

1                   PHASE CORRECTING CANALPHONE SYSTEM AND METHOD

2   CROSS-REFERENCE TO RELATED APPLICATIONS

3   **[0001]**       This application is a continuation-in-part of  
4   copending U.S. Patent Application No. 13/315,610, filed 9  
5   December 2011 (Agent Docket No. JH02), and this application  
6   also claims the benefit of copending U.S. Provisional  
7   Application No. 61/683,614, filed 15 August 2012 (Agent  
8   Docket No. JH05(P)). The present application and both  
9   applications identified above include identical  
10   inventorship and ownership.

11   BACKGROUND

12   **[0002]**       The embodiments relate to the field of  
13   canalphones and/or similar listening devices.

14               Description of Background

15   **[0003]**       There are many different types of personal  
16   listening devices such as headphones, earbuds, canalphones,  
17   and/or the like. Headphones are personal listening devices  
18   that are held in close proximity to the ear by some  
19   support system. Earbuds are small personal listening  
20   devices that are positioned directly in front of the ear  
21   canal and are substantially smaller than a person's outer  
22   ear. Similarly, canalphones are personal listening devices  
23   that are substantially smaller than a person's outer ear,  
24   but they differ from earbuds in that they are placed  
25   directly in one end of the ear canal. Both earbuds and

1 canalphones are held in positioned by friction between the  
2 ear and the device rather than the support system found in  
3 most headphones. Canalphones may also be held in place by  
4 retainers that engage a portion of the listener's head.

5 **[0004]** Canalphones are also referred to as in-ear  
6 monitors due to how the canalphone is worn by a listener.  
7 In other words, a canalphone housing is worn in the ear of  
8 the user and not over and/or around the ear of the user.  
9 Some canalphones also serve as earplugs due to the way the  
10 canalphone limits noise external to the canalphone from  
11 entering the ear canal.

12 SUMMARY

13 **[0005]** According to one embodiment, a canalphone system  
14 may include a high frequency sound bore carried within a  
15 canalphone. The system may also include a low frequency  
16 sound bore carried within the canalphone that is adjacent  
17 to the high frequency sound bore to form a single unit  
18 prior to the sound bores being introduced to the  
19 canalphone, the low frequency sound bore and the high  
20 frequency sound bore being sized so that the low frequency  
21 sound bore and the high frequency sound bore each deliver  
22 sound with correct time and phase. The system may further  
23 include a high acoustical driver carried within the  
24 canalphone where the high acoustical driver delivers sound  
25 through the high frequency sound bore. The system may  
26 additionally include a low acoustical driver carried within

1 the canalphone where the low acoustical driver delivers  
2 sound through the low frequency sound bore.

3 **[0006]** The low acoustical driver may comprise two low  
4 acoustical drivers. The high acoustical driver may comprise  
5 two high acoustical drivers.

6 **[0007]** The low frequency sound bore and/or the high  
7 frequency sound bore may carry an acoustical damper. The  
8 acoustical damper may be positioned without any rubber  
9 boot.

10 **[0008]** The low frequency sound bore and/or the high  
11 frequency sound bore may have extended lengths to reduce  
12 each sound bore's diameter. The high frequency sound bore's  
13 extended length may be greater than 3 millimeters.

14 **[0009]** The single unit may aid in the assembly of the  
15 canalphone. The single unit may be positioned at an angle  
16 between 30 degrees and 65 degrees with respect to the high  
17 acoustical driver and the low acoustical driver. The system  
18 may further include a resistor on the high acoustical  
19 driver to tune the high acoustical driver.

20 **[0010]** In another embodiment, the system may include a  
21 high frequency sound bore carried within a canalphone. The  
22 system may also include a low frequency sound bore carried  
23 within the canalphone that is adjacent to the high  
24 frequency sound bore to form a single unit prior to the  
25 sound bores being introduced to the canalphone, the low  
26 frequency sound bore and the high frequency sound bore

1 being sized so that the low frequency sound bore and the  
2 high frequency sound bore each deliver sound with correct  
3 time and phase, and where the low frequency sound bore and  
4 the high frequency sound bore have extended lengths to  
5 reduce each sound bore's diameter. The system may further  
6 include a high acoustical driver carried within the  
7 canalphone where the high acoustical driver delivers sound  
8 through the high frequency sound bore. The system may  
9 additionally include a low acoustical driver carried within  
10 the canalphone where the low acoustical driver delivers  
11 sound through the low frequency sound bore, and the single  
12 unit is positioned at an angle between 30 degrees and 65  
13 degrees with respect to the high acoustical driver and the  
14 low acoustical driver.

15 **[0011]** Another aspect of the embodiments is a method.  
16 The method may include positioning a high acoustical driver  
17 within a canalphone. The method may also include  
18 positioning a low acoustical driver within the canalphone  
19 adjacent to the high acoustical driver. The method may  
20 further include positioning a single unit comprising a low  
21 frequency sound bore adjacent to a high frequency sound  
22 bore within the canalphone where the low frequency sound  
23 bore and the high frequency sound bore are sized so that  
24 the low frequency sound bore and the high frequency sound  
25 bore each deliver sound with correct time and phase, and

1 the single unit adjoins both the high acoustical driver and  
2 low acoustical driver.

3 **[0012]** The method may additionally include inserting an  
4 acoustical damper within at least one of the low frequency  
5 sound bore and the high frequency sound bore. The method  
6 may also include inserting the acoustical damper within the  
7 sound bore without any rubber boot. The method may further  
8 include reducing the low frequency sound bore's diameter  
9 and the high frequency sound bore's diameter by extending  
10 the lengths of each sound bore.

11 **[0013]** According to another embodiment, a canalphone  
12 system may include a high audio driver carried by a  
13 canalphone housing, and a low audio driver carried by the  
14 canalphone housing adjacent to the high audio driver. The  
15 system may also include an acoustical-timer to phase  
16 correct a high audio signal from the high audio driver  
17 directed to the outside of the canalphone housing with  
18 delivery of a low audio signal from the low audio driver  
19 directed to the outside of the canalphone housing.

20 **[0014]** The acoustical-timer further includes a low audio  
21 sound-tube to carry a low audio signal from the low audio  
22 driver to outside of the canalphone housing, and a high  
23 audio sound-tube to carry a high audio signal from the high  
24 audio driver to the outside of the canalphone housing, the  
25 high audio sound-tube phase corrected with respect to the  
26 low audio sound-tube by sizing it to be longer than the low

1 audio sound-tube. The low audio sound-tube may be sized  
2 based upon its time response for the low audio signal to  
3 pass through the low audio sound-tube.

4 **[0015]** The high audio sound-tube may be longer to slow  
5 down the high audio signal's arrival to the outside of the  
6 canalphone housing so that it is closer in time to the low  
7 audio signal from the low audio driver arrival to the  
8 outside of the canalphone housing. The arrival of the high  
9 audio signal's to the outside of the canalphone housing is  
10 less than .05 milliseconds difference than the low audio  
11 signal from the low audio driver arrival to the outside of  
12 the canalphone housing.

13 **[0016]** The system may additionally include a mid audio  
14 driver carried by the canalphone housing adjacent to the  
15 high audio driver, and a mid audio sound-tube to carry a  
16 mid-audio signal from the mid audio driver to the outside  
17 of the canalphone housing, the mid audio sound-tube phase  
18 corrected by sizing it to be longer than the low audio  
19 sound-tube and shorter than the high audio sound-tube. The  
20 acoustical-timer may include a processor to phase correct a  
21 high audio signal from the high audio driver to the outside  
22 of the canalphone housing with delivery of a low audio  
23 signal from the low audio driver to the outside of the  
24 canalphone housing.

25 **[0017]** The processor may use digital signal processing  
26 to control the high audio signal's arrival at the outside

1 of the canalphone housing to be closer in time to the low  
2 audio signal from the low audio driver's arrival to the  
3 outside of the canalphone housing. The arrival of the high  
4 audio signal's to the outside of the canalphone housing is  
5 less than .05 milliseconds difference than the low audio  
6 signal from the low audio driver arrival to the outside of  
7 the canalphone housing.

8 **[0018]** The acoustical-timer may use a time response for  
9 the low audio signal to pass through the canalphone housing  
10 as a control point to set all other audio signals' phase in  
11 the system. The system may also include a mid audio driver  
12 carried by the canalphone housing adjacent to the high  
13 audio driver, the mid audio driver to provide a mid-audio  
14 signal to the outside of the canalphone housing based upon  
15 the low audio driver.

16 **[0019]** Another aspect of the embodiments is another  
17 method. The method may include providing a high audio  
18 driver carried by a canalphone housing, and a low audio  
19 driver carried by the canalphone housing adjacent to the  
20 high audio driver. The method may also include phase  
21 correcting a high audio signal from the high audio driver  
22 directed to the outside of the canalphone housing with  
23 delivery of a low audio signal from the low audio driver  
24 directed to the outside of the canalphone housing.

25 **[0020]** The method may further include carrying a low  
26 audio signal from the low audio driver to outside of the

1 canalphone housing via a low audio sound-tube, and carrying  
2 a high audio signal from the high audio driver to the  
3 outside of the canalphone housing via a high audio sound-  
4 tube phase corrected with respect to the low audio sound-  
5 tube by sizing it to be longer than the low audio sound-  
6 tube. The method may additionally include sizing the low  
7 audio sound-tube based upon its time response for the low  
8 audio signal to pass through the low audio sound-tube.

9 **[0021]** The method may also include selecting the low  
10 audio sound-tube's size to be acoustically proper and as  
11 short as can be readily fit into the canalphone housing.  
12 The method may further include slowing down the high audio  
13 signal's arrival to the outside of the canalphone housing  
14 so that it is closer in time to the low audio signal from  
15 the low audio driver arrival to the outside of the  
16 canalphone housing by making the high audio sound-tube  
17 longer.

18 **[0022]** The method may additionally include timing the  
19 arrival of the high audio signal to the outside of the  
20 canalphone housing compared to the low audio signal from  
21 the low audio driver arrival to the outside of the  
22 canalphone housing is within .05 milliseconds of each  
23 other. The method may also include using digital signal  
24 processing to phase correct a high audio signal from the  
25 high audio driver directed to the outside of the canalphone  
26 housing with delivery of a low audio signal from the low

1 audio driver directed to the outside of the canalphone  
2 housing.

3 **[0023]** The method may further include timing the arrival  
4 of the high audio signal to the outside of the canalphone  
5 housing compared to the low audio signal from the low audio  
6 driver arrival to the outside of the canalphone housing is  
7 within .05 milliseconds of each other. The method may  
8 additionally include using a time response for the low  
9 audio signal to pass through the canalphone housing as a  
10 control point to set all other audio signals' phase in the  
11 system.

12 **[0024]** The method may also include standardizing high  
13 audio sound-tube lengths based upon at least two low sound-  
14 tube lengths. The method may further include fabricating an  
15 assembly of a standardized high audio sound-tube length  
16 with a respective one of the two low audio sound-tube  
17 lengths to make installation in the canalphone housing  
18 easier and to provide repeatable acoustic characteristics.  
19 The method may additionally include aligning the  
20 standardized high audio sound-tube length's end with the  
21 respective one of the two low audio sound-tube lengths'  
22 end.

23 **[0025]** Another embodiment is computer readable program  
24 codes coupled to tangible media to provide canalphone phase  
25 correction. The computer readable program codes may be  
26 configured to cause the program to provide a high audio

1 driver carried by a canalphone housing, and a low audio  
2 driver carried by the canalphone housing adjacent to the  
3 high audio driver. The computer readable program codes may  
4 also be configured to cause the program to phase correct a  
5 high audio signal from the high audio driver to the outside  
6 of the canalphone housing with delivery of a low audio  
7 signal from the low audio driver to the outside of the  
8 canalphone housing. The computer program product may  
9 further include program code configured to phase correct a  
10 high audio signal from the high audio driver to the outside  
11 of the canalphone housing with delivery of a low audio  
12 signal from the low audio driver to the outside of the  
13 canalphone housing.

14 BRIEF DESCRIPTION OF the DRAWINGS

15 **[0026]** FIG. 1 is a schematic block diagram of a system  
16 in accordance with the embodiments.

17 **[0027]** FIG. 2 is a flowchart illustrating method aspects  
18 according to the embodiments.

19 **[0028]** FIG. 3 is a flowchart illustrating method aspects  
20 according to the method of FIG. 2.

21 **[0029]** FIG. 4 is a flowchart illustrating method aspects  
22 according to the method of FIG. 3.

23 **[0030]** FIG. 5 is a flowchart illustrating method aspects  
24 according to the method of FIG. 2.

25 **[0031]** FIG. 6 is a schematic block diagram of a system  
26 in accordance with various embodiments.

1   **[0032]**     FIG. 7 is an exemplary graph of a phase corrected  
2   response of the system in FIG. 6.

3   **[0033]**     FIG. 8 is a flowchart illustrating other method  
4   aspects according to the embodiments.

5   **[0034]**     FIG. 9 is a flowchart illustrating method aspects  
6   according to the method of FIG. 8.

7   **[0035]**     FIG. 10 is a flowchart illustrating method  
8   aspects according to the method of FIG. 9.

9   **[0036]**     FIG. 11 is a flowchart illustrating method  
10  aspects according to the method of FIG. 10.

11  **[0037]**     FIG. 12 is a flowchart illustrating method  
12  aspects according to the method of FIG. 9.

13  **[0038]**     FIG. 13 is a flowchart illustrating method  
14  aspects according to the method of FIG. 9.

15  **[0039]**     FIG. 14 is a flowchart illustrating method  
16  aspects according to the method of FIG. 8.

17  **[0040]**     FIG. 15 is a flowchart illustrating method  
18  aspects according to the method of FIG. 8.

19  **[0041]**     FIG. 16 is a flowchart illustrating method  
20  aspects according to the method of FIG. 8.

21  **[0042]**     FIG. 17 is a flowchart illustrating method  
22  aspects according to the method of FIG. 9.

23  **[0043]**     FIG. 18 is a flowchart illustrating method  
24  aspects according to the method of FIG. 16.

25  **[0044]**     FIG. 19 is a flowchart illustrating method  
26  aspects according to the method of FIG. 17.

1 DETAILED DESCRIPTION

2 **[0045]** Embodiments will now be described more fully  
3 hereinafter with reference to the accompanying drawings, in  
4 which preferred embodiments are shown. Like numbers refer  
5 to like elements throughout.

6 **[0046]** With reference now to Fig. 1, a dual bore  
7 canalphone system 10 is initially described. The system 10  
8 is carried by a canalphone housing 12 that frictionally  
9 engages the ear of a user (not shown) in its usage position  
10 as will be appreciated by those of skill in the art.

11 **[0047]** In one embodiment, the system 10 includes a high  
12 frequency sound bore 14 carried within the canalphone 12.  
13 The system 10 also include a low frequency sound bore 16  
14 carried within the canalphone 12 that is adjacent to the  
15 high frequency sound bore 14 to form a single unit 15 prior  
16 to the sound bores being introduced to the canalphone, the  
17 low frequency sound bore and the high frequency sound bore  
18 being sized so that the low frequency sound bore and the  
19 high frequency sound bore each deliver sound 18 with  
20 correct time and phase.

21 **[0048]** For example, the sizing of the low frequency  
22 sound bore 16 and the high frequency sound bore 14 involves  
23 selecting the diameter and/or length of each sound bore to  
24 provide the correct time and phase of sound 18 through the  
25 two sound bores with respect to each other. In other words,  
26 correct time and phase of the sound 18 through the low

1 frequency sound bore 16 and the high frequency sound bore  
2 14 as acoustically perceived by one using the system 10.

3 **[0049]** The system 10 further includes a high acoustical  
4 driver 20 carried within the canalphone where the high  
5 acoustical driver delivers sound 18 through the high  
6 frequency sound bore 14. The system 10 additionally include  
7 a low acoustical driver 22 carried within the canalphone 12  
8 where the low acoustical driver delivers sound 18 through  
9 the low frequency sound bore.

10 **[0050]** In one embodiment, the low acoustical driver 22  
11 comprises two low acoustical drivers. In another  
12 embodiment, the high acoustical driver 20 comprises two  
13 high acoustical drivers.

14 **[0051]** In one embodiment, the low frequency sound bore  
15 16 and/or the high frequency sound bore 14 carry an  
16 acoustical damper 24a and 24b. In another embodiment, the  
17 acoustical damper 24a and 24b is positioned without any  
18 rubber boot (not shown).

19 **[0052]** In one embodiment, the low frequency sound bore  
20 16 and/or the high frequency sound bore 14 have extended  
21 lengths to reduce each sound bore's diameter. Stated  
22 another way, the acoustical characteristics of either bore  
23 is preserved when reducing the bore's diameter by extending  
24 the bore's overall length. An advantage of the reduction of  
25 the two bores' diameter is that a user of system 10 can  
26 have a physically smaller ear canal. Stated another way, a

1 physically smaller person usually has a smaller ear canal  
2 than a physically larger person, and system 10 can properly  
3 fit the physically smaller ear canal because of its reduced  
4 bore diameters while other canalphone systems currently  
5 available do not fit such individuals. In another  
6 embodiment, the high frequency sound bore's 14 extended  
7 length is greater than 3 millimeters.

8 **[0053]** In one embodiment, the single unit 15 aids in the  
9 assembly of the canalphone. Stated another way, because the  
10 single unit 15 is one piece, the installation of the single  
11 unit into the canalphone 12 is easier than trying to  
12 install the low frequency sound bore 16 and the high  
13 frequency sound bore 14 as separate components. In another  
14 embodiment, the single unit 15 is positioned at an angle  
15 between 30 degrees and 65 degrees with respect to the high  
16 acoustical driver 20 and the low acoustical driver 22. In  
17 another embodiment, the system 10 includes a resistor 26 on  
18 the high acoustical driver 20 to tune the high acoustical  
19 driver.

20 **[0054]** In another embodiment, the system 10 includes a  
21 high frequency sound bore 14 carried within the canalphone  
22 12. The system also includes a low frequency sound bore 16  
23 carried within the canalphone 12 that is adjacent to the  
24 high frequency sound bore 14 to form a single unit 15 prior  
25 to the sound bores being introduced to the canalphone, the  
26 low frequency sound bore and the high frequency sound bore

1 being sized so that the low frequency sound bore and the  
2 high frequency sound bore each deliver sound 18 with  
3 correct time and phase, and where the low frequency sound  
4 bore and the high frequency sound bore have extended  
5 lengths to reduce each sound bore's diameter. The system  
6 further includes a high acoustical driver 20 carried within  
7 the canalphone 12 where the high acoustical driver delivers  
8 sound 18 through the high frequency sound bore 14. The  
9 system additionally include a low acoustical driver 22  
10 carried within the canalphone 22 where the low acoustical  
11 driver delivers sound 18 through the low frequency sound  
12 bore 16, and the single unit 15 is positioned at an angle  
13 between 30 degrees and 65 degrees with respect to the high  
14 acoustical driver 14 and the low acoustical driver.

15 **[0055]** Another aspect of the embodiments is a method,  
16 which is now described with reference to flowchart 28 of  
17 FIG. 2. The method begins at Block 30 and may include  
18 positioning a high acoustical driver within a canalphone at  
19 Block 32. The method may also include positioning a low  
20 acoustical driver within the canalphone adjacent to the  
21 high acoustical driver at Block 34. The method may further  
22 include positioning a single unit including a low frequency  
23 sound bore adjacent to a high frequency sound bore within  
24 the canalphone where the low frequency sound bore and the  
25 high frequency sound bore are sized so that the low  
26 frequency sound bore and the high frequency sound bore each

1 deliver sound with correct time and phase, and the single  
2 unit adjoins both the high acoustical driver and low  
3 acoustical driver at Block 36. The method ends at Block 38.

4 **[0056]** In another method embodiment, which is now  
5 described with reference to flowchart 40 of FIG. 3, the  
6 method begins at Block 42. The method may include the steps  
7 of FIG. 2 at Blocks 32, 34, and 36. The method may further  
8 include inserting an acoustical damper within at least one  
9 of the low frequency sound bore and the high frequency  
10 sound bore at Block 44. The method ends at Block 46.

11 **[0057]** In another method embodiment, which is now  
12 described with reference to flowchart 48 of FIG. 4, the  
13 method begins at Block 50. The method may include the steps  
14 of FIG. 3 at Blocks 32, 34, 36, and 44. The method may also  
15 include inserting the acoustical damper within the sound  
16 bore without any rubber boot at Block 52. The method ends  
17 at Block 54.

18 **[0058]** In another method embodiment, which is now  
19 described with reference to flowchart 56 of FIG. 5, the  
20 method begins at Block 58. The method may include the steps  
21 of FIG. 2 at Blocks 32, 34, and 36. The method may further  
22 include reducing the low frequency sound bore's diameter  
23 and the high frequency sound bore's diameter by extending  
24 the lengths of each sound bore at Block 60. The method ends  
25 at Block 62.

1   **[0059]**     With reference now to Fig. 6, a phase corrected  
2   canalphone system 10 is further described. In one  
3   embodiment, the system 10 includes a canalphone housing 12  
4   that frictionally engages the ear of a user (not shown) in  
5   its usage position.

6   **[0060]**     In one embodiment, the system 10 includes a high  
7   audio driver 20 carried by the canalphone housing 12, and a  
8   low audio driver 22 carried by the canalphone housing  
9   adjacent to the high audio driver. In another embodiment,  
10  the system 10 also includes an acoustical-timer 17a and/or  
11  17b to phase correct a high audio signal from the high  
12  audio driver 20 directed to the outside of the canalphone  
13  housing 12 with delivery of a low audio signal from the low  
14  audio driver 22 directed to the outside of the canalphone  
15  housing.

16  **[0061]**     In one embodiment, the acoustical-timer 17a  
17  includes a low audio sound-tube 16 to carry a low audio  
18  signal from the low audio driver 22 to the outside of the  
19  canalphone housing 12. In another embodiment, the  
20  acoustical-timer 17a further includes a high audio sound-  
21  tube 14 to carry a high audio signal from the high audio  
22  driver 20 to the outside of the canalphone housing 12, the  
23  high audio sound-tube phase corrected with respect to the  
24  low audio sound-tube 16 by sizing it to be longer than the  
25  low audio sound-tube.

1   **[0062]**     In one embodiment, the low audio sound-tube 16 is  
2   sized based upon its time response for the low audio signal  
3   to pass through the low audio sound-tube. In another  
4   embodiment, the high audio sound-tube 14 is longer to slow  
5   down the high audio signal's arrival to the outside of the  
6   canalphone housing 12 so that it is closer in time to the  
7   low audio signal from the low audio driver's 22 arrival to  
8   the outside of the canalphone housing.

9   **[0063]**     In one embodiment, the arrival of the high audio  
10  signal to the outside of the canalphone housing 12 is less  
11  than .05 milliseconds difference than the low audio signal  
12  from the low audio driver's 22 arrival to the outside of  
13  the canalphone housing. In another embodiment, the  
14  difference is less than .02 milliseconds difference.

15  **[0064]**     In one embodiment, the system 10 additionally  
16  includes a mid audio driver 23 carried by the canalphone  
17  housing 12 adjacent to the high audio driver 20, and a mid  
18  audio sound-tube 25 to carry a mid-audio signal from the  
19  mid audio driver to the outside of the canalphone housing,  
20  the mid audio sound-tube phase corrected by sizing it to be  
21  longer than the low audio sound-tube 16 and shorter than  
22  the high audio sound-tube 14.

23  **[0065]**     In one embodiment, the acoustical-timer 17b  
24  includes a processor 27 to phase correct a high audio  
25  signal from the high audio driver 20 directed to the  
26  outside of the canalphone housing 12 with delivery of a low

1 audio signal from the low audio driver 22 directed to the  
2 outside of the canalphone housing. In another embodiment,  
3 the processor 27 uses digital signal processing to control  
4 the high audio signal's arrival at the outside of the  
5 canalphone housing 12 to be closer in time to the low audio  
6 signal from the low audio driver's 16 arrival to the  
7 outside of the canalphone housing.

8 **[0066]** In one embodiment, the arrival of the high audio  
9 signal to the outside of the canalphone housing 12 is less  
10 than .05 milliseconds difference compared to the low audio  
11 signal from the low audio driver's 16 arrival to the  
12 outside of the canalphone housing. In another embodiment,  
13 the acoustical-timer 17a and 17b uses a time response for  
14 the low audio signal to pass through the canalphone housing  
15 12 as a control point to set all other audio signals' phase  
16 in the system 10. In another embodiment, the system 10  
17 further includes a mid audio driver 23 carried by the  
18 canalphone housing 12 adjacent to the high audio driver 20,  
19 and the mid audio driver provides a mid-audio signal to the  
20 outside of the canalphone housing based upon the low audio  
21 driver 22.

22 **[0067]** Fig. 7 illustrates an example of the phase  
23 corrected response of the system 10. The red line in the  
24 upper graph is the phase corrected response compared to an  
25 uncorrected response in the lower graph.

1   **[0068]**       Another aspect of the embodiments is another  
2   method, which is now described with reference to flowchart  
3   68 of FIG. 8. The method begins at Block 70 and may include  
4   providing a high audio driver carried by a canalphone  
5   housing, and a low audio driver carried by the canalphone  
6   housing adjacent to the high audio driver at Block 72. The  
7   method may also include phase correcting a high audio  
8   signal from the high audio driver directed to the outside  
9   of the canalphone housing with delivery of a low audio  
10   signal from the low audio driver directed to the outside of  
11   the canalphone housing at Block 74. The method ends at  
12   Block 76.

13   **[0069]**       In another method embodiment, which is now  
14   described with reference to flowchart 78 of FIG. 9, the  
15   method begins at Block 80. The method may include the steps  
16   of FIG. 8 at Blocks 72 and 74. The method may further  
17   include carrying a low audio signal from the low audio  
18   driver to outside of the canalphone housing via a low audio  
19   sound-tube at Block 82. The method may additionally include  
20   carrying a high audio signal from the high audio driver to  
21   the outside of the canalphone housing via a high audio  
22   sound-tube phase corrected with respect to the low audio  
23   sound-tube by sizing it to be longer than the low audio  
24   sound-tube at Block 84. The method ends at Block 86.

25   **[0070]**       In another method embodiment, which is now  
26   described with reference to flowchart 88 of FIG. 10, the

1 method begins at Block 90. The method may include the steps  
2 of FIG. 9 at Blocks 72, 74, 82, and 84. The method may also  
3 include sizing the low audio sound-tube based upon its time  
4 response for the low audio signal to pass through the low  
5 audio sound-tube at Block 92. The method ends at Block 94.

6 **[0071]** In another method embodiment, which is now  
7 described with reference to flowchart 96 of FIG. 11, the  
8 method begins at Block 98. The method may include the steps  
9 of FIG. 10 at Blocks 72, 74, 82, 84, and 92. The method may  
10 also include selecting the low audio sound-tube's size to  
11 be acoustically proper and as short as can be readily fit  
12 into the canalphone housing at Block 100. The method ends  
13 at Block 102.

14 **[0072]** Acoustically proper means that the audio sound  
15 tube does not promote distortion due to its length. As  
16 short as can be readily fit into the canalphone housing 12  
17 refers to the fact that the physical dimensions of the  
18 canalphone housing creates placement issues with regards to  
19 the low audio driver 22 and the other system 10 components  
20 such as the high audio driver 20 and respective sound  
21 tubes.

22 **[0073]** In another method embodiment, which is now  
23 described with reference to flowchart 104 of FIG. 12, the  
24 method begins at Block 108. The method may include the  
25 steps of FIG. 9 at Blocks 72, 74, 82, and 84. The method  
26 may also include slowing down the high audio signal's

1 arrival to the outside of the canalphone housing so that it  
2 is closer in time to the low audio signal from the low  
3 audio driver's arrival to the outside of the canalphone  
4 housing by making the high sound-tube longer at Block 108.  
5 The method ends at Block 110.

6 **[0074]** In another method embodiment, which is now  
7 described with reference to flowchart 112 of FIG. 13, the  
8 method begins at Block 114. The method may include the  
9 steps of FIG. 9 at Blocks 72, 74, 82, and 84. The method  
10 may also include timing the arrival of the high audio  
11 signal to the outside of the canalphone housing is within  
12 .05 milliseconds when compared to the low audio signal from  
13 the low audio driver arrival to the outside of the  
14 canalphone housing at Block 116. The method ends at Block  
15 118.

16 **[0075]** In another method embodiment, which is now  
17 described with reference to flowchart 120 of FIG. 14, the  
18 method begins at Block 122. The method may include the  
19 steps of FIG. 8 at Blocks 72 and 74. The method may further  
20 include using digital signal processing to phase correct a  
21 high audio signal from the high audio driver directed to  
22 the outside of the canalphone housing with delivery of a  
23 low audio signal from the low audio driver directed to the  
24 outside of the canalphone housing at Block 124. The method  
25 ends at Block 126.

1   **[0076]**       In another method embodiment, which is now  
2   described with reference to flowchart 128 of FIG. 15, the  
3   method begins at Block 130. The method may include the  
4   steps of FIG. 8 at Blocks 72 and 74. The method may further  
5   include timing the arrival of the high audio signal to the  
6   outside of the canalphone housing is within .05  
7   milliseconds when compared to the low audio signal from the  
8   low audio driver arrival to the outside of the canalphone  
9   housing at Block 132. The method ends at Block 134.

10   **[0077]**       In another method embodiment, which is now  
11   described with reference to flowchart 136 of FIG. 16, the  
12   method begins at Block 138. The method may include the  
13   steps of FIG. 8 at Blocks 72 and 74. The method may further  
14   include using a time response for the low audio signal to  
15   pass through the canalphone housing as a control point to  
16   set all other audio signals' phase in the system at Block  
17   140. The method ends at Block 142.

18   **[0078]**       In another method embodiment, which is now  
19   described with reference to flowchart 144 of FIG. 17, the  
20   method begins at Block 146. The method may include the  
21   steps of FIG. 9 at Blocks 72, 74, 82, and 84. The method  
22   may also include standardizing high sound-tube lengths  
23   based upon at least two low sound-tube lengths at Block  
24   148. The method ends at Block 150.

25   **[0079]**       In another method embodiment, which is now  
26   described with reference to flowchart 152 of FIG. 18, the

1 method begins at Block 154. The method may include the  
2 steps of FIG. 16 at Blocks 72, 74, and 140. The method may  
3 also include fabricating an assembly of a standardized high  
4 sound-tube length with a respective one of the two low  
5 sound-tube lengths to make installation in the canalphone  
6 housing easier and to provide repeatable acoustic  
7 characteristics at Block 156. The method ends at Block 158.

8 **[0080]** In another method embodiment, which is now  
9 described with reference to flowchart 160 of FIG. 19, the  
10 method begins at Block 162. The method may include the  
11 steps of FIG. 17 at Blocks 72, 74, 82, 84, and 148. The  
12 method may also include aligning the standardized high  
13 sound-tube length's end with the respective one of the two  
14 low sound-tube lengths' end at Block 164. The method ends  
15 at Block 166.

16 **[0081]** Another aspect of the embodiments are computer  
17 readable program codes coupled to tangible media to provide  
18 canalphone phase correction. The computer readable program  
19 codes may be configured to cause the program to provide a  
20 high audio driver carried by a canalphone housing, and a  
21 low audio driver carried by the canalphone housing adjacent  
22 to the high audio driver. The computer readable program  
23 codes may also phase correct a high audio signal from the  
24 high audio driver to the outside of the canalphone housing  
25 with delivery of a low audio signal from the low audio  
26 driver to the outside of the canalphone housing.

1   **[0082]**     The computer readable program codes may further  
2   phase correct a high audio signal from the high audio  
3   driver to the outside of the canalphone housing with  
4   delivery of a low audio signal from the low audio driver to  
5   the outside of the canalphone housing. The computer  
6   readable program codes may additionally use a time response  
7   for the low audio signal to pass through the canalphone  
8   housing as a control point to set all other audio signals'  
9   phase in the system.

10   **[0083]**     Since a canalphone housing 12 is very small, it  
11   is very difficult to achieve any of the preceding  
12   embodiments. However, system 10 overcomes the technical  
13   hurdles of providing more components in less space,  
14   providing superior sound reproduction, and provides a user  
15   a phase corrected canalphone system.

16   **[0084]**     As will be appreciated by one skilled in the art,  
17   aspects may be embodied as a system, method, and/or  
18   computer program product. Accordingly, embodiments may take  
19   the form of an entirely hardware embodiment, an entirely  
20   software embodiment (including firmware, resident software,  
21   micro-code, etc.) or an embodiment combining software and  
22   hardware aspects that may all generally be referred to  
23   herein as a "circuit," "module" or "system." Furthermore,  
24   embodiments may take the form of a computer program product  
25   embodied in one or more computer readable medium(s) having  
26   computer readable program code embodied thereon.

1   **[0085]**     Any combination of one or more computer readable  
2   medium(s) may be utilized. The computer readable medium may  
3   be a computer readable signal medium or a computer readable  
4   storage medium. A computer readable storage medium may be,  
5   for example, but not limited to, an electronic, magnetic,  
6   optical, electromagnetic, infrared, or semiconductor  
7   system, apparatus, or device, or any suitable combination  
8   of the foregoing. More specific examples (a non-exhaustive  
9   list) of the computer readable storage medium would include  
10  the following: an electrical connection having one or more  
11  wires, a portable computer diskette, a hard disk, a random  
12  access memory (RAM), a read-only memory (ROM), an erasable  
13  programmable read-only memory (EPROM or Flash memory), an  
14  optical fiber, a portable compact disc read-only memory  
15  (CD-ROM), an optical storage device, a magnetic storage  
16  device, or any suitable combination of the foregoing. In  
17  the context of this document, a computer readable storage  
18  medium may be any tangible medium that can contain, or  
19  store a program for use by or in connection with an  
20  instruction execution system, apparatus, or device.

21 **[0086]**     A computer readable signal medium may include a  
22 propagated data signal with computer readable program code  
23 embodied therein, for example, in baseband or as part of a  
24 carrier wave. Such a propagated signal may take any of a  
25 variety of forms, including, but not limited to, electro-  
26 magnetic, optical, or any suitable combination thereof. A

1 computer readable signal medium may be any computer  
2 readable medium that is not a computer readable storage  
3 medium and that can communicate, propagate, or transport a  
4 program for use by or in connection with an instruction  
5 execution system, apparatus, or device.

6 **[0087]** Program code embodied on a computer readable  
7 medium may be transmitted using any appropriate medium,  
8 including but not limited to wireless, wireline, optical  
9 fiber cable, RF, etc., or any suitable combination of the  
10 foregoing.

11 **[0088]** Computer program code for carrying out operations  
12 for aspects of the embodiments may be written in any  
13 combination of one or more programming languages, including  
14 an object oriented programming language such as Java,  
15 Smalltalk, C++ or the like and conventional procedural  
16 programming languages, such as the "C" programming language  
17 or similar programming languages. The program code may  
18 execute entirely on the user's computer, partly on the  
19 user's computer, as a stand-alone software package, partly  
20 on the user's computer and partly on a remote computer or  
21 entirely on the remote computer or server. In the latter  
22 scenario, the remote computer may be connected to the  
23 user's computer through any type of network, including a  
24 local area network (LAN) or a wide area network (WAN), or  
25 the connection may be made to an external computer (for

1 example, through the Internet using an Internet Service  
2 Provider).

3 **[0089]** Aspects of the embodiments are described above  
4 with reference to flowchart illustrations and/or block  
5 diagrams of methods, apparatus (systems) and computer  
6 program products according to the embodiments. It will be  
7 understood that each block of the flowchart illustrations  
8 and/or block diagrams, and combinations of blocks in the  
9 flowchart illustrations and/or block diagrams, can be  
10 implemented by computer program instructions. These  
11 computer program instructions may be provided to a  
12 processor of a general purpose computer, special purpose  
13 computer, or other programmable data processing apparatus  
14 to produce a machine, such that the instructions, which  
15 execute via the processor of the computer or other  
16 programmable data processing apparatus, create means for  
17 implementing the functions/acts specified in the flowchart  
18 and/or block diagram block or blocks.

19 **[0090]** These computer program instructions may also be  
20 stored in a computer readable medium that can direct a  
21 computer, other programmable data processing apparatus, or  
22 other devices to function in a particular manner, such that  
23 the instructions stored in the computer readable medium  
24 produce an article of manufacture including instructions  
25 which implement the function/act specified in the flowchart  
26 and/or block diagram block or blocks.

1   **[0091]**     The computer program instructions may also be  
2   loaded onto a computer, other programmable data processing  
3   apparatus, or other devices to cause a series of  
4   operational steps to be performed on the computer, other  
5   programmable apparatus or other devices to produce a  
6   computer implemented process such that the instructions  
7   which execute on the computer or other programmable  
8   apparatus provide processes for implementing the  
9   functions/acts specified in the flowchart and/or block  
10  diagram block or blocks.

11  **[0092]**     The flowchart and block diagrams in the Figures  
12  illustrate the architecture, functionality, and operation  
13  of possible implementations of systems, methods and  
14  computer program products according to various embodiments.  
15  In this regard, each block in the flowchart or block  
16  diagrams may represent a module, segment, or portion of  
17  code, which comprises one or more executable instructions  
18  for implementing the specified logical function(s). It  
19  should also be noted that, in some alternative  
20  implementations, the functions noted in the block may occur  
21  out of the order noted in the figures. For example, two  
22  blocks shown in succession may, in fact, be executed  
23  substantially concurrently, or the blocks may sometimes be  
24  executed in the reverse order, depending upon the  
25  functionality involved. It will also be noted that each  
26  block of the block diagrams and/or flowchart illustration,

1 and combinations of blocks in the block diagrams and/or  
2 flowchart illustration, can be implemented by special  
3 purpose hardware-based systems that perform the specified  
4 functions or acts, or combinations of special purpose  
5 hardware and computer instructions.

6 **[0093]** The terminology used herein is for the purpose of  
7 describing particular embodiments only and is not intended  
8 to be limiting. As used herein, the singular forms "a",  
9 "an" and "the" are intended to include the plural forms as  
10 well, unless the context clearly indicates otherwise. It  
11 will be further understood that the terms "comprises"  
12 and/or "comprising," when used in this specification,  
13 specify the presence of stated features, integers, steps,  
14 operations, elements, and/or components, but do not  
15 preclude the presence or addition of one or more other  
16 features, integers, steps, operations, elements,  
17 components, and/or groups thereof.

18 **[0094]** The corresponding structures, materials, acts,  
19 and equivalents of all means or step plus function elements  
20 in the claims below are intended to include any structure,  
21 material, or act for performing the function in combination  
22 with other claimed elements as specifically claimed. The  
23 description of the embodiments has been presented for  
24 purposes of illustration and description, but is not  
25 intended to be exhaustive or limited to the embodiments in  
26 the form disclosed. Many modifications and variations will

1 be apparent to those of ordinary skill in the art without  
2 departing from the scope and spirit of the embodiments. The  
3 embodiment was chosen and described in order to best  
4 explain the principles of the embodiments and the practical  
5 application, and to enable others of ordinary skill in the  
6 art to understand the various embodiments with various  
7 modifications as are suited to the particular use  
8 contemplated.

9 **[0095]** While the preferred embodiment has been  
10 described, it will be understood that those skilled in the  
11 art, both now and in the future, may make various  
12 improvements and enhancements which fall within the scope  
13 of the claims which follow. These claims should be  
14 construed to maintain the proper protection for the  
15 embodiments first described.  
16

1 CLAIMS

2

3 What is claimed is:

4

5 1. A system comprising:

6 a high audio driver carried by a canalphone  
7 housing;

8 a low audio driver carried by the canalphone  
9 housing adjacent to the high audio driver; and

10 an acoustical-timer to phase correct a high audio  
11 signal from the high audio driver directed to the outside  
12 of the canalphone housing with delivery of a low audio  
13 signal from the low audio driver directed to the outside of  
14 the canalphone housing.

15

16 2. The system of claim 1 wherein the acoustical-  
17 timer includes:

18 a low sound-tube to carry a low audio signal from  
19 the low audio driver to outside of the canalphone housing;  
20 and

21 a high audio sound-tube to carry a high audio  
22 signal from the high audio driver to the outside of the  
23 canalphone housing, the high audio sound-tube phase  
24 corrected with respect to the low audio sound-tube by  
25 sizing it to be longer than the low audio sound-tube.

26

1           3. The system of claim 2 wherein the low audio  
2 sound-tube is sized based upon its time response for the  
3 low audio signal to pass through the low audio sound-tube.  
4

5           4. The system of claim 2 wherein the high audio  
6 sound-tube is longer to slow down the high audio signal's  
7 arrival to the outside of the canalphone housing so that it  
8 is closer in time to the low audio signal from the low  
9 audio driver's arrival to the outside of the canalphone  
10 housing.  
11

12           5. The system of claim 4 wherein the arrival of  
13 the high audio signal's to the outside of the canalphone  
14 housing is less than .05 milliseconds difference than the  
15 low audio signal from the low audio driver arrival to the  
16 outside of the canalphone housing.  
17

18           6. The system of claim 1 wherein the acoustical-  
19 timer includes a processor to phase correct a high audio  
20 signal from the high audio driver to the outside of the  
21 canalphone housing with delivery of a low audio signal from  
22 the low audio driver to the outside of the canalphone  
23 housing.  
24

25           7. The system of claim 6 wherein the processor  
26 uses digital signal processing to control the high audio

1 signal's arrival at the outside of the canalphone housing  
2 to be closer in time to the low audio signal from the low  
3 audio driver's arrival to the outside of the canalphone  
4 housing.

5

6 8. The system of claim 7 wherein the acoustical-  
7 timer uses a time response for the low audio signal to pass  
8 through the canalphone housing as a control point to set  
9 all other audio signals' phase in the system.

10

11 9. A method comprising:

12 providing a high audio driver carried by a  
13 canalphone housing, and a low audio driver carried by the  
14 canalphone housing adjacent to the high audio driver; and  
15 phase correcting a high audio signal from the  
16 high audio driver directed to the outside of the canalphone  
17 housing with delivery of a low audio signal from the low  
18 audio driver directed to the outside of the canalphone  
19 housing.

20

21 10. The method of claim 9 further comprising:

22 carrying a low audio signal from the low audio  
23 driver to outside of the canalphone housing via a low audio  
24 sound-tube; and

25 carrying a high audio signal from the high audio  
26 driver to the outside of the canalphone housing via a high

1 audio sound-tube phase corrected with respect to the low  
2 audio sound-tube by sizing it to be longer than the low  
3 audio sound-tube.

4

5 11. The method of claim 10 further comprising  
6 sizing the low audio sound-tube based upon its time  
7 response for the low audio signal to pass through the low  
8 audio sound-tube.

9

10 12. The method of claim 11 further comprising  
11 selecting the low audio sound-tube's size to be  
12 acoustically proper and as short as can be readily fit into  
13 the canalphone housing.

14

15 13. The method of claim 10 further comprising  
16 slowing down the high audio signal's arrival to the outside  
17 of the canalphone housing so that it is closer in time to  
18 the low audio signal from the low audio driver's arrival to  
19 the outside of the canalphone housing by making the high  
20 audio sound-tube longer.

21

22 14. The method of claim 10 further comprising  
23 timing the arrival of the high audio signal's to the  
24 outside of the canalphone housing compared to the low audio  
25 signal from the low audio driver arrival to the outside of

1 the canalphone housing is within .05 milliseconds of each  
2 other.

3

4           15. The method of claim 9 further comprising  
5 using digital signal processing to phase correct a high  
6 audio signal from the high audio driver directed to the  
7 outside of the canalphone housing with delivery of a low  
8 audio signal from the low audio driver directed to the  
9 outside of the canalphone housing.

10

11           16. The method of claim 15 further comprising  
12 timing the arrival of the high audio signal's to the  
13 outside of the canalphone housing compared to the low audio  
14 signal from the low audio driver arrival to the outside of  
15 the canalphone housing is within .05 milliseconds of each  
16 other.

17

18           17. The method of claim 9 further comprising  
19 using a time response for the low audio signal to pass  
20 through the canalphone housing as a control point to set  
21 all other audio signals' phase in the system.

22

23           18. The method of claim 10 further comprising  
24 standardizing high audio sound-tube lengths based upon at  
25 least two low audio sound-tube lengths.

26

1           19. The method of claim 17 further comprising  
2 fabricating an assembly of a standardized high audio sound-  
3 tube length with a respective one of the two low audio  
4 sound-tube lengths to make installation in the canalphone  
5 housing easier and to provide repeatable acoustic  
6 characteristics.

7  
8           20. The method of claim 18 further comprising  
9 aligning the standardized high audio sound-tube length's  
10 end with the respective one of the two low audio sound-tube  
11 lengths' end.

12  
13           21. A computer program product embodied in a  
14 tangible media comprising:  
15           computer readable program codes coupled to the  
16 tangible media to provide canalphone phase correction, the  
17 computer readable program codes configured to cause the  
18 program to:

19           provide a high audio driver carried by a  
20 canalphone housing, and a low audio driver carried by the  
21 canalphone housing adjacent to the high audio driver; and  
22           phase correct a high audio signal from the  
23 high audio driver to the outside of the canalphone housing  
24 with delivery of a low audio signal from the low audio  
25 driver to the outside of the canalphone housing.

26