(12) **APPLICATION**

(11) **20220217** (13) **A1**

(19) NO

NORWAY (51) Int Cl.

G08B 3/10 (2006.01)
G08B 7/06 (2006.01)
A62B 3/00 (2006.01)
H04R 27/00 (2006.01)
E21F 17/00 (2006.01)
G08B 21/02 (2006.01)

Norwegian Industrial Property Office

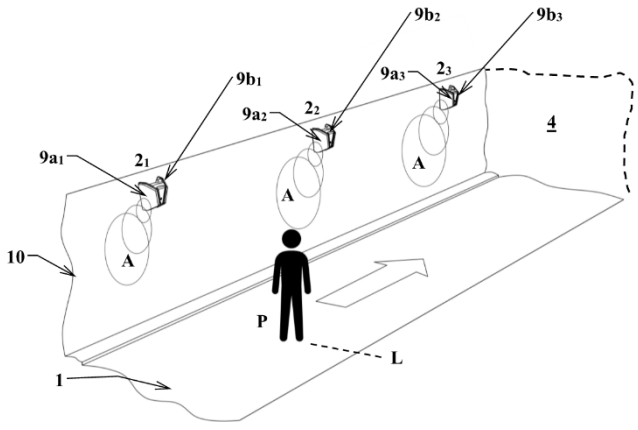
(21)	Application nr	20220217	(86)	Int. application day and application nr
(22)	Application day	2022.02.16	(85)	Entry into national phase
(24)	Date from which the industrial right has effect	2022.02.16	(30)	Priority
(41)	Available to the public	2023.08.17		

(71) Applicant Norphonic AS, Fjellsdalen 3, 5155 BØNES, Norge
(72) Inventor Eugene Zaikonnikov, c/o Norphonic AS, Fjellsdalen 3, 5155 BØNES, Norge
Tron Vedul TRONSTAD, Frostavegen 8, 7630 ÅSEN, Norge
(74) Agent or Attorney ZACCO NORWAY AS, Postboks 488, 0213 OSLO, Norge

(54) Title **An auditory guidance method and system**

(57) Abstract

An auditory guidance system and method for use along a pathway (1) between an initial location (L) and a target location (4). A plurality of nodes ($2_{1\text{-}n}$) are arranged at intervals along the pathway and are activated in a sequence from the initial location and towards the target location. Each node comprises a directional sound generator ($9a_{1\text{-}n}$) which is configured to emit a sound pulse (A) towards the initial location (L), in a sequence from the directional sound generator ($9a_1$) in the first node (21) to the directional sound generator ($9a_n$) in the last node (2_n), each sound pulse emission being interrupted by a time interval (Δt). The system and method may be used for evacuating individuals from a tunnel or other confined space.



An auditory guidance method and system

Technical field of the invention

The invention concerns an auditory guidance method and a system for executing such method, as set out by the preambles of claims 5 and 1 respectively.

Background of the invention

Public announcement (PA) systems for tunnels, corridors and other long and narrow rooms or passages, whether they are in buildings, below ground, on ships or part of any other type of structure, are fraught with problems related in particular to reverberation, echo, and interference between loudspeakers that are mounted at a distance from each other. These problems may become critical in emergencies where correct receipt and interpretation of information is essential in order to inform and guide people who are evacuating for example a tunnel. However, the problems are also relevant to situations that are not critical.

Currently, information helping people navigate in long corridors rely heavily on visual aids such as signs, arrows, and markings on the floor. Visual aid solutions are numerous, but they have the disadvantage of poor performance in low visibility and smoke. Audio is under-utilized. Auditory assistance systems do exist but are basic PA systems with only minor adaptations to the specific challenges associated with long tunnels and corridors.

The prior art includes EP 3 629 604 A1, which discloses a sound system and associated devices and methods for delivering synchronized sound in long and narrow passageways such as tunnels and corridors. The system includes nodes installed at intervals in the passageway, each node having a microphone and two speakers, one pointing in each direction. Configuration of the system includes a first phase where the relative position of nodes to each other is determined by each node playing a test sound and the remaining nodes report the arrival time and/or sound level registered by its microphone, and a second phase where the distance between adjacent nodes is determined by one node playing a test sound and an adjacent node registering the delay caused by propagation of the sound between the two nodes. During use the system is configured to play in a manner synchronized based on the determined delays.

Summary of the invention

The invention is set forth and characterized in the main claim, while the dependent claims describe other characteristics of the invention.

It is thus provided an auditory guidance system for installation along a pathway between an initial location and a target location, comprising a plurality of nodes arranged at intervals along the pathway, wherein a first node is the closer node to the initial location and a last node is the closer node to the target location, characterized in that each node comprises a directional sound generator which is configured to emit a sound pulse towards the initial location, in a sequence from the directional sound generator in the first node to the directional sound generator in the last node, each sound pulse emission being interrupted by a time interval. In one embodiment, the directional sound generator is a directional loudspeaker or an array or loudspeakers. The nodes may be connected to one of a plurality of switches and controlled by a control system. The guidance system may be used as an evacuation system in a tunnel or other confined space, and the target location may be an emergency exit or another opening out of the tunnel or confined space.

It is also provided an auditory guidance method, for guiding at least one individual along a pathway from an initial location to a target location, characterized by emitting directional sound pulses from a plurality of nodes arranged at intervals along the pathway between the initial location and the target location, said directional sound pulses being emitted in a sequence at time intervals such that each node emits a directional sound pulse towards the initial location; wherein a second node is emitting a sound pulse at a time interval following the emission of a sound pulse from a first node, a third node is emitting a sound pulse at a time interval following the emission of a sound pulse from the second node, and so on until a last node has emitted a sound pulse; whereby the sequential emission of sound pulses from the same side directional sound generators in subsequent nodes creates a spatial effect and an illusion of a sound travelling towards the target location and thus encourages the individual to follow the sequentially emitted sounds pulses.

In one embodiment, the time interval is constant. The pathway may be inside a tunnel or other confined space, and the target location may comprise an emergency exit or another exit from the tunnel or other confined space, and the sound pulse duration may be determined such that it is significantly shorter than the reverberation time for the tunnel or other confined space. In one embodiment, the method is executed in multiple segments of nodes, either simultaneously of at different intervals. The method may be executed by the invented auditory guidance system.

Brief description of the drawings

These and other characteristics of the invention will become clear from the following description of embodiments of the invention, given as non-restrictive examples, with reference to the attached schematic drawings, wherein:

Figure 1 is a schematic illustration of an embodiment of the auditory guidance system according to the invention; and

Figure 2 is a schematic illustration of an embodiment of the auditory guidance method and system according to the invention;

Figure 3 is a schematic illustration of another embodiment of the auditory guidance system according to the invention;

Figure 4 is a schematic illustration of another embodiment of the auditory guidance method and system according to the invention

Detailed description of embodiments of the invention

The following description may use terms such as “horizontal”, “vertical”, “lateral”, “back and forth”, “up and down”, ”upper”, “lower”, “inner”, “outer”, “forward”, “rear”, etc. These terms generally refer to the views and orientations as shown in the drawings and that are associated with a normal use of the invention. The terms are used for the reader’s convenience only and shall not be limiting.

Referring initially to figure 1, the invented auditory guidance system comprises a plurality of nodes 2 arranged along a pathway 1. The pathway 1 may be a roadway inside a tunnel or any other surface in a confined space (such as a mine shaft, rail

tunnel, corridor) or room. The pathway 1 may also be in the open, out of doors. The nodes 2 are arranged at intervals along the pathway, on a wall along the pathway, in a ceiling above the pathway, or on ant other suitable support. It should be understood that there may be several more nodes than what the figure indicates, for example in a long tunnel. The distance between the nodes may be known or be determined by the system, for example as described by EP 3 629 604 A1. The distance between the nodes may for example be between 10 and 30 meters, but this invention shall not be limited to this interval.

In figure 1, the pathway 1 is inside a confined space having walls 10 with side exits (e.g. emergency exits) 3, a fire extinguisher 5 and an emergency phone 6, and the nodes 2 are connected to one of a plurality of switches 7 and controlled by a control system 8. However, the invention shall not be limited to this configuration.

Reference number 4 denotes a target area for the auditory guidance performed by the nodes 2. A target area may for example be at a tunnel opening or the exit from a corridor or other confined space, or one of the emergency exits 3. These areas 4 and exits 3 will therefore in the following also be referred to as “target locations”.

Each node 2 comprises two directional sound generators 9a,b that each are configured to emit sound in a predetermined direction. The directional sound generators may be assembled in a common housing, but not necessarily. In the embodiment illustrated in figure 1, the two directional sound generators 9a,b are pointing along the pathway and in opposite directions.

The directional sound generators 9a,b may be loudspeakers, for example loudspeakers with small apertures arranged into an array. The left and right facing directional loudspeakers in each node provides for optimal use of acoustic energy. For example, referring to figure 2, a person located between two nodes 2_1, 2_2 will perceive the sound generated by the right-hand sound generator $9a_1$ as being substantially (e.g. more than 12dB) lower than the sound generated by the left-hand sound generator $9b_1$ of the same node 2_1.

The use of such directional loudspeakers contributes to reducing the reverberation effects that may be pronounced in confined spaces, such as tunnels. This is an advantage

over the prior the non-directional loudspeakers of the prior art PA systems, where reverberation effects may last several seconds and render precise auditory guidance impossible.

Each sound generator 9a,b in each node 2 is configured and controlled (e.g. via the control system 8) to emit a sound pulse A with predefined characteristics (e.g. duration, pitch, volume). Examples of emitted sound pulses are bell chimes, sound of footsteps on pavement, but a number of other sounds are conceivable. The system may be configured to emit the same sound pulse from all the nodes, or the sound pulse characteristics and type may be different between the nodes. The nodes are configured to be activated in a sequence, from an initial location L and towards the target location 4.

Sound generators 9a,b in each node 2 may be controlled to emit the same sound pulse at the same time, or to emit sound pulses in a desired sequence, as will be explained in the following, with reference also to figures 2-4.

If it is desirable to guide one or more individuals P away from a location L, where for example a fire E or other critical event may have occurred, to a target location (e.g. a tunnel opening 4 or an emergency exit 3), the invented auditory guidance system may be operated in a manner described in the following.

A node 2_1, which is the closer one to the individual P (and therefore for the purpose of illustrating the method is designated as a first node), is activated such that its sound generator $9a_1$ facing the initial location L emits a directional sound pulse A. Then, after a time interval Δt, a subsequent, second, node 2_2, which is adjacent to the first node 2_1 but farther away from the initial location L, is activated such that its sound generator $9a_2$ facing the first node 2_1 emits a directional sound pulse A. Following another time interval Δt, a third node 2_3, which is adjacent to the second node 2_2 but closer to the desired location 4, is activated such that its sound generator $9a_3$ facing the second node 2_2 emits a directional sound pulse A. Figure 2 illustrates three nodes between the initial location L and the target location 4, but it will be understood that the system may comprise fewer (at least two) or more nodes, e.g. nodes $2_{1\text{-}n}$. For example, figure 3 illustrates 13 nodes 2 arranged along a passageway 1. It should also be understood that

the other sound generators (i.e. $9b_{1\text{-}n}$) will be activated in a similar manner if it is desirable to guide individuals in the opposite direction along the pathway.

For an individual P between nodes 1 and 2, the sound pulse A emitted from the sound generator $9a_1$ in the first node 2_1 will be perceived as being at a lower level than the sound pulse A emitted from the sound generator $9a_2$ in the second node 2_2. This directionality assures that there is reduced perception of incoming sound from the node 2_1 compared to perception of departing sound from nodes 2_2 and then 2_3. The sequential emission of sound pulses A from the same side directional sound generators $9a_{1\text{-}n}$ in subsequent nodes $2_{1\text{-}n}$ creates a spatial effect and an illusion of a sound travelling towards the target location 4. This encourages the individual to follow the sequentially emitted sounds pulses towards the target location. Optionally, the sound pulse emission may be interrupted at intervals by voice instructions such as “follow the sound to safety.” The directional effect helps remove ambiguity as to which way to go, and provides an imperative for moving in the desired direction, away from the initial location (e.g. a fire) and towards the target location.

The sound pulse duration t_A and time interval Δt may be controlled or pre-programmed according to the specific environment. For example, if the pathway 1 is inside a tunnel og similar passage, the sound pulse duration t_A is advantageously significantly shorter than the tunnel reverberation time. If, for example, the tunnel reverberation time is between 2 and 4 seconds, the sound pulse duration t_A may preferably between 0.2 and 0.5 second, and the time interval Δt may be between 0.5 and 1 second. The sound pulse duration t_A may be constant or may be different for each node.

If the target location (e.g. emergency exit 3 or tunnel opening 4) is far away from the initial location L, for example as illustrated in figure 3 (a total of 13 nodes), the delay from the first sound pulse is emitted from the first node 2_1 and the last sound pulse is emitted from the last node 2_n (in figure n=13), may be unacceptably long. It may therefore be desirable to activate groups of nodes individually, for example at the same time. This is illustrated in figure 4, where an activation sequence corresponding to the one described above is shown as being be repeated on adjacent groups G of nodes. The pathway is thus divided into smaller segments and the sound level may be adjusted such that multiple segments G can play at the same time without being heard from another

section. The number of nodes per segment will vary (depending on for example the distance between the nodes, acoustical properties of the environment, the sound to be used). These parameters may be measured (e.g. by microphones at or in the nodes) and the sound emission may be adjusted accordingly.

The invented auditory guidance method and system is particularly useful for evacuating individuals from a tunnel or other confined space when visibility is low or non-existing, for example in the event of a fire.

Claims

1. An auditory guidance system for installation along a pathway (1) between an initial location (L) and a target location (3, 4), comprising a plurality of nodes (2_{1-n}) arranged at intervals along the pathway, wherein a first node (2_1) is the closer node to the initial location (L) and a last node (2_n) is the closer node to the target location (3, 4), **characterized in that** each node comprises a directional sound generator ($9a_{1-n}$) which is configured to emit a sound pulse (A) towards the initial location (L), in a sequence from the directional sound generator ($9a_1$) in the first node (2_1) to the directional sound generator ($9a_n$) in the last node (2_n), each sound pulse emission being interrupted by a time interval (Δt).

2. The system of claim 1, wherein the directional sound generator ($9a_{1-n}$) is a directional loudspeaker or an array or loudspeakers.

3. The system of any one of claims 1-2, wherein the nodes are connected to one of a plurality of switches (7) and controlled by a control system (8).

4. Use of the system as defined by any one of claims 1-3 as an evacuation system in a tunnel or other confined space, and where the target location is an emergency exit (3) or another opening (4) out of the tunnel or confined space.

5. An auditory guidance method, for guiding at least one individual (P) along a pathway (1) from an initial location (L) to a target location (3, 4), **characterized by** emitting directional sound pulses (A) from a plurality of nodes (2_{1-n}) arranged at intervals along the pathway between the initial location (L) and the target location (3, 4), said directional sound pulses being emitted in a sequence at time intervals (Δt) such that each node (2_{1-n}) emits a directional sound pulse (A) towards the initial location (L);
wherein a second node (2_2) is emitting a sound pulse (A) at a time interval (Δt) following the emission of a sound pulse (A) from a first node (2_1), a third node (2_3) is emitting a sound pulse (A) at a time interval (Δt) following the emission of a sound pulse (A) from the second node (2_2), and so on until a last node (2_n) has emitted a sound pulse (A);
whereby the sequential emission of sound pulses from the same side directional sound generators in subsequent nodes creates a spatial effect and an illusion of a sound

travelling towards the target location and thus encourages the individual to follow the sequentially emitted sounds pulses.

6. The method of claim 5, wherein the time interval (Δt) is constant.

7. The method of any one of claims 5-6, wherein the pathway (1) is inside a tunnel or other confined space, and the target location comprises an emergency exit (3) or another exit (4) from the tunnel or other confined space, and wherein the sound pulse (A) duration (t_A) is determined such that it is significantly shorter than the reverberation time for the tunnel or other confined space.

8. The method of any one of claims 5-7, wherein the method is executed in multiple segments (G) of nodes ($2_{1\text{-}n}$), either simultaneously of at different intervals.

9. The method of any one of claims 5-8, executed by the auditory guidance system as defined by any one of claims 1-3.

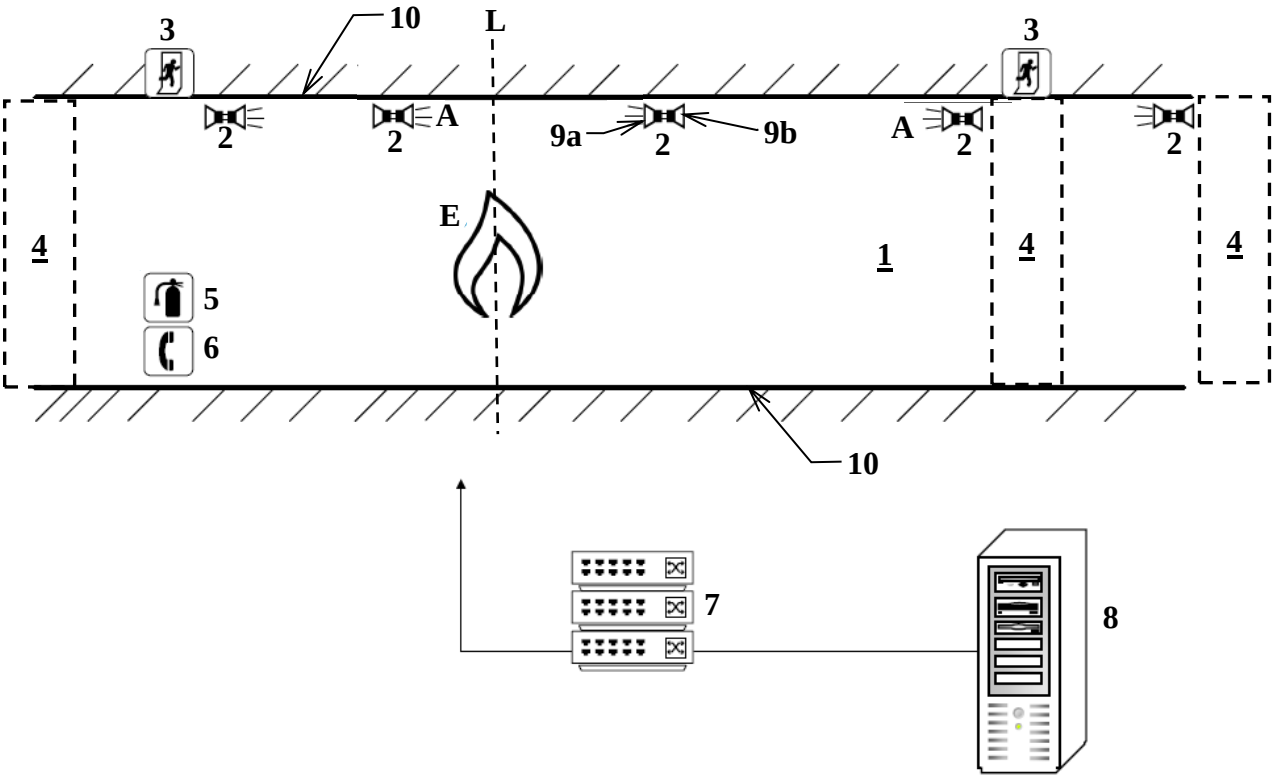

3
10
L
3
2
2
A
9a
2
9b
A
2
2
E
4
1
4
4
5
6
10
7
8

Fig. 1

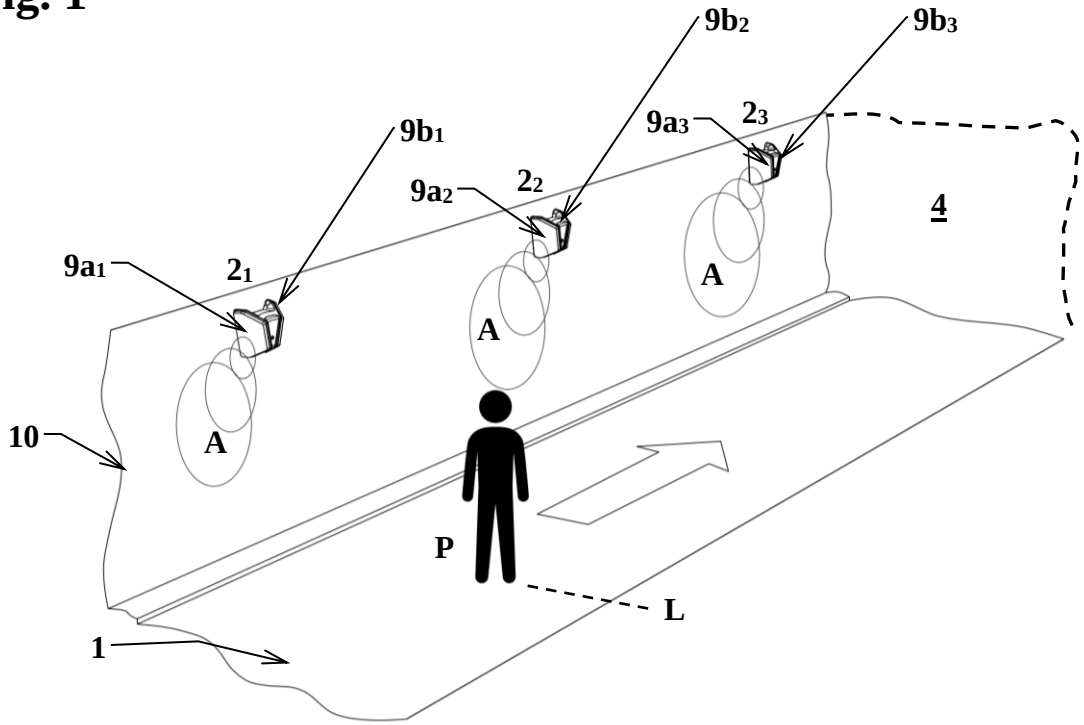

9b2
9b3
9a3
23
9b1
9a2
22
4
9a1
21
A
A
A
10
P
L
1

Fig. 2

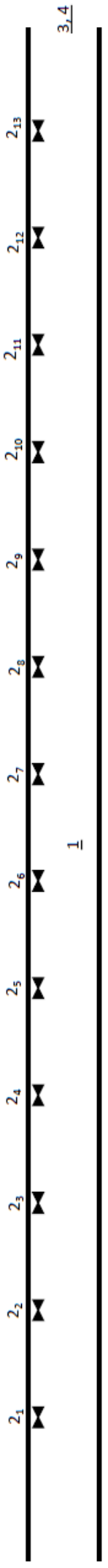

3, 4
2 13
2 12
2 11
2 10
2 9
2 8
2 7
2 6
2 5
2 4
2 3
2 2
2 1
1

Fig. 3

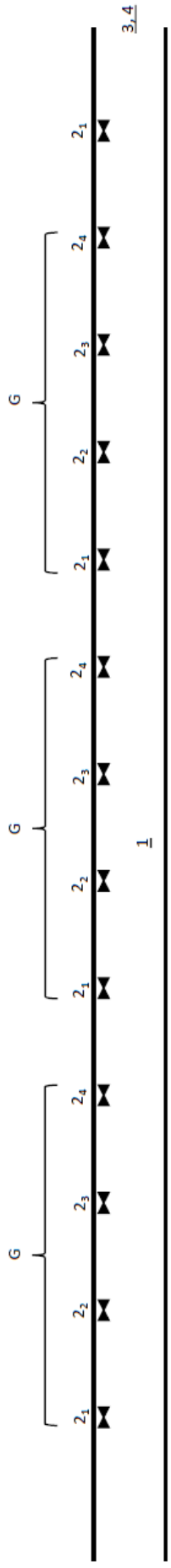

3, 4
2 1
2 4
2 3
2 2
2 1
G
2 4
2 3
2 2
2 1
G
2 4
2 3
2 2
2 1
G
1

Fig. 4