610. For example, the BCT 120 may be positioned within a lower portion of the ear hook. In this regard, when the device is worn, the BCT may contact a portion of the user's cartilage and/or skull behind the user's lobe.

The BCTs provide audio to the user by vibrating against the user's cartilage and/or skull. For example, the BCTs may vibrate against the cartilage in the auricle, or pinna, of the user's ear in order to provide audio to the user. The vibration against the cartilage may be the primary source of audio provided to the user provided from the device. The BCTs may additionally or alternatively vibrate against the mastoid process and other portions of the temporal bone of the user's skull to provide the audio. Bone conduction requires an amount of contact force against the user in order for the vibration of the BCTs to reliably cause a same or similar vibration of the user's cartilage and/or skull and, ultimately, the user's inner ear, thereby providing clear audio output.

In the audio device system, the BCTs may be enclosed in pods. The pods may be shaped to fit a user's ears. For example, the pod may be pill-shaped, or a generally long oval shape, and may have surfaces that are concave to fit the curvature of the backs of the user's ears, such as the crease where the auricle of the user's ear connects to the user's head. The shape and the surfaces of the pod may be configured to attach to an ear hook via an opening in the ear hook, such as in a snap-fit configuration.

When attached to the ear hook, a first portion of the pod may be configured to fit through the opening of an ear hook and contact the user's cartilage and/or skull. A second portion of the pod may be configured to house components of a BCT that may generate a vibration in response to received audio information. The second portion may be hidden behind the surface of the ear hook and/or the user's ear. As shown in FIGURE 7, the BCT 120 may be
enclosed in a pod having a first portion 710 and second portion 720. The first portion 710 may be configured to fit through an opening in an ear hook. As shown, the second portion 720 may be disposed between the first portion and the cable 130. The vibration may be translated to the user’s ear through the contact between the first pod and the user’s ear. The second portion of one or both pods may also include sensors, such as accelerometers, a heat sensor, and a gyroscope. The pods may also be sealed off in order to be water-proof or sweat-proof.

The BCTs may be connected to one or more components of the audio device. The components may include one or more processors, a circuitry board, a battery, a memory, one or more sensors, a microphone, an amp, and/or other components. The one or more components may be located remotely from the BCT. In some examples, the components may be in the pendant of the audio device system.

The features described above provide for a bone conduction audio device system that may be worn comfortably by a user for long periods of time. The simple hook design of the ear hooks coupled with the pendant does not require any clipping or clamping as required by other designs, such as those that wrap around and clamps down on a user’s head using a spring force. Unlike, clipping or clamping designs, which may cause discomfort to a user’s head over time, the features of the audio device system described above provide the amount force that is needed in the right location to allow the user to hear the audio output clearly. Moreover, the ear hooks may be easily put on and removed, without requiring significant adjustment to place the BCTs for improved sound quality. The described features of the audio device system also provide a sleek design such that a user may where the device inconspicuously if so desired.
Unless stated otherwise, the foregoing alternative examples are not mutually exclusive. They may be implemented in various combinations to achieve unique advantages. As these and other variations and combinations of the features discussed above can be utilized, the foregoing description of the embodiments should be taken by way of illustration rather than by way of limitation. As an example, the preceding operations do not have to be performed in the precise order described above. Rather, various steps can be handled in a different order or simultaneously. Steps can also be omitted unless otherwise stated. In addition, the provision of the examples described herein, as well as clauses phrased as "such as," "including" and the like, should not be interpreted as limiting the subject matter to the specific examples; rather, the examples are intended to illustrate only one of many possible embodiments and that other arrangements may be devised without departing from the spirit and scope of the present disclosure. Further, the same reference numbers in different drawings can identify the same or similar elements.
Wearable Open-Ear Audio Device System With Weighted Pendant

FIGURE 6A

FIGURE 6B