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Gabara et al.

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(54) **METHODS AND APPARATUS FOR PREVENTING A THIRD PARTY FROM OVERHEARING A TELEPHONE CONVERSATION**

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H04M 1/68 (2006.01)
H04M 3/16 (2006.01)

(52) **U.S. Cl.** **455/411**; 379/7; 379/35

(58) **Field of Classification Search** 379/7, 379/35, 406.01, 406.03, 406.06, 406.15, 379/406.16, 388.05; 455/410, 411

See application file for complete search history.

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(57) **ABSTRACT**

Methods and apparatus are provided for preventing a third party from listening to a conversation between at least two participants on a telephone. The telephone generates an audio stimulus signal that is presented through a secondary speaker. The audio stimulus signal may be, for example, pseudorandom noise or a cancellation signal. According to one aspect of the invention, the telephone ensures that the audio stimulus signal does not significantly impair the conversation for the at least two participants. To prevent the third party from listening to the local portion of the conversation, the audio stimulus signal is subtracted from the received signal prior to presenting the received signal to the user. To prevent the third party from listening to the remote portion of the conversation, the audio stimulus signal is subtracted from the received signal.

20 Claims, 4 Drawing Sheets

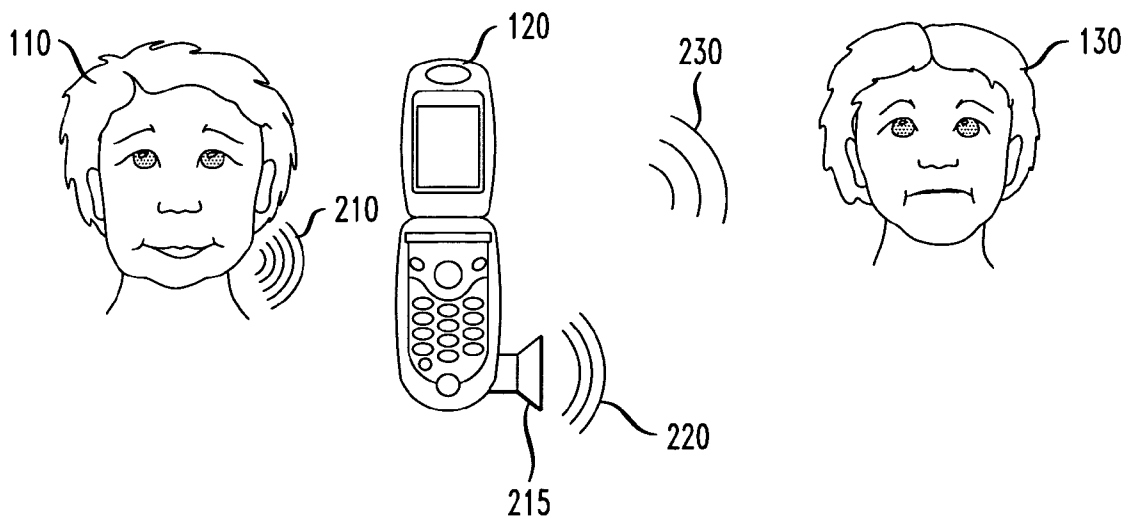


FIG. 1

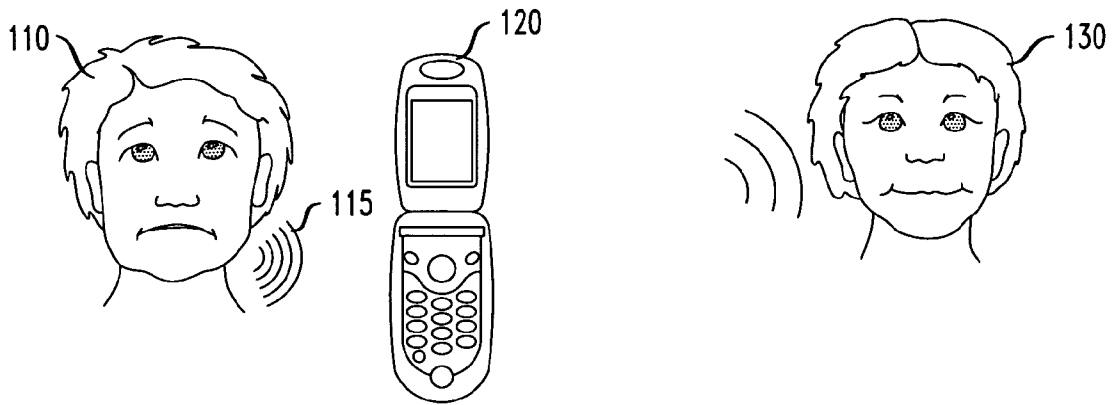


FIG. 2

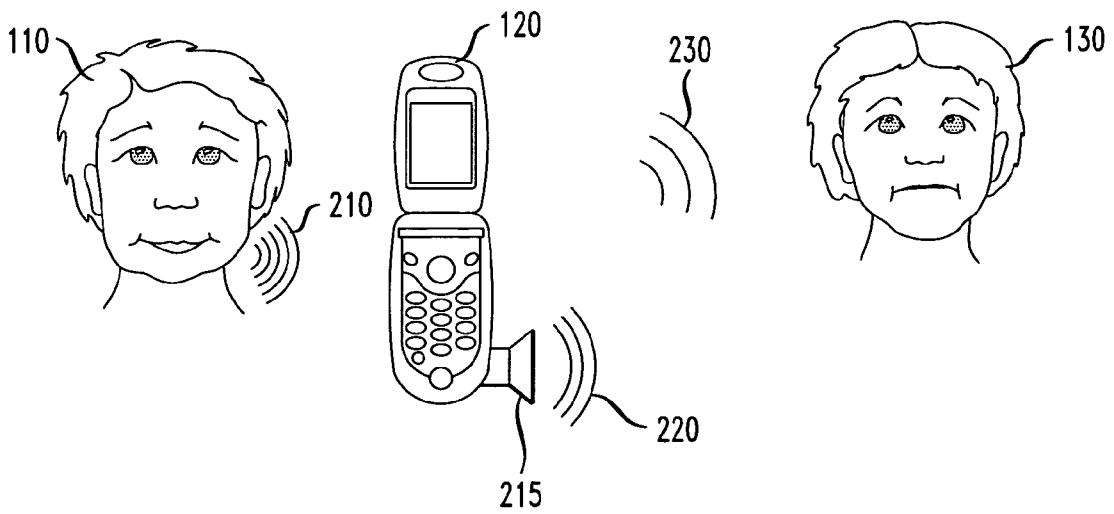


FIG. 3
300

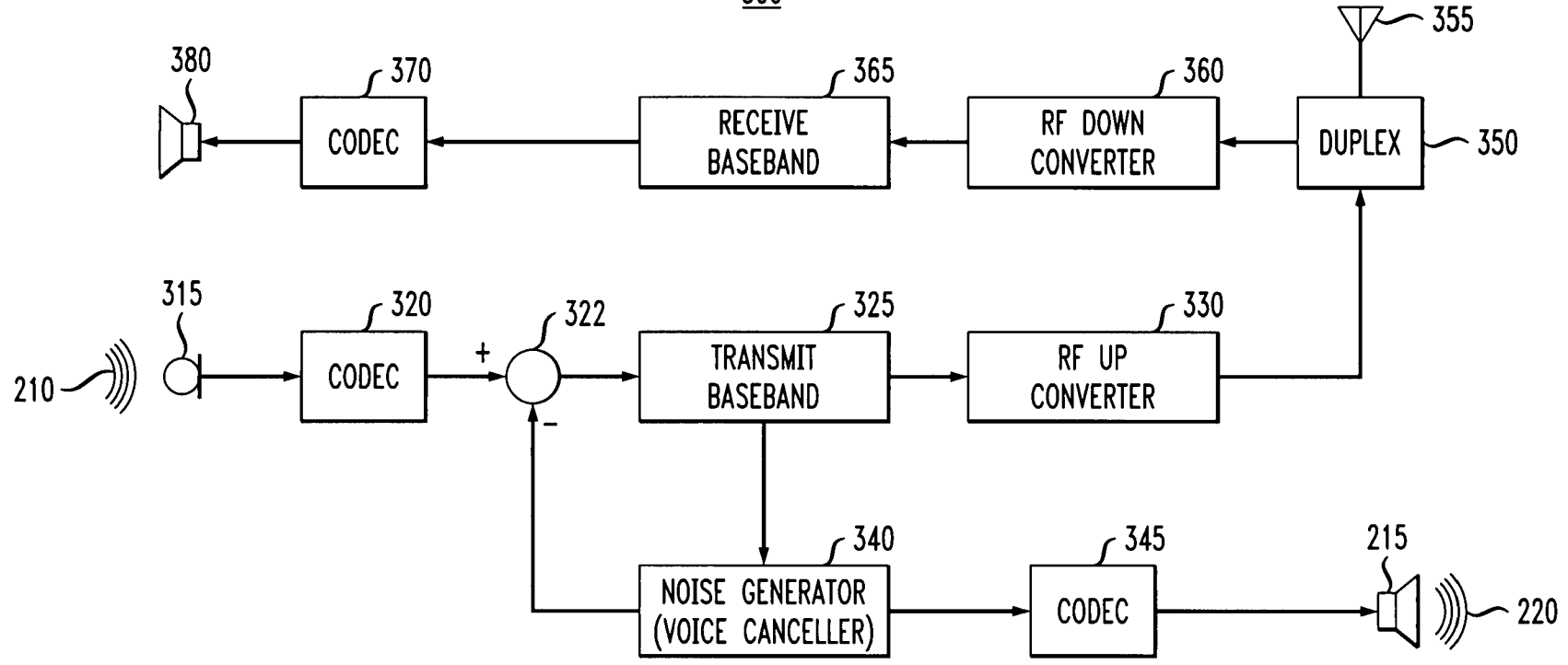


FIG. 4

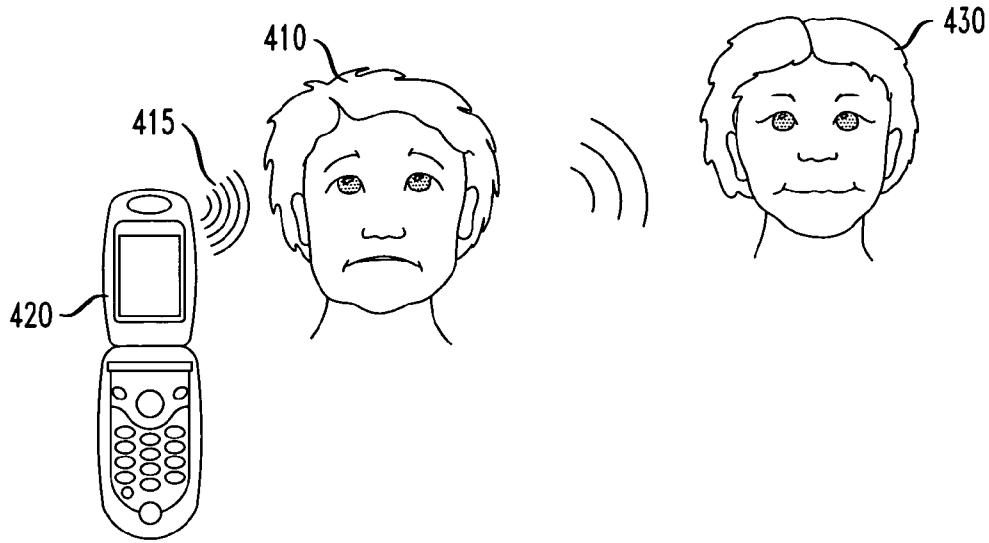


FIG. 5

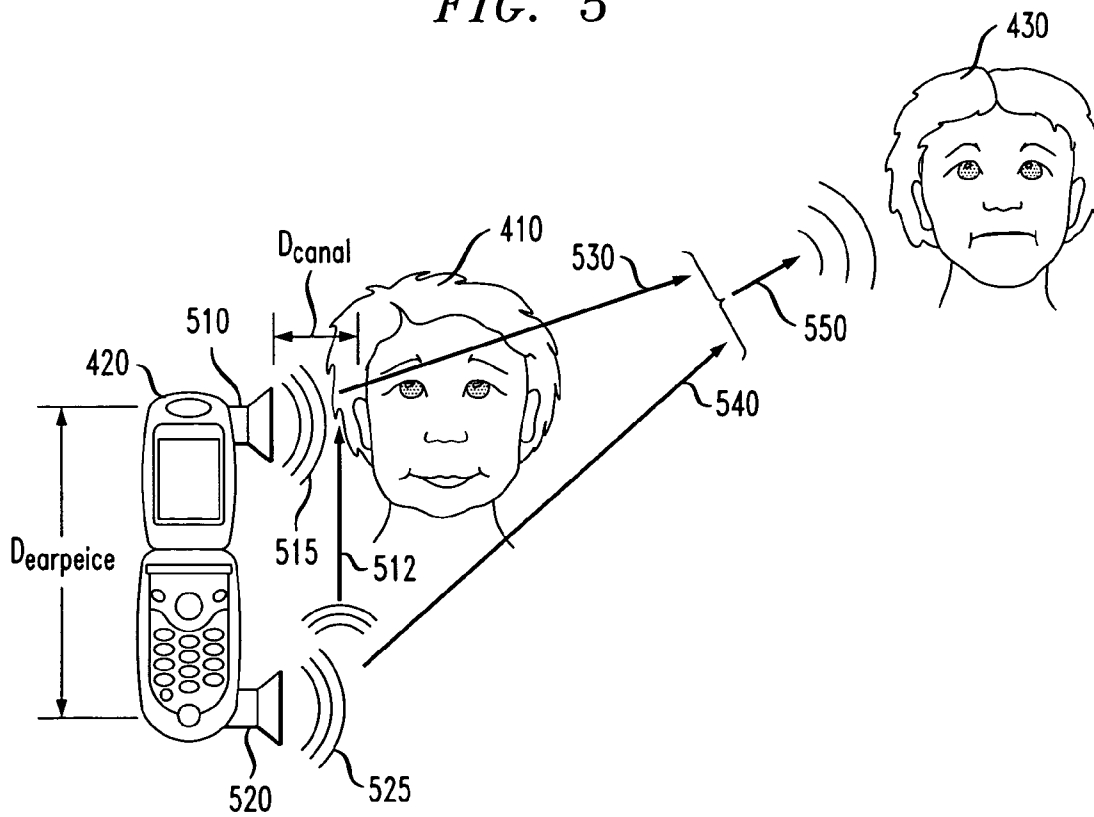
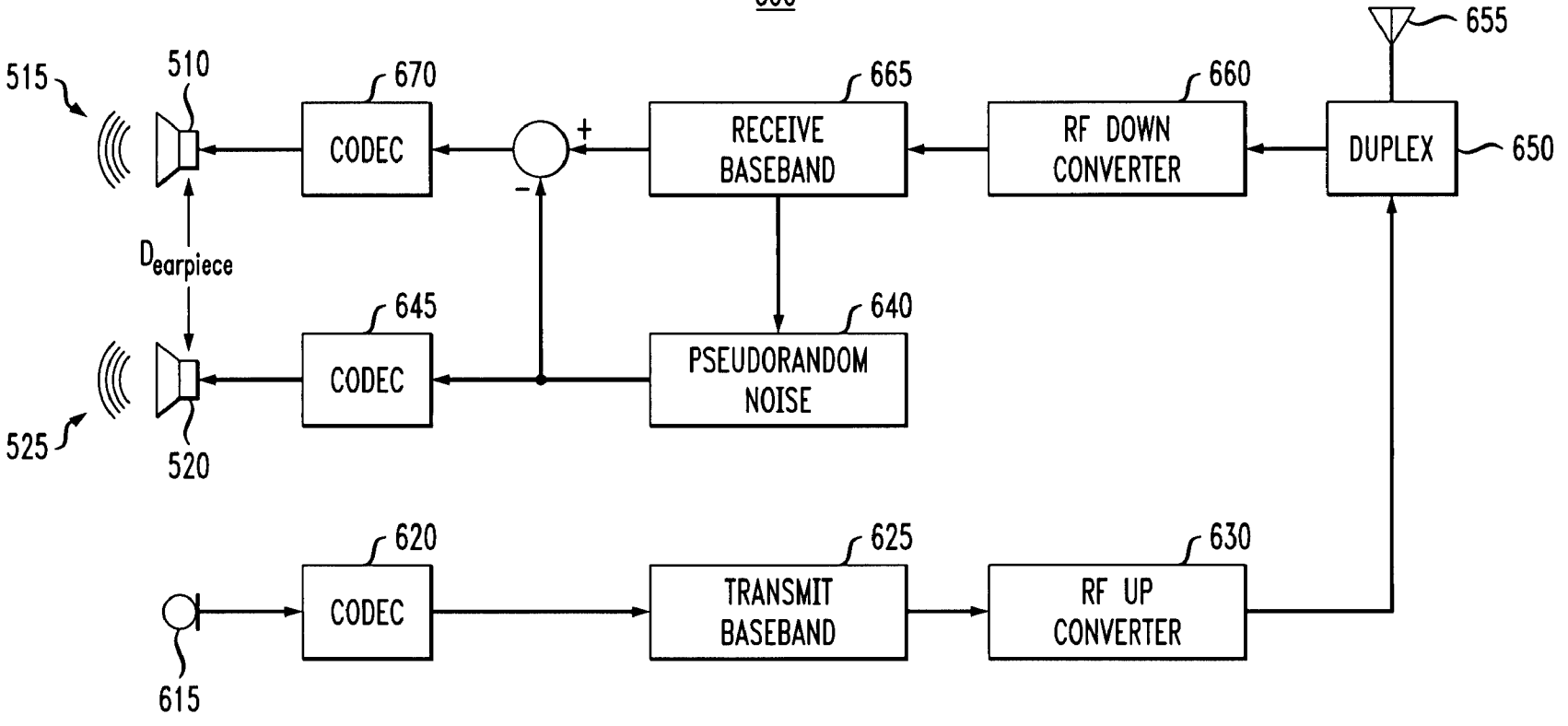


FIG. 6
600



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METHODS AND APPARATUS FOR PREVENTING A THIRD PARTY FROM OVERHEARING A TELEPHONE CONVERSATION

FIELD OF THE INVENTION

The present invention is related to techniques for ensuring private telephone conversations, and more particularly, to methods and apparatus for preventing a third party from over-
hearing a telephone conversation.

BACKGROUND OF THE INVENTION

In today's mobile society, people increasingly have private telephone conversations in public settings. Even in many office environments, a number of people do not have a private office and their telephone conversations are subject to being overheard. A need therefore exists for methods and apparatus for preventing a third party from overhearing a telephone conversation.

SUMMARY OF THE INVENTION

Generally, methods and apparatus are provided for preventing a third party from listening to a conversation between at least two participants on a telephone. The telephone generates an audio stimulus signal that is presented through a secondary speaker. The audio stimulus signal may be, for example, pseudorandom noise or a cancellation signal. According to one aspect of the invention, the telephone ensures that the audio stimulus signal does not significantly impair the conversation for the at least two participants.

To prevent the third party from listening to the local portion of the conversation, the audio stimulus signal is subtracted from the received signal prior to presenting the received signal to the user to isolate the voice signal of the remote participant. To prevent the third party from listening to the remote portion of the conversation, the audio stimulus signal is subtracted from the received signal to isolate the voice signal of the remote participant. In this manner, the subtraction cancels the feedback of the audio stimulus signal that would otherwise be received by the user of the telephone.

A more complete understanding of the present invention, as well as further features and advantages of the present invention, will be obtained by reference to the following detailed description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an eavesdropper attempting to listen in on a local portion of a telephone conversation;

FIG. 2 illustrates a technique for preventing the eavesdropper of FIG. 1 from overhearing the local portion of the telephone conversation in accordance with the present invention;

FIG. 3 is a schematic block diagram of a telephone incorporating features of the present invention to prevent an eavesdropper from listening to the owner's side of the telephone conversation;

FIG. 4 illustrates an eavesdropper attempting to listen in on a remote portion of a telephone conversation;

FIG. 5 illustrates a technique for preventing the eavesdropper of FIG. 4 from overhearing the remote portion of the telephone conversation in accordance with the present invention; and

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FIG. 6 is a schematic block diagram of a telephone incorporating features of the present invention to prevent an eavesdropper from listening to the remote portion of the telephone conversation.

DETAILED DESCRIPTION

FIG. 1 illustrates an eavesdropper **130** attempting to listen in on a telephone call conducted by an owner **110** of a telephone **120**. In particular, in the embodiment of FIG. 1, the eavesdropper **130** is attempting to listen to the owner's side **115** of the telephone conversation (i.e., to the words spoken by the telephone owner **110**). The eavesdropper **130** is physically in the vicinity of the telephone owner **110**. The telephone **120** may be embodied, for example, as a cellular telephone, a cordless telephone, or a standard wired telephone. It is thus noted that while the present invention is illustrated in the context of a cellular telephone, the present invention can be applied to any telephone type, as would be apparent to a person of ordinary skill.

According to one aspect of the invention, shown in FIG. 2, the eavesdropper **130** is prevented from overhearing the telephone conversation, by introducing a secondary speaker **215** to the telephone **120**. The secondary speaker **215** allows a stimulus **220**, such as pseudorandom noise or a cancellation signal, to be generated. As shown in FIG. 2, the voice signal **210** of the telephone owner **110** is received by a mouthpiece (i.e., a microphone) of the telephone **120**. In addition, the stimulus **220** is generated by the secondary speaker **215**. The cancellation signal is generally an audio signal that is of equal yet opposite magnitude to the voice signal **210** of the telephone owner **110**, so that the net effect experienced by the eavesdropper **130** is no signal at all.

In this manner, the eavesdropper **130** will hear the combination **230** of the generated stimulus **220** and the voice signal **210** of the telephone owner **110**. In the case of a pseudorandom noise, the eavesdropper **130** will not be able to distinguish the voice signal **210** of the telephone owner **110** from the noise **220**. In the case of a cancellation signal, the cancellation signal **220** will cancel the voice signal **210** of the telephone owner **110** from the noise **220** and the eavesdropper **130** should not hear anything.

As discussed hereinafter, the telephone **120** knows the generated stimulus **220**, and can therefore subtract the stimulus **220** from the voice signal **210** of the telephone owner **110**, to thereby isolate the voice signal **210** of the telephone owner **110** for transmission to the remote party (not shown) of the telephone conversation. FIG. 3 is a schematic block diagram of a telephone **300** incorporating features of the present invention to prevent an eavesdropper **130** from listening to the owner's side **115** of the telephone conversation.

As shown in FIG. 3, a mouthpiece **315** (i.e., a microphone) of the telephone **300** receives a signal **310** that comprises the voice signal **210** of the telephone owner **110** and the stimulus **220** generated by the secondary speaker **215**. A codec **320** encodes the signal **310**, in a known manner, and applies the encoded signal to a first input of a subtractor **322**. In addition, in accordance with the invention, a pseudorandom noise generator **340** (or a voice canceller) generates the stimulus **220**. The stimulus **220** is encoded by a codec **345** and presented by the secondary speaker **215**. In addition, the pseudorandom noise generator **340** applies the stimulus **220** to a second input of the subtractor **322**. In this manner, the known generated stimulus **220** can be subtracted from the voice signal **210** of the telephone owner **110**, to thereby isolate the voice signal **210** of the telephone owner **110** for transmission to the remote party (not shown) of the telephone conversation.

Thus, the voice signal **210** of the telephone owner **110** is processed by a transmit baseband stage **325**, an RF upconverter **330** and a duplex **350**, in a known manner beyond the scope of the present invention, for transmission on an antenna **355**. The receive branch of the telephone **300** comprises an RF down converter **360**, receive baseband stage **365**, codec **370** and an earpiece **380**, in a conventional manner.

FIG. 4 illustrates an eavesdropper **430** attempting to listen in on a telephone call conducted by an owner **410** of a telephone **420**. In particular, in the embodiment of FIG. 4, the eavesdropper **430** is attempting to listen to the remote side **415** of the telephone conversation (i.e., to the words spoken by the remote party of the telephone conversation (not shown), as played through the earpiece or speaker of the telephone **420**). The telephone **420** may be embodied, for example, as a cellular telephone, a cordless telephone, a speaker telephone or a standard wired telephone.

According to another aspect of the invention, shown in FIG. 5, the eavesdropper **430** is prevented from overhearing the remote portion of the telephone conversation, by introducing a secondary speaker **520** to the telephone **420**. The secondary speaker **520** allows a stimulus **525**, such as pseudorandom, to be generated. The distance, $D_{earpiece}$, between the primary speaker **510** and the secondary speaker **520**, should be significantly greater than the distance, D_{canal} , between the ear of the owner **410** and the primary speaker **510**.

As discussed further below in conjunction with FIG. 6, the primary speaker **510** generates the correct signal **515** at the ear canal of the owner **410**, since the pseudorandom noise **525** generated by the secondary speaker **520** is subtracted inside the telephone **400**. The eavesdropper **430** receives a signal **550** over two paths **530**, **540** from the two speakers **510**, **520**, respectively. The signal **550** is a random signal since it is a summation of sound from both speakers **510**, **520**. The random signal **550** will mask the correct signal **515**, as long as the distance from the eavesdropper **430** to the speakers **510**, **520** does not equal the difference ($D_{earpiece} - D_{canal}$) or a multiple thereof. Generally, the energy from both speakers **510**, **520** is randomized as the distance from the telephone **400** increases greater than the phone-ear canal distance. In this manner, the eavesdropper **430** will hear the combination **550** of the generated stimulus **525** and the voice signal **515** of the remote telephone participant (not shown) (generally sensed as noise or no signal).

The distance, $D_{earpiece}$, between the primary speaker **510** and the secondary speaker **520** is known, and the distance, D_{canal} , between the ear of the owner **410** and the primary speaker **510**. In one implementation, the relative movement between the telephone **400** and the ear canal of the owner **410** can be sensed and the signal adjusted accordingly. In a further variation, the owner **400** can optionally adjust the quality of signal using test signals.

FIG. 6 is a schematic block diagram of a telephone **600** incorporating features of the present invention to prevent an eavesdropper **130** from listening to the remote portion of the telephone conversation. As shown in FIG. 6, a mouthpiece **615** (i.e., a microphone) of the telephone **600** receives a signal **310** that comprises the voice signal of the telephone owner **410** and the stimulus generated by the speakers **510**, **520**. A codec **620** encodes the signal, in a known manner, and applies the encoded signal to a transmit baseband stage **625**, an RF upconverter **630** and a duplex **650**, in a known manner beyond the scope of the present invention, for transmission on an antenna **655**.

The receive branch of the telephone **600** comprises an RF down converter **660**, receive baseband stage **665**, codec **670**

and an earpiece **510**. The RF down converter **660**, receive baseband stage **665** operate in a conventional manner. The output of the receive baseband stage **665** is applied to a first input of a subtractor **667**.

In addition, in accordance with the invention, a pseudorandom noise generator **640** (or a voice canceller) generates the stimulus **525**. The stimulus **525** is encoded by a codec **645** and presented by the secondary speaker **520**. As shown most clearly in FIG. 5, the owner **410** of a telephone **420** will hear the stimulus **525** from the secondary speaker **520** via a path **512**. Thus, as shown in FIG. 6, the pseudorandom noise generator **640** applies the stimulus **525** to another input of the subtractor **667**. In this manner, the known generated stimulus **525** can be subtracted from the receiver voice signal of the remote participant, to thereby isolate the received voice signal **515** of the remote participant for presentation to the owner **410**.

It is to be understood that the embodiments and variations shown and described herein are merely illustrative of the principles of this invention and that various modifications may be implemented by those skilled in the art without departing from the scope and spirit of the invention.

We claim:

1. A method for preventing a third party from listening to a conversation between at least two participants on a telephone, comprising the steps of:

- generating an audio stimulus signal;
- ensuring said audio stimulus signal does not significantly impair said conversation for said at least two participants; and
- presenting said audio stimulus signal through a secondary speaker on said telephone.

2. The method of claim 1, wherein said audio stimulus signal is pseudorandom noise.

3. The method of claim 1, wherein said audio stimulus signal is a cancellation signal.

4. The method of claim 1, wherein said third party is attempting to listen to a local portion of said conversation.

5. The method of claim 4, wherein said ensuring step further comprises the step of subtracting said audio stimulus signal from a signal captured by a microphone of said telephone.

6. The method of claim 1, wherein said third party is attempting to listen to a remote portion of said conversation.

7. The method of claim 6, wherein said ensuring step further comprises the step of subtracting said audio stimulus signal from a signal received by said telephone.

8. The method of claim 7, wherein said subtracting step cancels feedback of said audio stimulus signal received by a user of said telephone.

9. A telephone that prevents a third party from listening to a conversation between a user of said telephone and a remote participant, comprising:

- a microphone for capturing an audio signal;
- a signal generator for generating an audio stimulus signal;
- a subtractor for subtracting said audio stimulus signal from said audio signal to isolate a voice signal of a user of said telephone for transmission to said remote participant; and
- a secondary speaker for presenting said audio stimulus signal.

10. The telephone of claim 9, further comprising a primary speaker for presenting a voice signal of said remote participant to said user of said telephone.

11. The telephone of claim 9, wherein said audio stimulus signal is pseudorandom noise.

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12. The telephone of claim 9, wherein said audio stimulus signal is a cancellation signal.

13. The telephone of claim 12, wherein said cancellation signal prevents said third party from hearing said audio signal.

14. The telephone of claim 9, wherein said third party is attempting to listen to said voice signal.

15. A telephone that prevents a third party from listening to a conversation between a user of said telephone and a remote participant, comprising:

an input for receiving a received signal from said remote participant;

a signal generator for generating an audio stimulus signal;

a subtractor for subtracting said audio stimulus signal from said received signal to isolate a voice signal of said remote participant;

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a primary speaker for presenting said voice signal of said remote participant to said user of said telephone; and a secondary speaker for presenting said audio stimulus signal.

5 16. The telephone of claim 15, further comprising a microphone for capturing an audio signal.

17. The telephone of claim 15, wherein said audio stimulus signal is pseudorandom noise.

10 18. The telephone of claim 15, wherein said audio stimulus signal is a cancellation signal.

19. The telephone of claim 15, wherein said third party is attempting to listen to said voice signal.

15 20. The telephone of claim 15, wherein said subtractor cancels feedback of said audio stimulus signal received by said user of said telephone.

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