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(54) **Foldable speaker**

(57) Speaker device (10), comprising a transducer (18) devised to convert an electric signal into mechanical movement, a membrane (11), and a support structure (12,13,14,15) for the membrane, wherein the support structure is convertible between an active mode at which

the membrane is held in a stretched state, and an inactive mode at which the membrane is folded. The support structure preferably has a central shaft (12) about which the membrane is suspended in an umbrella-like manner, with the transducer is connected to the central shaft.

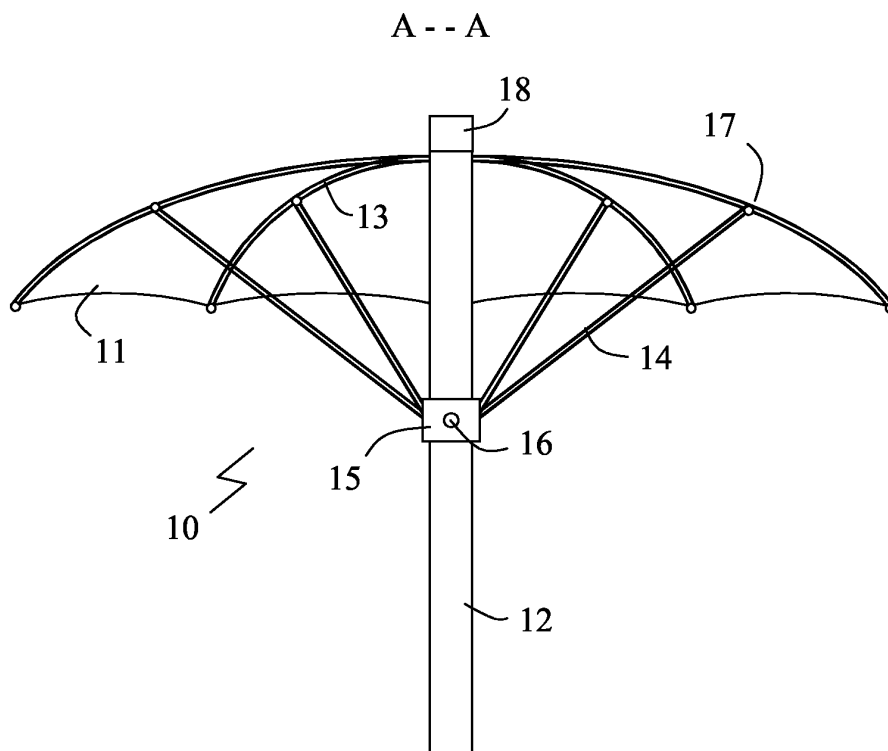


Fig. 2

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Description

Field of the invention

[0001] The present invention relates to the field of speakers for audio players, devised to convert electric signals to sound waves. More particularly, the invention relates to a compact speaker solution which has excellent low frequency performance for its size and weight.

Background

[0002] The traditional speaker design involves a transducer, devised to transform electric signals to mechanical movement, attached to a membrane which transfers the movement of the transducer to a movement of a mass of air. The speaker is generally mounted in a box or baffle in order to avoid short-cutting the sound. As a result, low and mid range audio frequencies will be muted, dependent on the size of the speaker and the box. Low frequency sound, commonly referred to a bass, means long waves compared to high frequency sound, and therefore requires larger boxes. The bigger the box or baffle is, the better the low frequency performance will typically be.

[0003] Obviously, size will at one point or another be a limiting issue, dependent on the intended use of the speaker. Furthermore, since the speaker box also needs to be rigid to avoid or at least limit unwanted resonances in the box, also the weight will increase with the size of the speaker box or baffle.

Summary of the invention

[0004] A general object of the invention is to provide an improved speaker solution, providing good low frequency sound performance, and at the same time being compact and lightweight. An aspect of this object is to provide a speaker solution which is suitable for portable use.

[0005] According to a first aspect of the invention, this object is fulfilled by a speaker device, comprising a transducer devised to convert an electric signal into mechanical movement, a membrane, and a support structure for the membrane, wherein the membrane is flexible, and held in a stretched state by the support structure.

[0006] Preferably, the transducer is connected to the support structure.

[0007] In one embodiment the support structure has a central support member and at least one suspension member connected between the membrane and the central support member.

[0008] Preferably, the support structure has at least one spoke extending along the membrane between the central support member and a peripheral portion of the membrane, to which spoke the suspension member connects.

[0009] In one embodiment the suspension member is a strut.

[0010] In a preferred embodiment, the support structure has a central shaft about which the membrane is suspended in an umbrella-like manner.

[0011] Preferably, the transducer is attached to the central shaft.

[0012] In one embodiment the membrane forms a dome-shaped canopy in the stretched state.

[0013] In one embodiment the support structure has a mounting member for placing the speaker device with its membrane facing at least partly horizontally.

[0014] Preferably, the mounting member is foldable. In one embodiment the membrane is a canopy of an umbrella or parasol.

[0015] According to a second aspect of the invention, the object of the invention is fulfilled by a speaker device, comprising a transducer devised to convert an electric signal into mechanical movement, a membrane, and a support structure for the membrane, wherein the support structure is convertible between an active mode at which the membrane is held in a stretched state, and an inactive mode at which the membrane is folded.

[0016] In one embodiment, the transducer is connected to the support structure.

[0017] In one embodiment, the support structure has a central support member and at least one suspension member which is connected to the membrane and displaceable along the central support member for folding and unfolding the membrane.

[0018] In one embodiment, the support structure has at least one spoke extending along the membrane between the central support member and a peripheral portion of the membrane, to which spoke the suspension member connects.

[0019] In one embodiment, the suspension member is a strut.

[0020] In one embodiment, the support structure has a central shaft about which the membrane is suspended in an umbrella-like manner.

[0021] In one embodiment, the transducer is attached to the central shaft.

[0022] In one embodiment, the membrane forms a dome-shaped canopy in the stretched state.

[0023] In one embodiment, the support structure has a mounting member for placing the speaker device with its membrane facing at least partly horizontally.

[0024] In one embodiment, the mounting member is foldable.

[0025] In one embodiment, the membrane is a canopy of an umbrella or parasol.

[0026] In one embodiment, the membrane is flexible.

Brief description of the drawings

[0027] The features and advantages of the present invention will be more apparent from the following description of the preferred embodiments with reference to the accompanying drawings, on which

Fig. 1 schematically illustrates a first embodiment of an umbrella-like speaker according to the invention, as seen from underneath;

Fig. 2 schematically illustrates the embodiment of Fig. 1 from a cross-sectional side view;

Fig. 3 schematically illustrates the embodiment of Figs 1 and 2 from a cross-sectional side view, in a folded state;

Fig. 4 schematically illustrates a second embodiment of speaker according to the invention, as seen from underneath;

Fig. 5 schematically illustrates the embodiment of Fig. 4 from a cross-sectional side view;

Fig. 6 schematically illustrates the embodiment of Figs 4 and 5 from a cross-sectional side view, in a folded state;

Fig. 7 schematically illustrates an alternative to the embodiment of Fig. 5; and

Figs 8-15 schematically illustrates different fields of use and ways of mounting a speaker according to the invention;

Detailed description of preferred embodiments

[0028] The present description relates to the field of loudspeakers for converting electric audio signals, provided by an audio device, into sound. The proposed speaker is usable together with any type of audio player having an output for a speaker signal, such as traditional stationary Hi-Fi equipment or a radio receiver. The speaker is also usable for providing real time sound from a microphone or similar, through suitable amplifying means. In particular, the invention has significant benefits as a portable speaker. As such, it may be used for transport between different sound sources, but even more advantageously, it may be carried along together with portable audio devices, such as portable radio receivers, MD or CD players, mp3 players and so on. It should be emphasised that the term comprising or comprises, when used in this description and in the appended claims to indicate included features, elements or steps, is in no way to be interpreted as excluding the presence of other features elements or steps than those expressly stated.

[0029] The present invention relates to a speaker design, which involves a membrane with a relatively large surface. The membrane is attached to a support structure, but the speaker device does not need to include any box or baffle, and is therefore also lightweight. A transducer is used to convert electric audio signals into mechanical movement. The transducer may be attached to the membrane, but is preferably attached or built into the support structure, which in turn supports the membrane. The membrane may be such that it would fold or collapse unless held in the stretched state by the support structure, such as a flexible cloth or a pre-folded element. Exemplary embodiments will now be described with references made to the accompanying drawing.

[0030] Figs 1-3 illustrate a first embodiment of a speak-

er device 10, having an umbrella-like structure, which makes it possible to collapse the speaker to a very compact format. In Fig. 1 the speaker device 10 is depicted in an active, unfolded state from what would correspond to the bottom side of an umbrella, which is a main sound output direction for the speaker. Speaker device 10 includes a membrane 11 carried by a support structure. The support structure includes a central support member 12 attached to the membrane. Eight spoke-like members 13, hereinafter called spokes, project substantially radially from the central support member 12, in engagement with membrane 11. Dashed line A-A indicate the cross-sectional side view from which Fig. 2 is taken. In Fig. 2, the umbrella-like appearance of the speaker device is even more clear. Central support member 12 includes a shaft extending substantially parallel to the main sound output direction of speaker device 10. A folding member 15 forms part of the central support member 12, and is displaceable along the shaft of the central support member for folding and unfolding the speaker device 10. At least one suspension member in the form of a strut 14 is connected between folding member 15 and spokes 13. As is well known from the traditional umbrella design, one strut may be included for each or e.g. every second spoke. Furthermore, the design may involve any number of spokes. The strut may also be divided into several parts linked together, as is e.g. common for compact umbrellas.

[0031] In the position shown in Figs 1 and 2, the speaker is shown in its active mode, meaning that membrane 11 is held in a stretched state and thus usable for conveying sound. This is achieved by folding member 15 being placed in an upper position, whereby struts 14 force spokes outwardly. Folding member 15 is preferably fixed in the upper position by a lock mechanism 16. The spokes are typically slightly flexible, and the shape of membrane 11 and the tension caused by stretching it, will therefore bend the spokes as illustrated. The material of membrane 11 is preferably flexible but substantially non-resilient. In an alternative embodiment, the membrane is a pre-folded element, similar to a lamp-shade, which typically assumes a generally cylindrical tube shape when folded. By expanding one end of that tube, the membrane will unfold to a pyramid shape. For a design with a flexible non-resilient membrane, such as a cloth, the shape obtained in the unfolded state is predominantly determined by how the membrane is cut, and the support structure is preferably designed such that tension is maintained throughout the entire membrane. Fig. 1 illustrates a dome-shaped membrane, which has shown excellent results in tests, but other shapes are also possible, such as a flat membrane, or a sail-shaped membrane, e.g. a spinnaker. In order to create sound waves, a transducer 18 is connected to the support structure. In the illustrated embodiment, transducer 18 is attached at a top portion of the central support member 12. Transducer 18 may alternatively be built into the support structure, or e.g. be attached at a side portion of the shaft of central support

member 12. When acoustic waves are induced in the support structure by means of transducer 18, membrane 11 will be forced to follow, and thereby set the air surrounding the membrane 11 in motion. As a result, sound waves are emitted. In a traditional speaker, the membrane is generally non-flexible and its movement is piston-like. The present invention, in an embodiment such as that of Fig. 2 with a flexible and potentially foldable membrane, is believed to work differently, in that sound waves instead will propagate from the centrally placed transducer and radially outwards along the membrane. In tests made on an ordinary umbrella, fitted with a transducer 18 in a position as illustrated in the drawing of Fig. 2 and connected to an audio player, surprisingly rich and deep sound quality has been obtained. Particularly the low frequency performance has been surprisingly good.

[0032] Fig. 3 illustrates speaker device 10 in an inactive mode, where it is folded such that there is no tension in the membrane 11. This folded position is obtained by releasing lock mechanism 16 and displacing folding member 15 downwards. Struts 14 are thereby forced to pull and pivot the spokes 13 towards the shaft of central support member 12. In order for this to be possible, spokes 13 are preferably hinged to central support member 12, and struts 14 are preferably also hinged both to spokes 13 and to folding member 15.

[0033] Figs 4-6 illustrate a second embodiment of the speaker device according to the invention, where Figs 4 and 5 show the speaker in the active mode and Fig. 6 in the inactive mode. In Fig. 4 the speaker device 40 is illustrated perpendicular to its membrane 41. As is shown more clearly in Fig. 5, seen from a cross-sectional side view indicated by dashed line B--B in Fig. 4, membrane 41 is substantially flat in this embodiment in its unfolded state. Membrane 41 is held by a support structure comprising a central support member with a shaft 42, and a folding member 45 corresponding to folding member 15 of the first embodiment. In this embodiment, however, shaft 42 of the central support is not by necessity attached to the membrane 41, even if it may be as will exemplified below. In the illustrated embodiment of Figs 4-6, membrane 41 is only suspended in peripheral portions by spokes 43, arranged underneath the membrane and extend at an angle away from the membrane to a pivotable connection point at the central support member. Suspension members in the form of struts 44 are connected between folding member 45 and spokes 44, such that displacement of folding member 45 downwards to the preferably locked position shown in Fig. 5 pivots spokes 43 to stretch membrane 41. Since spokes 43 do not extend in engagement with membrane 41, and are subjected to pulling and bending forces at connection points 47 to struts 44, spokes 43 are preferably substantially non-resilient. A transducer 48 is connected to the support structure to convey mechanical movement to membrane 41, for emitting sound waves. In the illustrated embodiment, transducer 48 is connected to a spoke 43, at a position where the spoke is attached to membrane 41.

[0034] Fig. 7 illustrates an alternative to the embodiment of Figs 4-6, in the active mode, also using the same reference numbers for like features. The difference is that in this speaker device 70 membrane 41 is also attached to the top of central portion 42, similar to the first embodiment shown in Figs 1-3. Preferably, transducer 48 is also placed at the top portion of the central portion, close to the membrane 41. The speaker device may be designed such that membrane 41 is flat in the unfolded, stretched, state also in this embodiment, by the point of attachment of the central portion 42 to membrane 41 being flush with a plane defined by the points of connection between spokes 43 and membrane 41. However, in the illustrated embodiment, the point at which membrane 41 attaches to central portion 42 is somewhat lower than the plane defined by the points of connection between spokes 43 and membrane 41. In the stretched state as shown in Fig. 14, membrane 41 will slope slightly inwardly towards the centre.

[0035] Fig. 6 illustrates speaker device 40 in the inactive mode. This folded position is obtained by releasing a lock mechanism 46 and displacing folding member 45 upwards. Struts 44 are thereby forced to push and pivot spokes 43 to collapse the membrane 41. Spokes 43 are preferably hinged to central support member 42, and struts 44 are preferably also hinged both to spokes 43 and to folding member 45.

[0036] As is illustrated in both Figs 3 and 6, the membrane of the speaker device will be non-stretched in the folded state, and the entire speaker device will be extremely compact. The speaker device may for example be transported in a protective cylinder casing.

[0037] The speaker device as shown in the drawings is also devised with either an input for an electric audio signal, connected to the transducer 18, or incorporate a built-in audio device, such as a radio or a music player.

[0038] Even though the speaker device in one embodiment resembles an umbrella, that type of embodiment does not necessarily have to be an umbrella. If the purpose is to provide a compact portable speaker for connection to a music player, such as a CD player or a mobile phone incorporating e.g. an mp3 player, the size of a speaker device need not be as large as a traditional umbrella, but rather with an unfolded diameter in the range of 5-50 cm.

[0039] Furthermore, the membrane need not be designed to withstand rain and strong wind, but can be made from any material suitable for it to act as a speaker membrane, such as thin plastics high performance membrane material, or a woven material. To further improve the sound performance the membrane surface may be enforced, e.g. at the outer edges.

[0040] The shape of the membrane may basically take any shape from triangular or rectangular, to multisided or circular, and it does not have to be symmetrical. As mentioned and as shown in the drawings, the surface of the membrane may also take different shapes, such as flat, conical, pyramid-shaped or dome-shaped.

[0041] The transducer used in the speaker device may be an electro-dynamic transducer, a piezo-electric transducer, or an electrostatic transducer, but need not be restricted to these types.

[0042] Different fields of use of a speaker according to the invention will now be described by reference to Figs 8-15, in which the speaker device is shown only schematically.

[0043] Fig. 8 illustrates a speaker device making use of a parasol canopy 80 as a membrane. A transducer 81 is attached at the top of the canopy, and connected by means of internal wiring through a central shaft 82 to a connector 83 for audio input. A Hi-Fi equipment 84 is connected by cable to connector 83. Music or other audio content played by equipment 84 will be provided through the canopy membrane 80, and by mainly focused downwards. This way, a rich sound can be obtained for the people sitting at the parasol, while not bothering others in the vicinity. In this sense, the speaker device is directional. The parasol is preferably foldable and provided with a generally flexible canopy 80, but need not be.

[0044] Fig. 9 illustrates a speaker device in mounted to a ceiling 90, e.g. in a conference room, with the transducer 91 at the centre of the speaker membrane. Typically, wiring is led from transducer 91 to an audio signal input for connection to e.g. a Hi-Fi equipment or a conference telephone. The speaker device, when used for this basically stationary purpose, need not be foldable.

[0045] Fig. 10 illustrates an embodiment where the speaker device is incorporated in an umbrella, with the umbrella canopy 100 acting as the membrane. The drawing illustrates schematically how a mobile phone 103 is connected from a speaker output connector and via a cable to an audio input connector 102 at the umbrella handle. Audio input connector 102 is internally connected to transducer 101. The speaker device may in this configuration be used as a loudspeaker when using the phone 103, but perhaps more preferably when using a built-in music player in the phone 103. It could in this context be noted that the narrow idea of combining a speaker with an umbrella has been suggested before by Nesbit in U.S. Patent 4,915,670. However, in that case the umbrella canopy was simply a carrier for attached auxiliary speakers, and did not act as the membrane itself.

[0046] Figs 11 and 12 illustrate two different concepts for mounting members, usable for placing the speaker device on a support surface such as a desktop or a floor. Though not shown in detail, the tripod 111 of Fig. 11 attached at the top of side of the membrane of the speaker device 110, and the long feet arrangement 121 of Fig. 12 attached to the central shaft of the speaker device 120, are easily made foldable by use of suitable joints and hinges. Common for the embodiments of Figs 11 and 12 is that the mounting members are devised for placing the speaker device with its membrane facing at least partly horizontally. By facing at least partly horizontally is meant that a main sound output direction can be

defined for the speaker device, basically the direction of the central support member 12 for a design such as that of Fig. 2, which main direction is tilted from a vertical direction. An alternative embodiment may include a spike for penetrating the ground, such that the speaker device can be conveniently arranged outdoors.

[0047] Fig. 13 discloses a typical way of operating a speaker device according to the embodiment of Fig. 12. In this case, a portable speaker device 120 with a foldable mounting member 121 is connected to a mobile phone 130 by suitable connection means 131. Typically, a speaker cable 131 is used, but in an alternative embodiment a wireless connection means 131 using IR or radio, may be used, by including an adapted receiver in the speaker device 120.

[0048] Fig. 14 illustrates a setup similar to that of Fig. 13, but where the audio device is an mp3 player 140, an where a stereo cable 141 is used, connected to two speaker devices 120.

[0049] Fig. 15 illustrates another setup similar to that of Fig. 13, but where a speaker device 70 as illustrated in Fig. 7 is instead used, having a mounting member 151 which preferably is foldable.

[0050] It should of course be noted that the different embodiments shown in the drawings can be combined in different ways for adapting them to the different modes of operation shown in Fig 8-15. Furthermore, it should be kept in mind that the drawings and description disclose selected embodiments, whereas modifications may be made while still providing the same effects using substantially the same means. As an example, folding need not necessarily be achieved by sliding a folding member along a shaft, which is the traditional umbrella mechanism. A variant could instead involve a lever mechanism. Nevertheless, an extremely compact design for a speaker, particularly when not in use, is provided by the proposed foldable embodiment. The invention should therefore not be construed as being limited to the particular embodiments discussed above, which are illustrative rather than restrictive, and it should be appreciated that variations may be made in those embodiments by persons skilled in the art, without departing from the scope of the present invention as defined by the appended claims.

Claims

1. Speaker device (10), comprising a transducer (18) devised to convert an electric signal into mechanical movement, a membrane (11), and a support structure (12,13,14,15) for the membrane, **characterised in that** the membrane is flexible, and held in a stretched state by the support structure.
2. The speaker device as recited in claim 1, **characterised in that** the transducer is connected to the support structure.

3. The speaker device as recited in claim 1, **characterised in that** the support structure has a central support member (12) and at least one suspension member (14) which is connected between the membrane and the central support member.
4. The speaker device as recited in claim 3, **characterised in that** the support structure has at least one spoke (13) extending along the membrane between the central support member and a peripheral portion of the membrane, to which spoke the suspension member connects.
5. The speaker device as recited in claim 3, **characterised in that** the suspension member is a strut (14).
6. The speaker device as recited in claim 1, **characterised in that** the support structure has a central shaft (12) about which the membrane is suspended in an umbrella-like manner.
7. The speaker device as recited in claim 6, **characterised in that** the transducer is attached to the central shaft.
8. The speaker device as recited in claim 1, **characterised in that** the membrane forms a dome-shaped canopy in the stretched state.
9. The speaker device as recited in claim 1, **characterised in that** the support structure has a mounting member (121) for placing the speaker device (120) with its membrane facing at least partly horizontally.
10. The speaker device as recited in claim 9, **characterised in that** the mounting member is foldable.
11. The speaker device as recited in claim 1, **characterised in that** the membrane is a canopy (100,80) of an umbrella or parasol.
12. Speaker device (10), comprising a transducer (18) devised to convert an electric signal into mechanical movement, a membrane (11), and a support structure (12,13,14,15) for the membrane, **characterised in that** the support structure is convertible between an active mode at which the membrane is held in a stretched state, and an inactive mode at which the membrane is folded.
13. The speaker device as recited in claim 12, **characterised in that** the transducer is connected to the support structure.
14. The speaker device as recited in claim 12, **characterised in that** the support structure has a central support member (12) and at least one suspension member (14) which is connected to the membrane and displaceable along the central support member for folding and unfolding the membrane.
15. The speaker device as recited in claim 14, **characterised in that** the support structure has at least one spoke (13) extending along the membrane between the central support member and a peripheral portion of the membrane, to which spoke the suspension member connects.
16. The speaker device as recited in claim 14, **characterised in that** the suspension member is a strut (14).
17. The speaker device as recited in claim 12, **characterised in that** the support structure has a central shaft (12) about which the membrane is suspended in an umbrella-like manner.
18. The speaker device as recited in claim 17, **characterised in that** the transducer is attached to the central shaft.
19. The speaker device as recited in claim 12, **characterised in that** the membrane forms a dome-shaped canopy in the stretched state.
20. The speaker device as recited in claim 12, **characterised in that** the support structure has a mounting member (121) for placing the speaker device (120) with its membrane facing at least partly horizontally.
21. The speaker device as recited in claim 20, **characterised in that** the mounting member is foldable.
22. The speaker device as recited in claim 12, **characterised in that** the membrane is a canopy (100,80) of an umbrella or parasol.
23. The speaker device as recited in claim 12, **characterised in that** the membrane is flexible.

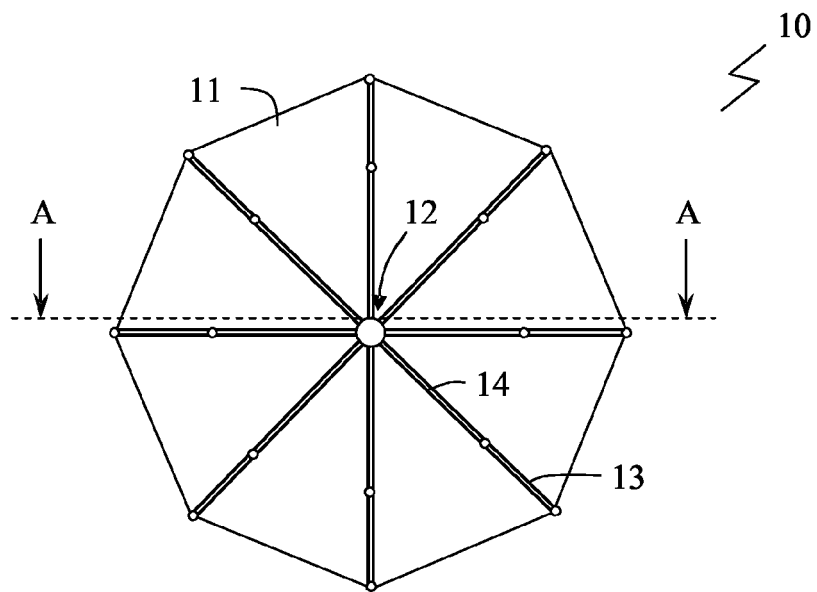


Fig. 1

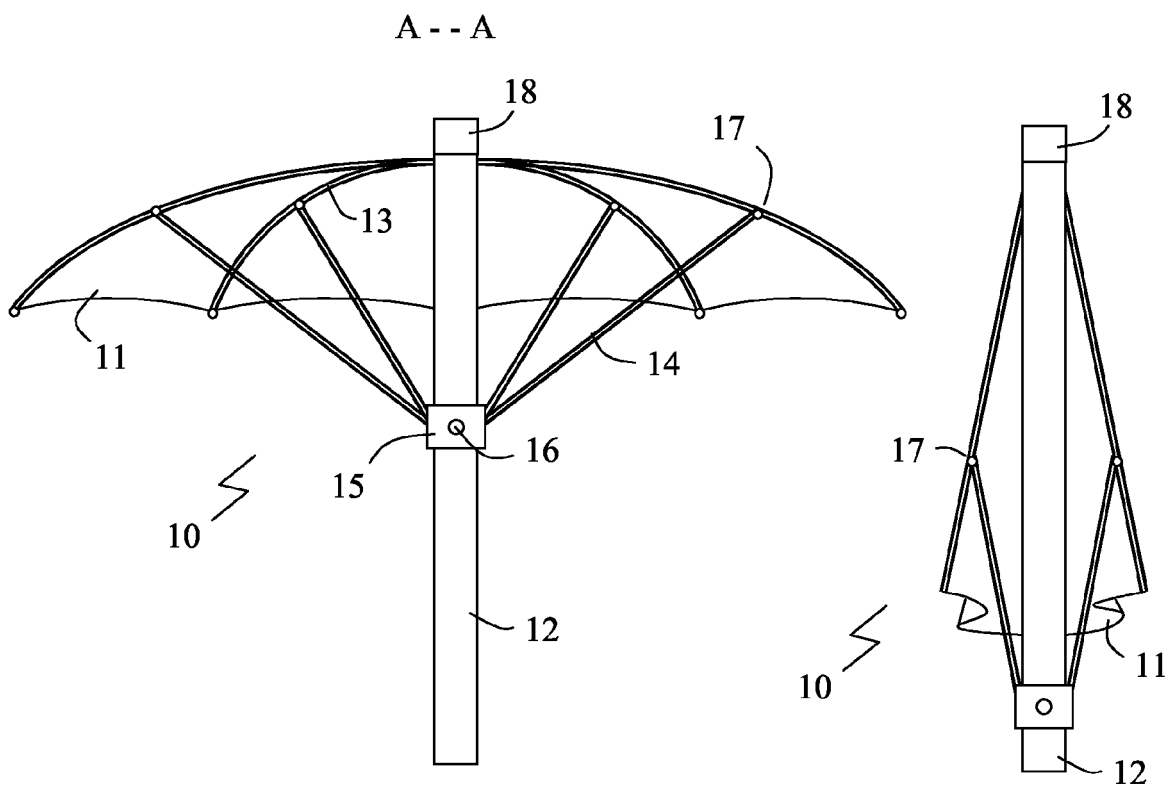


Fig. 2

Fig. 3

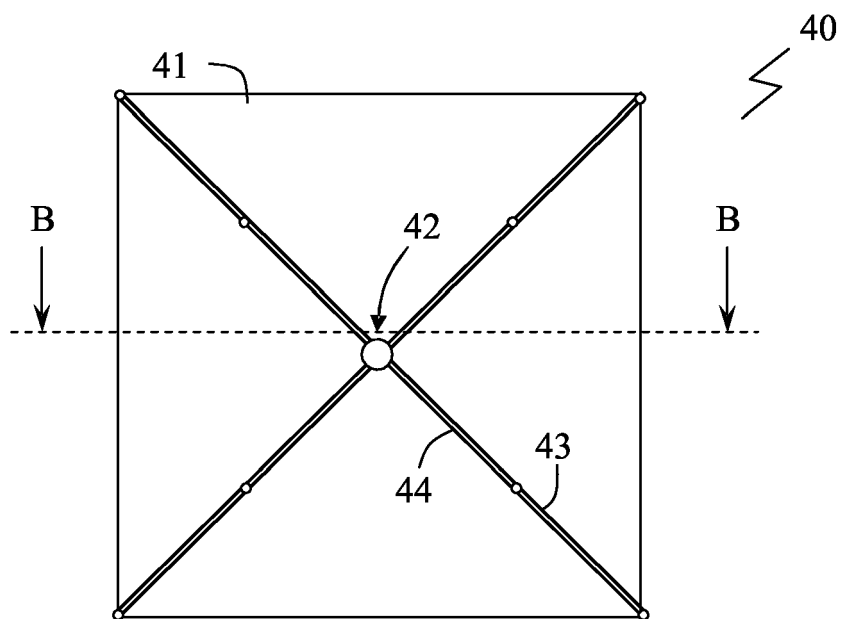


Fig. 4

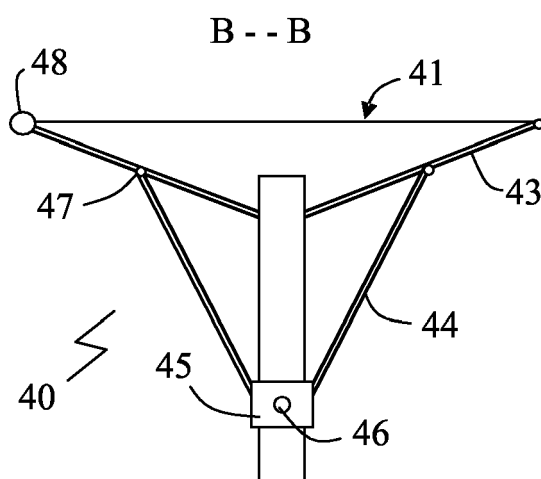


Fig. 5

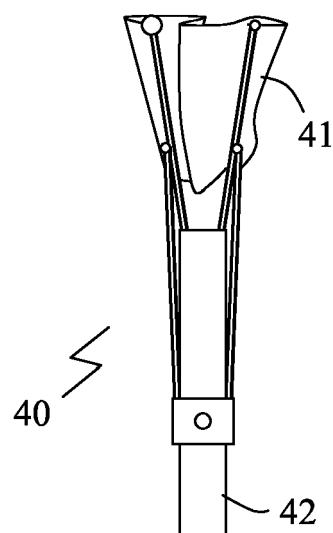


Fig. 6

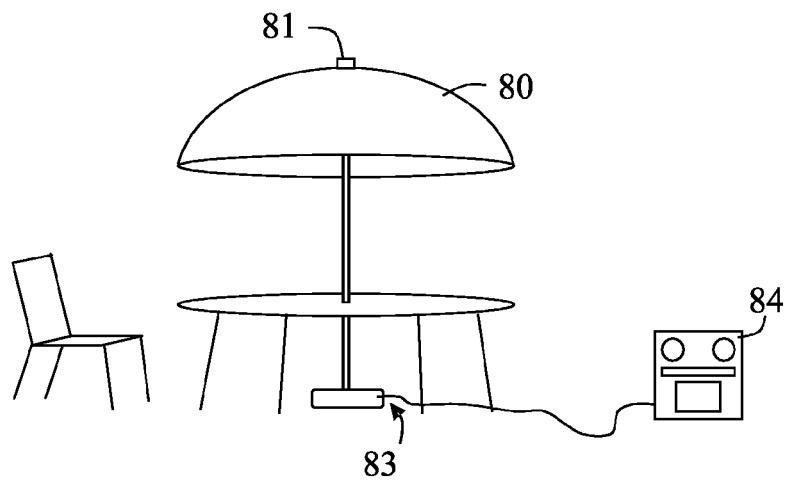


Fig. 8

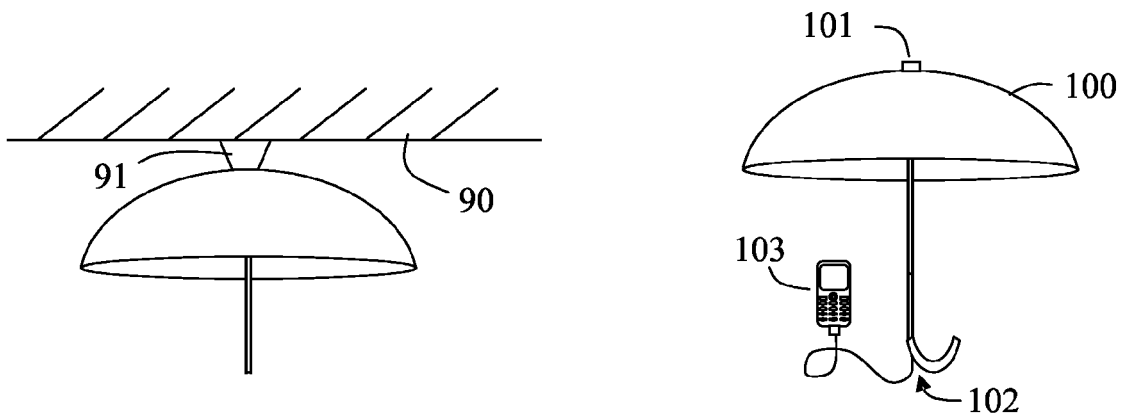


Fig. 9

Fig. 10

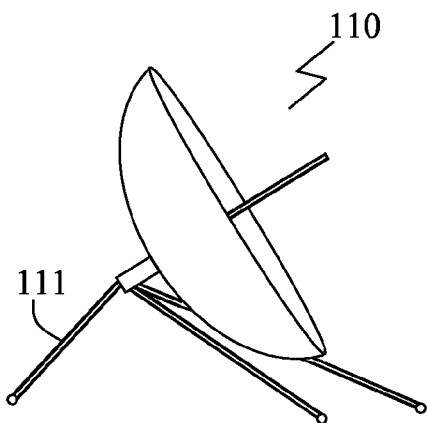


Fig. 11

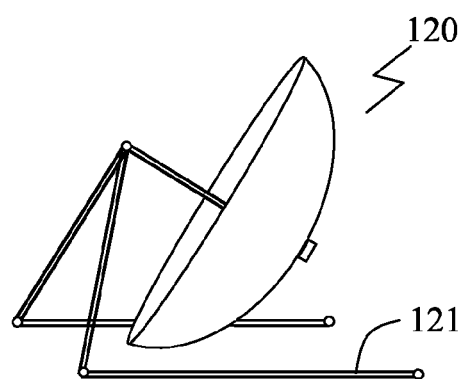


Fig. 12

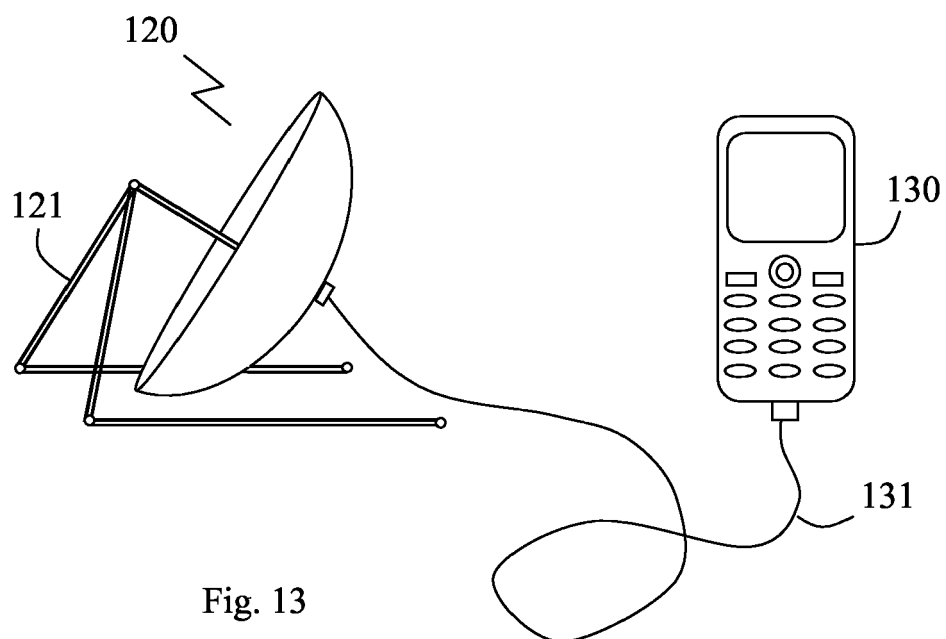


Fig. 13

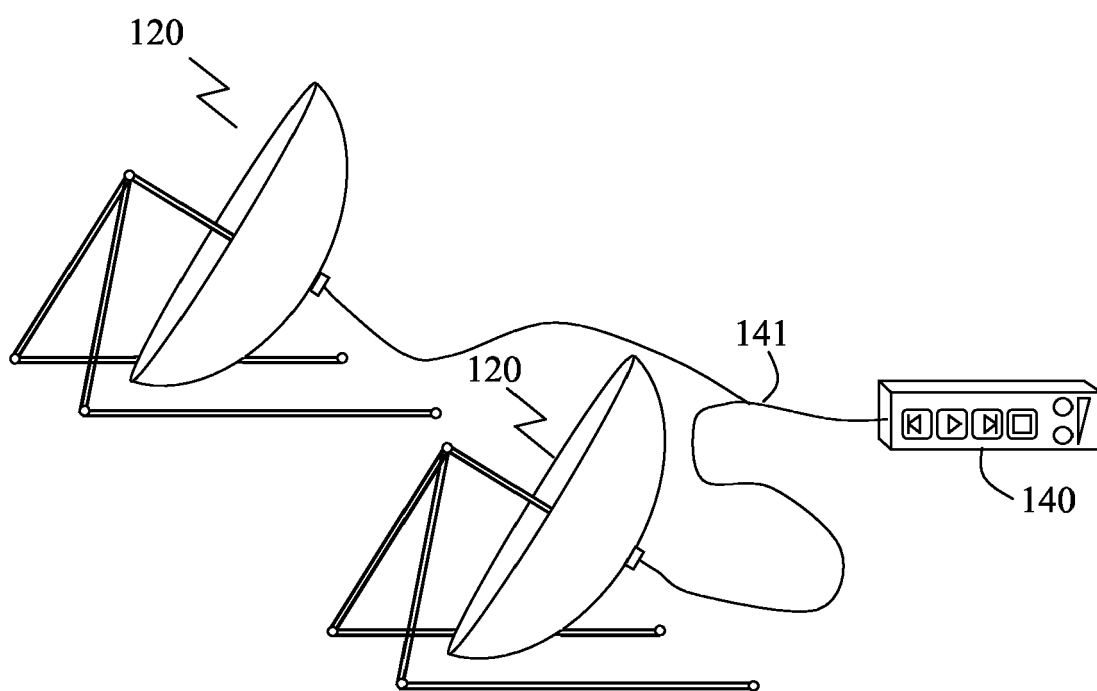


Fig. 14

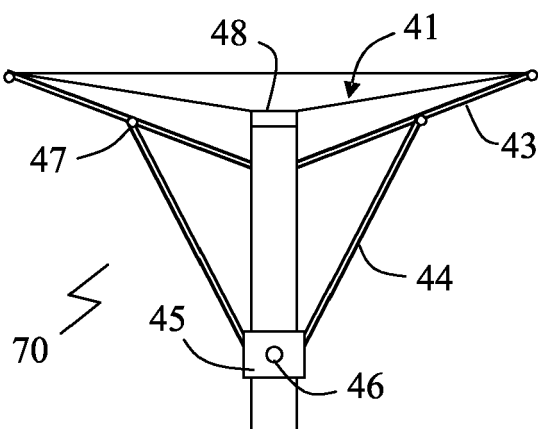


Fig. 7

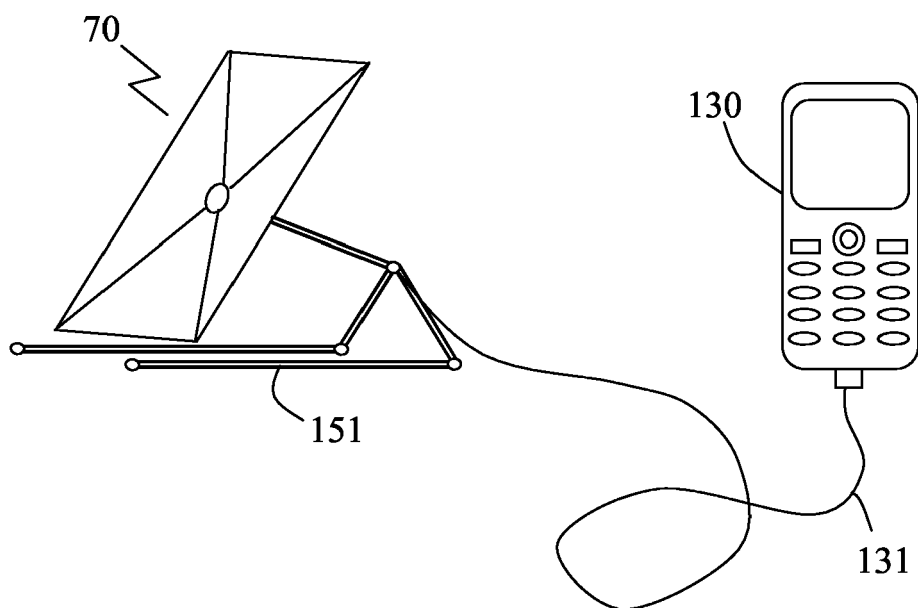


Fig. 15



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 05 10 3159

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	GB 229 382 A (HENRY JOSEPH ROUND) 19 February 1925 (1925-02-19) * page 1, left-hand column, lines 5-17 * * page 1, left-hand column, line 52 - right-hand column, line 63 * * page 1, right-hand column, line 66 - page 2, left-hand column, line 5 * * figures 1,3 *	1-8,11	H04R7/12
X	* the whole document *	9,10, 13-23	
X	----- PATENT ABSTRACTS OF JAPAN vol. 004, no. 063 (E-010), 13 May 1980 (1980-05-13) -& JP 55 033351 A (OLYMPUS OPTICAL CO LTD), 8 March 1980 (1980-03-08) * figures 1,2 *	1-3,5-7, 12-18	
X	* the whole document *	4,8,19, 23	
A	* figures 1,2 *	9,10,20, 21	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 4 October 2005	Examiner Fachado Romano, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 10 3159

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04-10-2005

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