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[Continued on next page]

(54) **Title**: A DEVICE FOR DETECTING ENVIRONMENTAL RADIO FREQUENCY ELECTROMAGNETIC FIELDS

Fig. 15

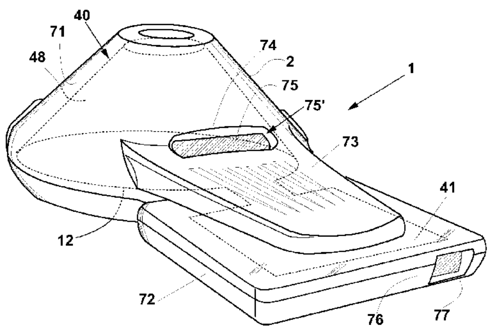
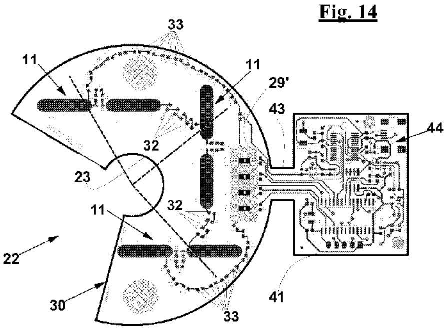


Fig. 14



(57) **Abstract**: A device (1) for detecting a pollution due to a radio frequency electromagnetic field by detecting the intensity of its electric component, with a three-dipoles antenna unit (12) comprising three dipole detection units (11) comprising respective dipole elements (9), said dipole detection units configured to provide a respective electric detection signal in response to the field; a two- dimensional flexible support element (10) for said dipole detection units (11) and a plurality of connection resistances (32,33); a plurality of collection terminals (29) for the electric detection signals; a processor unit (44) for acquiring the detection signals through the collection terminals (29) and to generate an overall signal, which is responsive to the electromagnetic field; an interface means (75,77) for delivering the overall signal, in particular a LED interface means, where the dipole elements (9) are mounted to a two- dimensional flexible support element (30) deformed into a three-dimensional shell support body (40) wherein the dipole elements (9) are at a substantially right angle with respect to each other. In a preferred exemplary embodiment the two-dimensional flexible support element (30) has the shape of a circular crown sector, and is deformed into a frustum-conical support body (40). The support (30) may comprise an appendix portion (41) on which the processor unit (44) is arranged. The substantially isotropic antenna unit (12) is easy and cheap to manufacture, and is well suited for a large mass production, moreover, the device can be manufactured in a size small enough to enhance its portability for a long time and without discomfort.

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TITLE

A DEVICE FOR DETECTING ENVIRONMENTAL RADIO FREQUENCY ELECTROMAGNETIC FIELDS

DESCRIPTION

Field of the invention

The present invention relates to a device for detecting an electromagnetic field in an environment, whose intensity is higher than a predetermined value, in order to assess whether an electromagnetic pollution is present. For instance, the device can be used to know how the environment is affected by radio frequency emitters such as mobile phone devices, indoor TV signal repeaters, signalling devices, remote control switches and so on.

The device can be also used for real time notifications that a predetermined electromagnetic field threshold value has been exceeded.

Background of the invention - Technical problems

As well known, devices equipped with radio frequency emitters, such as the above-mentioned ones, are more and more widely used at home and in workplaces. This determines accumulation of electromagnetic waves of different frequencies, causing concern to people living in electromagnetic crowded environments, in particular those who are electro sensitive.

Devices are known for detecting and measuring the intensity of a radio frequency electromagnetic field by measuring the electric component of the electromagnetic field. These portable devices comprise a dipole isotropic antenna and a control unit that can be functionally connected to the antenna. The control unit is configured for receiving an electric signal produced by the antenna when the latter is exposed to electromagnetic waves, said signal depending upon the intensity of the electric component. Moreover, the control unit is configured for processing this electric signal, in order to display the intensity of the electromagnetic field, how it changes with time as well as average values thereof versus time, as required by the regulations concerning admissible electromagnetic fields. Therefore, these devices are conceived as professional instruments for officially assessing whether the electromagnetic field values exceed upper threshold values provided by the regulations, and how much the upper threshold values are exceeded.

Such devices are described, for example, by Paul Clayton in "Concetti fondamentali di elettromagnetismo - applicazioni progettuali" (electromagnetics fundamentals – applicative solutions) Hoepli ed.

In these devices, the isotropic antenna is made by mounting a plurality of conductive elements and/or printed circuits, normally three printed circuits, each comprising a respective dipole, in such a way that the dipoles are arranged along mutually orthogonal directions. This manufacture process comprises different working steps, which normally comprise welding spatially oriented printed circuits with one another. Steps are also required of controlling the execution of the welding steps and so on. Therefore, these devices cannot be manufactured by a mass production process, and the production cost is relatively high.

Moreover, the control unit must be arranged at a long distance from the isotropic antenna, in order to avoid mutual interference between the two components. Therefore, the devices are bulky, and their size can be even one meter in one direction. This reduces the portability of these devices. In particular, these devices cannot be born for a long time, which could be useful for an electro sensible person, in order to warn him/her when he/she moves in an environment where an electromagnetic field is present whose intensity can be dangerous.

In the light of the above, the prior art devices are not well-suited for an unskilled user who wishes to receive a qualitative indication of an electromagnetic hazard that may be present, for instance, at home.

The need is therefore felt of a device that is suitable for detecting, in an environment, radio frequency electromagnetic fields, even of different frequencies, which pile with one another until an electric field is formed whose intensity is higher than a predetermined alarm value.

WO 89/10086 describes a probe for insertion into a tumour to be subjected to a hyperthermia therapeutic treatment by electromagnetic waves of a prefixed wavelength, in order to measure the electric field components of the magnetic field, and for measuring the temperature in the tumour. The probe comprises a triangular support prism on whose side faces three dipole antenna elements are arranged at mutually orthogonal directions, whose size depends upon the wavelength, i.e. upon the frequency of the therapeutic waves, and which are electrically connected in series, in order to obtain a globally isotropic antenna.

The device described in WO 89/10086 is not able to detect electromagnetic fields in air whose frequency may belong to a wide frequency range, for example between 100 kHz and 3 GHz, which comprises the working frequencies of radio frequency emitters commonly used at home and in general workplaces. Moreover, the miniaturization required to allow the introduction of the device into a catheter presupposes precise and expensive operations, so that the manufacturing costs of the device are not compatible with a wide use of it.

Summary of the invention

It is therefore a main object of the present invention to provide a device for detecting radio frequency electromagnetic fields, said device having a substantially isotropic antenna and being adapted to detect fields whose polarization, orientation and frequency are not known previously, and whose overall intensity is higher than a predetermined low threshold value.

It is also a feature of the invention to provide such a device that is easy and cheap to manufacture, so that its price is accessible to a large number of users, even to non-professional users.

It is a particular feature of the invention to provide such a device whose size is smaller and whose weight is lower than in the prior art devices, in order to enhance its portability even for a long time and without particular discomfort for the user.

It is another particular feature of the invention to provide such a device that is easy to use and that does not require a specific training.

It is also a particular feature of the invention to provide such a device that has a size smaller and a weight lower than the currently known devices, to enhance its use and its portability also for a long time, for example by electro sensitive people and/or by workers, in order to warn them the presence of potentially dangerous electromagnetic fields.

It is also particular feature of the invention to provide such a device for detecting electromagnetic fields of any frequency selected among common telecommunication frequencies, which are generally set between 100 kHz and 3 GHz, whose reliability is substantially the same at any frequency.

It is also a feature of the invention to provide a portable detector device that makes it possible to simplify and to generalize the detection and possibly the instantaneous measurement of intensity values that can be referred to radio frequency electromagnetic fields.

These and other objects are achieved by a device for detecting pollution due to an electromagnetic field in air, by detecting the intensity of the electric component of this electromagnetic field, the device comprising:

- a three-dipoles antenna unit comprising:
  - three dipole detection units comprising respective dipole elements configured to provide respective electric detection signals in response to the electric component;
  - a support element to which the dipole detection units are mounted;
  - a plurality of collection terminals for collecting the electric detection signals;
  - a resistance connection means for connecting each dipole detection unit with the collection terminals;
- a processor unit configured for receiving the detection signals through the collection terminals and for generating an overall signal, which is responsive to said electromagnetic field;
- an interface means for delivering the overall signal,

wherein the support element is a two-dimensional flexible support element configured for being deformed into a three-dimensional shell support body,

wherein the dipole elements are arranged on the two-dimensional flexible support element in such a way that, when the support element is deformed into the three-dimensional shell support body, the dipole elements extend along respective directions of three lines that are substantially orthogonal to one another, and

wherein a rigid box can be provided that contains, supports and protects said three-dimensional shell support body.

This way, an antenna unit is obtained that comprises three two-by-two substantially orthogonal dipole elements by folding a same circuit or plane support, on which the three dipole elements have been previously arranged. Such manufacturing process comprises less steps than the prior art process for making isotropic antennas, in which three distinct printed circuits are connected orthogonally to one another by a plurality of welded joints, or by a different connection procedure.

In particular, each dipole detection unit comprises:

- a linear dipole element extending on a plane, in particular a conventional dipole element;
- a radio frequency rectifier diode for detecting the oscillation signals received by the dipole element and for generating a low frequency component, also-called base-band component or detection signal, which recovers the level of the signal envelope that can be detected;
- a capacitive element for smoothing the detection signal coming from the diode;
- a couple of end resistances through which the detection signal is delivered.

Moreover, a plurality of connection resistances associated to the dipole element transfers the base-band electric signal from the capacitive element of the dipole detection units to the combination and/or control means, in order to minimize the interferences with the radio frequency signals.

The expression "dipole elements oriented according to an angle substantially supported with respect to each other" means that the dipole elements are arranged with the lines that are tangent in their respective middle points substantially orthogonal to one another.

As well known, a radio frequency electromagnetic field can be ranked according to the intensity of its electric component, which can be expressed in V/m, since the electric component $\underline{E}$ and the magnetic field component $\underline{B}$ of a radio frequency electromagnetic field can be immediately related to each other, at least beyond a sufficient distance from the source that emits them.

In particular, the frequency range of the radio frequency electromagnetic field, and so the frequency range of its electric component, is set between 100 kHz and 3 GHz. The electromagnetic field frequencies normally used in the technique belong to this range.

Therefore, the dipole detection units are advantageously broadband dipole detection units, i.e. they are configured to provide a perceptible electric detection signal in response to an electric field whose frequency is set between 100 kHz and 3 GHz.

In particular, the two-dimensional flexible support element has a planar initial shape.

Advantageously, the two-dimensional flexible support element has, in particular in an own planar conformation, a perimeter that comprises an arc of a circumference and two radial borders of the arc of circumference defining a predetermined central angle, and the three-dimensional shell support body, which is obtained from the bent two-dimensional flexible support element, comprises a conical surface in which the radial borders are adjacent to each other.

In particular the radial borders are connected to each other.

The three dipole elements extend along the conical surface at prefixed generatrices of the conical surface that correspond to three radial lines of the arc of circumference, i.e. the generatrices correspond to respective radial lines of the two-dimensional flexible support element, i.e., for instance, of the circular sector or of the circular crown sector that forms the development of the conical surface.

Besides the above mentioned advantages, the construction of such substantially isotropic antenna requires a small number of dimensional control operations, since the mutual arrangement of dipole elements only depends upon the aperture angle of the cone and upon the initial arrangement of the dipole elements on the plane support. This is useful in a mass production of the device.

In an advantageous exemplary embodiment, the circumference is an outer circumference, and the perimeter comprises an arc of an inner circumference that is substantially concentric to the outer circumference and has a diameter smaller than the diameter of the outer circumference, the arc of the inner circumference defined between the radial borders of the outer circumference, and the eventual three-dimensional support has a frustum-conical shape.

Preferably, the resistance connection means comprises sequences of resistances that are arranged on the three-dimensional shell support body along a path consisting of points where the three-dimensional shell support body has a curvature shorter than a predetermined curvature value.

In particular, the path is arranged substantially along a generatrix of the conical surface. The path may also be arranged along cross sectional circumferences that are orthogonal to the axis of the conical surface and have a curvature shorter than the predetermined curvature value. The path may also comprise a combination of the described paths as described above.

This reduces, or even eliminates, the stress which would arise in the resistances, and in the connections of the resistance to the support, when the flexible plane support is folded to obtain the three-dimensional support, and that would remain also in the three-dimensional support once formed, thus reducing the strength and the useful life of the antenna unit.

In an embodiment that is advantageous for a portable instrument, the three-dimensional shell support body has an overall size set between 3 and 5 cm, in particular this overall size is about 4 cm.

In particular the three-dimensional shell support body comprises a conical surface that has a height and/or a base radius that has a length set between 3 cm and 5 cm, in particular a length of about 4 cm.

In a particular exemplary embodiment, the conical surface is the surface of a cone that has a height substantially equal to the base radius of the cone same, such that the conical surface has an aperture angle close to a right angle.

In particular the dipole elements are arranged with an own central point crossing a respective reference radial line intermediate between the two portions of radial borders, wherein each reference radial line of the initial circular sector is arranged at an angular distance from at least one other of such reference radial lines of about one-third of the central angle of the sector. In the above case, in which the base radius of the cone is substantially long as the height of the conical surface, the angular distance of at least two couples of radial lines is about 84,85°.

For instance, two of these radial lines may be at a distance from each other of an angle close to one sixth of the angle comprised between respective next rectilinear sides, i.e., respective next cut radial borders, of the circular sector or of the circular crown sector. In the above case, in which the base radius is substantially long as the height of the conical surface, these radial lines may be at an angular distance from the respective next sides or next cut radial borders of about 42,43°.

In an exemplary embodiment, the three antennas meet these radial lines substantially at a same distance from the vertex of the cone, in particular this distance is one half of the radial lines.

In particular, the three antennas have a development that is substantially long as the height of the cone or the cone frustum.

For example, starting from the circular-sector-shaped board that forms the development of the cone, each of the three dipole elements forms an inclination angle of 45° with the respective reference radial line of the circular sector, therefore the three dipole elements form at least one couple of mutually orthogonal antennas in the plane of the circular sector.

In an exemplary embodiment, the flexible support comprises a polygon consisting of at least three polygons, each two of them having a common edge, and the three-dimensional support comprises at least three faces of a polyhedron. In particular, the polygon may comprise three isosceles triangles and the polyhedron is a triangular pyramid. In particular, the polygon may comprise three rectangles and the polyhedron is a portion of a parallelepiped comprising three sides of the parallelepiped that are two-by-two orthogonal to each other.

In particular, a rigid box is provided that contains, supports and protects said three-dimensional shell support body, in particular said rigid box follows the shape of said three-dimensional shell support body, for example a conical shape, a frustum-conical shape, a frustum-pyramidal shape, a parallelepiped shape, etc., thus reducing the shape and the size of the device to a minimum value.

Advantageously, the plurality of collection terminals comprises two collection terminals, and the resistance connection means comprises a plurality of sequences of connection resistances arranged in series with respect to each dipole detection unit and with respect to the two collection terminals, so that an overall voltage electric signal is formed, i.e., the overall signal, is formed and delivered to said processor, said overall voltage electric signal substantially equal to the sum of the electric detection signals and, accordingly, to the square root of the intensity of the electric component of the detected electromagnetic field. In this case, the substantially isotropic antenna unit delivers an overall electric signal at the collection terminals that is obtained as a combination of the electric detection signals produced by each dipole detection unit when at least one of them is in an electromagnetic field, and that is responsive of the intensity of the electric component of the detected electromagnetic field.

In an exemplary embodiment in which a conical or frustum-conical three-dimensional shell support body is provided, the two collection terminals are arranged adjacent to each other in an intermediate portion, in particular in a central portion of the curvilinear side, at a predetermined distance from each other. The positions of the two collection terminals may correspond to two central positions of the curvilinear side. This way, the distance between the two collection terminals keeps substantially unchanged once the two collection terminals have been arranged on the two-dimensional flexible support element before the latter is deformed, i.e. this distance is substantially unaffected by how the two-dimensional flexible support element is folded to form the conical surface of the three-dimensional shell support body. This enhances dimensional stability of this distance.

In an alternative exemplary embodiment, the two collection terminals are positioned at opposite ends of the curvilinear side of the two-dimensional flexible support element before the latter is deformed, proximate to the points where they meet the respective cut rectilinear radius of the flexible circular crown shaped two-dimensional support element.

In alternative, the connection between the dipole detection units and the processor unit is a parallel connection. In other words, for each of the dipole detection units, the plurality of collection terminals comprises a couple of collection terminals, and the resistance connection means comprises a couple of sequences of connection resistances, each located close to a collection terminal of the couple of collection terminals, so that the electric detection signals are directly delivered to the processor unit, and the processor unit comprises a signal combination means for combining means the electric detection signals of the dipole detection units to generate the overall signal.

Preferably, the collection terminals are arranged in respective positions of a line contour of the three-dimensional shell support body, in particular in respective positions of the base circumference of the conical surface.

The overall electric signal can be obtained as the square root of the sum of the square values of the respective electric detection signals. In alternative, but without excluding further possibilities, the overall electric signal can be obtained as the sum of the respective electric detection signals, taken in absolute value.

In an advantageous exemplary embodiment, the processor unit is arranged on an appendix portion of the two-dimensional flexible support element and of the three-dimensional shell support body, said appendix portion located at a predetermined separation distance from each dipole element. In particular, this separation distance is set between 10 mm and 400 mm.

Preferably, the portion of the two-dimensional flexible support element maintains a planar shape in the three-dimensional support. Advantageously, the portion of the two-dimensional flexible support element is an appendix portion connected to an antenna portion of the support element. This way, a same printed circuit comprises both the antenna unit and the processor unit, i.e. the electronic for processing the overall electric signal or the electric detection signals. This provides a small size device that enhances the portability and in any case without discomfort. The peripheral position of the appendix portion, with respect to the portion of antenna of the three-dimensional shell support body, makes it possible to locate the dipole elements at a distance from the electronic to electromagnetically separate them, i.e. to reduce mutual interferences.

In an exemplary embodiment, the device comprises a linearization means comprising a plurality of impedances selected in such a way that the overall electric signal, which is created when an electric field of a determined intensity is detected, has a value comprised within a same range, i.e. a same unreliability range, substantially for any frequency value comprised in the working frequency range of the device. This way, a same response, i.e. a same overall electric signal can be obtained, apart from the measurement tolerances.

The device advantageously comprises a calibration means for carrying out a calibration among a plurality of values of electric component intensity, that can be detected by the device, and a plurality of values of an electric output signal obtained by the overall electric signal, so that the intensity of the electric component can be represented with an unambiguous value of the electric output signal. The calibration means may comprise a processor means unit adapted to generate a correspondence between values of intensity of field and values of the electric output signal, and/or they may comprise an amplification means and/or an overall signal compression means, in particular configured for amplifying and/or for compressing the overall signal according to said correspondence.

Advantageously, the interface means comprises an indication means for indicating the intensity of the electric component of the electromagnetic field, said means configured for signalling whether a predetermined threshold value of the intensity of the electric component of the electromagnetic field is exceeded, wherein the indication means is triggered/switched off by the processor unit according to the overall electric signal, i.e. by the electric output signal after calibration. For instance, the indication means may be an optical means, in particular a LED means, suitably visibly arranged on the outer surface of the container of the device.

Advantageously, an optical indication means is provided that is configured for signalling that a plurality of predetermined threshold values of the intensity of the electric component of the electromagnetic field is exceeded.

In alternative, or in addition to the optical means, the device can comprise an acoustic indication means, in particular adapted to generate different tones that can be distinguished from each other according to values of the intensity of the detected electromagnetic field.

In alternative, or in addition to the optical and/or acoustic indication means, the device may comprise a vibration means, in particular configured for generating an adjustable vibration of the device responsive to the value of the intensity of the detected electromagnetic field.

This allows directly and practically perceiving the severity of radio frequency electromagnetic fields, i.e. of the radio frequency electromagnetic fields pollution in any detection space.

In particular the threshold value or values is/are selected among 6 V/m and 20 V/m. The value of 6 V/m corresponds in Italy to a law limit value, to which people must not be exposed for a more than 4 consecutive hours. Value of 20 V/m is also an absolute law limit, beyond which people must not be exposed at all.

Said value or the threshold values may also be selected among 1 V/m and 3 V/m. The threshold value of 1 V/m is a practical exposition limit long that is normally taken into consideration when designing plants and/or dwellings. The threshold value of 3 V/m it is another reference value of the intensity, which is under consideration in the frame of some possible new safety Regulations.

Preferably, the device comprises a memory means for recording instant values of the overall signal, i.e. values of the intensity of the electric component. In particular, the interface means is arranged to connect the memory means with a readout means and/or with an external processor means for reading and/or for processing this at least one instantaneous and/or recorded intensity value of the electric component, for example by a personal computer, in particular in the form of a time trend of the intensity of the electric component in one or more predetermined detection periods of time. This allows using the device, basically conceived for an instantaneous reading of the intensity, even for processing the instantaneous values, in order to obtain parameters useful for assessing whether a radio frequency electromagnetic field may be present at a given time in a given detection space, for example the parameters prescribed by current health regulations.

The above mentioned objects are also reached by a method for manufacturing a device for detecting an electromagnetic field, by detecting the intensity of the electric component of this electromagnetic field, the comprising the steps of:

- prearranging a two-dimensional flexible support element;
- arranging three dipole detection units at predetermined positions of the two-dimensional flexible support element, each dipole detection unit comprising a dipole element and configured to provide a respective electric detection signal in response to the electric component;
- arranging a plurality of connection resistances on the two-dimensional

flexible support element;

- bending the two-dimensional flexible support element, along with the three dipole detection units and the connection resistances arranged upon it, into a three-dimensional shell support body, thus obtaining a three dipoles antenna comprising the detection unit and the connection resistances arranged on the three-dimensional shell support body,

wherein the arrangement of three detection units on the two-dimensional flexible support element is carried out in such a way that the dipole elements which are arranged on the three-dimensional shell support body along respective directions of three lines substantially orthogonal to one another;

- connecting the detection units through the connection resistances, with:
  - a combination means for combining means the detection signals provided by the dipole detection units, in order to form an overall signal according to the intensity of the electric component;
  - a processor unit configured for receiving the detection signals and/or the overall signal, the processor unit comprising an interface means to provide a representation of the overall signal.

In an exemplary embodiment, the two-dimensional flexible support element, in an own planar conformation, has the shape of a circular sector or preferably of circular crown sector, and said step of deformation changes said two-dimensional support element into a conical or frustum-conical shell support body, respectively.

Preferably, the two-dimensional flexible support element comprises an appendix portion that remains substantially in a planar conformation during the step of deformation, and steps of arranging the combination means and/or the processor unit on said appendix portion of said two-dimensional flexible support element are carried out preferably before said step of deformation.

Brief description of the drawings

The invention will be now shown with the following description of an exemplary embodiment thereof, exemplifying but not limitative, with reference to the attached drawings in which:

- Fig. 1 is a perspective diagrammatical view of a substantially isotropic antenna unit of a device according to an exemplary embodiment of the invention, comprising a three-dimensional conical support;

- Fig. 2 is a diagrammatical top plan view of a flexible plane support, showing dipole elements of the detection unit of the substantially isotropic antenna unit, to obtain the antenna unit of Fig. 1;
- Figs. 3-5 are diagrammatical perspective views of the flexible planar support of Fig. 2 in three subsequent deformation steps, to obtain the three-dimensional support of Fig. 1;
- Fig. 6 diagrammatically shows a dipole detection unit used to provide a substantially isotropic antenna according to an exemplary embodiment of the invention;
- Fig. 7 is a perspective diagrammatical view of a substantially isotropic antenna unit of a device according to another exemplary embodiment of the invention, comprising a three-dimensional support that has a frustum-conical shape;
- Fig. 8 is a diagrammatical top plan view of a flexible plane support, showing the dipole units of the substantially isotropic antenna unit, to obtain the antenna unit of Fig. 7;
- Figs. 9 and 10 are diagrammatical top plan views of two substantially isotropic antennas according to two exemplary embodiments of the invention;
- Fig. 11 is a diagrammatical circuit of a substantially isotropic antenna according to an exemplary embodiment of the invention, with the three dipole units connected in series;
- Fig. 12 is a perspective diagrammatical view of a substantially isotropic antenna unit comprising a three-dimensional support that has the shape of a frustum of cone, and is provided with an appendix portion for the acquisition electronic of the antenna unit;
- Fig. 13 is a diagrammatical top plan view of a flexible plane support, showing the dipole units of the substantially isotropic antenna unit, to obtain the antenna unit of Fig. 12;
- Fig. 14 is a more detailed top plan view of an embodiment of the flexible planar support of Fig. 13;
- Fig. 15 is a perspective view of a device according to an exemplary embodiment of the invention;

- Fig. 16 is a diagrammatical circuit of the calibration means according to an exemplary embodiment of the invention;
- Fig. 17 is a perspective diagrammatical view of a substantially isotropic antenna unit of a device according to an exemplary embodiment of the invention, comprising a three-dimensional support that has the shape of a pyramid and that is provided with an appendix portion for the acquisition electronic of the antenna unit;
- Fig. 18 is a diagrammatical top plan view of a flexible plane support, showing the dipole units of the substantially isotropic antenna unit, to obtain the antenna unit of Fig. 17;
- Fig. 19 is a perspective diagrammatical view of a substantially isotropic antenna unit of a device according to an exemplary embodiment of the invention, where a three-dimensional support is provided comprising two faces of a parallelepiped, in particular of a cube;
- Fig. 20 is a diagrammatical top plan view of a flexible plane support, showing the dipole units of the substantially isotropic antenna unit to obtain the antenna unit of Fig. 19.

Description of a preferred exemplary embodiment.

With reference to Figs. 1-5, a substantially isotropic antenna unit 12 is described of a device for detecting a radio frequency electromagnetic field by detecting the intensity of the electric component associated to the electromagnetic field, according to an exemplary embodiment of the invention.

Antenna unit 12 comprises three dipole detection units 11, shown more in detail in Fig. 6, that comprise respective dipole elements 9, which are mounted, i.e. stuck on the surface of a three-dimensional shell support body 20. In the exemplary embodiment of Fig. 1, support body 20 comprises a surface that as a conical shape, in particular a cone shape.

Support body 20 is obtained starting from a two-dimensional support element 10 (Fig. 2). Two-dimensional support element 10 may have the structure of an electronic flexible board, on which dipole elements 9 of detection units 11 can be printed according to a technique conventional.

For example, the electronic flexible board can be made of an epoxy resin, in particular a resin FR-4. The base resin is an insulating material, in its final shape the circuit is coated with conductive sheets, which are typically made of copper. Connection paths may be obtained by a conventional process, for example by a UV-cut process.

Dipole detection units 11 can be of a known type. As shown in Fig. 6, dipole element 9 of dipole detection units 11 comprises two conductive elements 13 that extend aligned and opposite to each other. Each conductive element 13 can also be a track obtained by a print process on support or flexible board 10 (Fig. 2), of length set between 4 and 5 mm. Dipole detection units 11 also comprises typically in the central intermediate position between the two conductive elements 13, a detection diode 61, for example a Schottky diode 61 and, in parallel to the detection diode, a capacitive element and two resistances 14, for example a condenser 62. In an exemplary embodiment, Schottky diode 61 can be a diode BAT62, or other equivalent or upper selected from the group consisting of: SMS2850, HSMS2860, HSMS8101, BAT62. In an exemplary embodiment, resistance 14 may be a resistance of 10 kΩ, and condenser 62 can be a condenser of 1 nF. As shown in Fig. 11, each dipole detection unit 11 may also comprise a couple of end resistances 31, for example in this case resistances of 10 kΩ, through which is drawn a detection signal produced by dipole detection units 11 when the latter is exposed to an electric field whose intensity is higher than a minimum detectable value.

Sill with reference to Fig. 1, the three dipole units are arranged on three-dimensional support 20 with its respective dipole elements 9 arranged orthogonal a with respect to other. This way, it is obtained an antenna unit 12 substantially isotropic.

More in detail, dipole elements 9 follow the profile of three-dimensional support 20, in particular follow the curvature of conical surface 20. In Fig. 1 dipole elements 9 are shown as arcs arranged on conical surface 20. Dipole elements 9 are tangent, in the respective median points, to lines 16,16',16" substantially orthogonal to one another. In other words, the lines 16,16',16" are two-by-two substantially orthogonal. Even more in detail, as shown in Fig. 1', three lines 16,16',16" lines tangent to three respective dipole elements 9 in their respective middle points are parallel to three lines 26,26',26", respectively, which form substantially right angles π with one another.

As described above, and as shown in Figs. 2-5, this configuration is obtained, according to the invention, by arranging three dipole detection units 11 with three dipole elements 9 in predetermined zones of two-dimensional flexible support element 10, at a predetermined mutual orientation, and then bending the two-dimensional flexible support element in space until three-dimensional shell support body 20 is formed, so that three dipole elements 9 are arranged at a right angle in the space with respect to one another, as described above. In particular, Fig. 2 relates to an initial planar conformation of two-dimensional flexible support element 10, which, in this case, has the shape of a circular sector.

More in detail, flexible support 10, in its planar conformation, is defined by a perimeter that comprises a curvilinear side 18, which is an arc of circumference of amplitude defined by a central angle ω, and by two rectilinear sides 19 that coincide with two radial borders of the circumference, also indicated as cut radial borders 19. To obtain antenna unit 12 starting from the printed circuit comprising flexible support 10, flexible support 10 is deformed as shown in Figs. 3-5. Rectilinear sides 19 are progressively approached until they are arranged adjacent to each other. In particular, rectilinear sides 19 are put on each other, and may be connected to each other by conventional connection means, for example by adhesive connection means or mechanical connection means. This way, a conical surface is obtained, in particular, a continuous or closed conical surface, which form three-dimensional shell support body 20.

In an advantageous exemplary embodiment, the overall or external size 24,27, in particular the height H and the base radius R of conical support body 20',20' are advantageously set the height H between 3 and 5 cm, in particular are about 4 cm.

Fig. 7 shows an antenna unit 12 in which three dipole elements 9 are arranged on a three-dimensional support 20' that has the shape of a surface of a cone frustum. Three-dimensional support 20' differs from three-dimensional support 20 of Fig. 1 in that a high curvature top portion of the conical surface is absent. Antenna unit 12, according to an exemplary embodiment of Fig. 7, may be obtained starting from a flexible support 10' that has the shape of a circular crown sector, as shown in Fig. 8, which differs from flexible support 10 of Fig. 2 in that the perimeter also comprises an arc 23 of an inner circumference concentric to the outer circumference comprising arc 18. The process for obtaining antenna unit 12 comprising support 20' is similar to the one that is shown in Figs. 3-5, therefore it will not be shown. Support body 20' is advantageous since it does not comprise portions that are excessively deformed when two-dimensional flexible support 10' is deformed, as it happens near the vertex of the cone, beyond the limits that many printed circuits materials can tolerate without breaking.

Sill with reference to Figs. 2 and 6, radius R of the base circumference 27 and/or height 24 of cone 20 advantageously have respective lengths H,R set between 2 and 6 cm, in particular set between 4 and 5 cm, more in particular, such respective lengths are about 4 cm.

In a particular exemplary embodiment, length R of the radius of base circumference 27 is substantially the same as length H of height 24 of cone 20. This way, cone 20 has an aperture angle α close to a right angle. This can be obtained using a circular sector shaped support as the two-dimensional initial flexible support element 10, which extends for a central angle ω close to $360°/\sqrt{2}$, i.e. close to 254,56°, and whose radius 19 has a length R' that has preferably about the same length H of height 24 multiplied by an approximating value of the square root of 2.

In order to obtaining an orientation of three dipole elements 9 on support 20,20' according to three lines two-by-two substantially orthogonal, each three dipole elements 9 can be arranged at form a predetermined inclination angle β with a respective radius 17 of the circular sector. Inclination angle β depends upon the angular distance δ between consecutive radial borders 17, which are transformed into respective generatrices 15 of conical or frustum-conical shell support body 20,20', by bending two-dimensional flexible support 10,10'.

In the case of a shell support body 20 or of a frustum-conical shell support body 20' whose height 24 is substantially equal to base radius 27 (H=R), the mutually orthogonal orientation of three dipole elements 9 may be achieved by arranging three dipole elements 9 on two-dimensional flexible support 10 with an inclination angle β of about 45° with respect to radial borders 17, which are arranged at a mutual angular distance δ equal to one third of central angle ω, i.e. at an angular distance δ of about 84,85°. Each radius 17 can be selected at an angle γ of about one sixth of central angle ω from a respective cut radius 19.

On three-dimensional support 20,20', and then also on two-dimensional flexible support 10,10' before bending it, are also arranged collection terminal 29 for collecting the dipole electric signals or the overall signal of the antenna that the dipole detection units produce in the presence of an electromagnetic field whose electric component has an intensity higher than a minimum detectable value.

With reference to Figs. 9 and 10, two initial printed circuits 22' and 22" are described to provide respective substantially isotropic antennas of two devices according to the invention. Printed circuits 22' 22" comprise two-dimensional flexible support element 10' of Fig. 8, three dipole detection units 11 arranged, for instance, as shown in Fig. 8, a resistance connection means in which a plurality of connection lines, i.e. a plurality of sequences of connection resistances, comprises connection resistances 32,33, and a couple of terminals 29 for electrically connecting the substantially isotropic antenna 12 with an acquisition electronics of an electric signal produced by antenna 12. In both printed circuits 22' and 22", dipole detection units 11 are connected in series with respect to each other by a plurality of first connection resistances 32. The series of three dipole detection units 11 is connected to two collection terminals 29 through a plurality of second connection resistances 33. In other words, dipole detection units 11 are connected in series between collection terminals 29 through connection resistances 32,33.

This way, antenna unit 12 can interact with an electromagnetic field that is present in the environment to create an overall electric signal, regardless of the orientation of antenna unit 12 with respect to the electromagnetic field. In other words, with the mutually orthogonal arrangement of three dipole elements 9, resulting antenna unit 12, when arranged in an electromagnetic field whose electric component has an intensity higher than a detectable minimum value, can detect the electromagnetic field producing an electric signal, regardless of the orientation of the field. In particular, the electric signal may be a voltage electric signal that represents the intensity of the electric component of the field.

According to this arrangement, which is also shown in Fig. 11, an overall signal can be collected at terminals 29 which is a combination of the detection signals produced by single dipole detection units 11. In other words, connection resistances 32,33 provide a combination means for combining the detection signals. In this case, the overall electric signal is a voltage signal that is substantially equal to the sum of the electric detection signals, each of which is, in turn, proportional to the accordingly oriented component of the electric field. Therefore, the overall electric signal collected at collection terminals 29 is proportional to the square root of the intensity of the electric field associated to the detected electromagnetic field.

For example, connection resistances 32,33 may be 2kΩ resistance.

In printed circuit 22' of Fig. 9, two collection terminals 29 are arranged in an intermediate portion of curvilinear side 18 of two-dimensional flexible support element 10, in this case they are arranged in a central portion of curvilinear side 18, such that terminals 29, after the deformation, are substantially at a distance from each other and from the end of cut radial borders 19 in the frustum-conical shell support body 20' that is substantially the same distance at which they were before bending two-dimensional flexible support element 10.

Each of two sequences 34',34" of connection resistances 33 is located between a respective collection terminal 29 and the corresponding end of a dipole detection unit 11 along a respective path that is slightly stretched when two-dimensional flexible support element 10 is deformed. In particular, a first part of sequence 34' of connection resistances 33 is arranged proximate to a radius of two-dimensional flexible support element 10', in its planar conformation, which is deformed into a generatrix of the frustum of cone, without substantially being deformed, in other words it remains substantially rectilinear. The remainder of resistance sequence 34', and of resistance sequence 34" is advantageously arranged along cross sectional circumferences that are perpendicular to the axis of the conical surface and have a curvature lower than a predetermined curvature value, in particular is arranged proximate to boundary circumference 18 of two-dimensional flexible support element 10', which is slightly deformed when two-dimensional flexible support element 10' is deformed. This way, the zone near edge 18 receives a curvature that is compatible with the mechanical strength of resistances 33 and, in particular with the mechanical strength of the connections between resistances 33 and support 10'.

In printed circuit 22" of Fig. 10, two collection terminals 29 are arranged at respective opposite end portions of curvilinear side 18 of two-dimensional flexible support element 10, i.e. proximate to cut radial borders 19. Each of two sequences 35',35" of connection resistances 33 is located between a respective collection terminal 29 and the corresponding end of a dipole detection unit 11, along a respective path that is slightly or even not at all stretched, when two-dimensional flexible support element 10 is deformed. In particular, sequence 35' of connection resistances 33 is arranged along a radius of two-dimensional flexible support element 10'.

Terminals 29 may be connected to an acquisition electronics of the overall signal, for example they may be connected to a remote acquisition electronics, or they may be connected to a processor unit 44 that belongs to device 1 according to the invention. Figs. 12 and 13 respectively show an antenna unit 12 that comprises a three-dimensional support body 40, which can be obtained from a two-dimensional flexible support element 30 by a deformation process similar to the one that is shown in Figs. 3-5. Three-dimensional shell support body 40 comprises two-dimensional flexible support element 30 including an appendix portion 41 besides a shell frustum-conical portion 48 of the antenna and a circular sector shaped support portion 38 of the antenna. Appendix portion 41, in this case a rectangular portion, extends along an axis 42 that passes through the centre of support portion 38 of the antenna. It can be connected to support portion 38 of the antenna through a narrow connection portion 43. As shown in Fig. 12, appendix portion 41 is not substantially deformed, in particular it maintains its planar shape, when two-dimensional flexible support element 30 is deformed into three-dimensional shell support body 40.

As shown more in detail in Fig. 14, appendix portion 41 can house, on printed circuit 22 same of antenna unit 12, an electronics for acquiring and preferably also processing, displaying, and memorizing the overall signal produced by antenna unit 12. The electronics comprises a processor unit 44 that is configured for receiving the electric detection signals through collection terminals 29 and for generating an overall signal, which is responsive to the detected electromagnetic field. Fig. 14 also shows, an advantageous arrangement of connection resistances 32 and 33, which are arranged in portions of two-dimensional flexible support 30 that are slightly deformed when two-dimensional flexible support element 30 is deformed into support body 40. A rechargeable battery, in particular a lithium polymers battery, may also be arranged on appendix portion 41.

With reference to Fig. 15, a device 1, according to the invention, is further described comprising a box 2 that has a substantially frustum-conical part 71 and a planar part 72 that may have a substantially rectangular cross section. A junction fitting 73 is also provided for fitting substantially frustum-conical part 71 with planar part 72. Box 2 may contain antenna unit 12 of Fig. 12, shown by a dashed line, wherein the support portion of antenna 48 and appendix portion 41 are housed within frustum-conical part 71 and in planar part 72, respectively.

This way, the acquisition electronics is arranged at a suitable separation distance from each dipole detection unit 11, in order to electromagnetically separate dipole detection units 11 and processor unit 44.

In device 1, an optical indication means 75 may be provided for indicating that a predetermined intensity threshold value of the electric component is exceeded. Optical indication means 75 is functionally connected with processor unit 44, which is configured for triggering/switching off indication means 75, according to a value of the overall electric signal. These means is visible from outside box 2 through a window 75' of box 2. For instance, indication means 75 may comprise a plurality of LEDs each of which is configured for signalling that a predetermined threshold value of the intensity of the electric component is exceeded. Typically, this value or these values of intensity of said electromagnetic field is/are selected among 1 V/m, 3 V/m, 6 V/m and 20 V/m.

Regardless of whether indication means 75 is provided or not, device 1 may comprise a memory unit, not shown, for memorizing instant values of the overall signal, which are detected in a detection session. Device 1 may also comprise an interface means 77 for connecting processor unit 44, in particular the memory unit, with a readout means and/or an external processor means. For example, interface means 77 may comprise a normal USB port, and is preferably arranged in a front surface 76 of planar part 72 of box 2. USB port 77 may also be used for recharging a battery, not shown, of device 1.

The device according to the invention advantageously comprises, a linearization means to obtain an electric detection signals, or an overall electric signal whose values are set within a predetermined range, regardless of the frequency of the detected electromagnetic field.

For instance, electric signals whose value differs from a reference value by less than 2-3 dB may be associated to electric fields that have a predetermined intensity, for each frequency value set between 100 kHz and 3 GHz. In this case, linearization means 50 may comprise impedances 14,62 that have the values indicated when describing Fig. 6, or other linearization means whose selection is obvious for a skilled person.

Processor unit 44 may also comprise a calibration means for calibrating an electric output signal of processor unit 44, which is obtained starting from the overall electric signal, with respect to a plurality of values of intensity of the electric component that can be detected by the device. The calibration means serves for representing the intensity of the electric component by an unambiguous value of the electric output signal. The calibration means can having the form of a circuit 60 of Fig. 16, which is well known to a skilled person, comprising a means for amplifying and/or compressing the overall signal according to a predetermined correspondence between values of the electric field and values of the electric voltage of the electric output signal.

For example, calibration circuit 60 may comprise resistances 54,55,57 of 47 kΩ, 1 MΩ, 47 kΩ, respectively, and capacities 53,56 of 2,2 nF and 100 pF respectively. By this selection of values, a gain is obtained of 212 dB for the lowest intensity values and of 10 dB for the highest intensity values of the electric component in a range of the electric component between 0,1 V/m and 50 V/m. More in general, a calibration means may be provided which allows a ratio lower than 100 between the above gain values, i.e. between the gain for the lowest intensity and the highest intensity of the electric component. This makes it possible to use a conventional analog-to-digital conversion means, such as a 12 bit ADC converter.

In an exemplary embodiment, not shown, dipole detection units 11 can be connected in parallel to each other, instead of in series. In this case, for each dipole detection unit 11, the plurality of collection terminals comprises a couple of collection terminals, and the resistance connection means comprises a couple of sequences of connection resistances, each located between a collection terminal of the couple of collection terminals, so that the electric detection signals are directly delivered to processor unit 44. In this case, the combination means for combining the detection signals into an overall signal that represents the intensity of the electric component are resident in processor unit 44. In particular, also in this case the combination means may be configured for forming an overall signal such as the square root of the sum of the square values of the respective electric detection signals, or such as the sum of said respective electric detection signals, taken in absolute value.

In an exemplary embodiment of the invention, the three-dimensional shell support body may have the shape of a polyhedron, for example a pyramid, a prism or in particular a parallelepiped.

In particular, in Fig. 17 a shell support body 80 for a substantially isotropic antenna is shown that has the shape of a pyramid, in this case a triangular pyramid. Pyramidal shell support body 80 may also be provided with an appendix portion 41 for an acquisition electronics for receiving the signals produced by the antenna, which is similar to what is shown in Figs. 12 and 14. The antenna comprising pyramidal shell support body 80 may be obtained starting from a two-dimensional planar flexible support element 70, as shown in Fig. 18, which in a planar conformation the shape of a polygon has defined by a perimeter of sides 78, 79, and in turn consisting of three triangles 76 which have two-by-two a common oblique edge 73. Polygonal flexible support element 70 may be deformed into pyramidal shell support body 80 of Fig. 17 in an obvious way. A dipole detection unit 11 is arranged on each triangle. The size of triangles 76, and the orientation of the respective dipole element on each triangle, are chosen in such a way that, after folding, the three dipole elements are arranged two-by-two orthogonal to each other.

In Fig. 19 a substantially isotropic antenna unit 12 is shown, which comprises a three-dimensional shell support body 80' in which three faces 86' of a parallelepiped, for example of a cube, are two-by-two orthogonal to each other. Parallelepiped shell support body 80' has an appendix portion for an acquisition electronics, not shown. Antenna unit 12, comprising parallelepiped shell support body 80', can be obtained by folding a polygonal flexible support element 70’ along its sides 73’ (Fig. 20), said support element defined by a perimeter having sides 78',79' and in turn consisting of three rectangles 76’, in particular three squares that are arranged to form a L-shape and that have two-by-two a common edge 73'. A dipole element 9 of a detection unit 11 is arranged on each rectangle. The orientation of each dipole element 9 on respective rectangle 73’ is selected in such a way that, after folding, three dipole elements 9 are arranged two-by-two orthogonal to each other. In the shown case, three dipole elements 9 of antenna unit 12 are parallel to three sides 83’,83”,83”’ that meet in a vertex of parallelepiped 80’, and that have therefore the direction of three lines 26,26’,26” orthogonal to each other.

The foregoing of description exemplary specific embodiments will so fully reveal the invention according to the conceptual point of view, so that others, by applying current knowledge, will be able to modify and/or adapt in various applications such exemplary embodiments without further research and without parting from the invention, and, accordingly, it is meant that such adaptations and modifications will have to be considered as equivalent to an exemplary embodiments exemplified. The means and the materials to realise the different functions described herein could have a different nature without, for this reason, departing from the field of the invention. It is to be understood that the phraseology or terminology that is employed herein is for the purpose of description and not of limitation.

CLAIMS

1. A device for detecting a pollution due to an electromagnetic field by detecting the intensity of an electric component of said electromagnetic field, said device comprising:

- a three-dipoles antenna unit (12) comprising:
  - three dipole detection units (11), comprising respective dipole elements (9) configured to provide respective electric detection signals in response to said electric component;
  - a support element (10,10',30,70,70') on which said dipole detection units (11) are mounted;
  - a plurality of collection terminals (29) for said electric detection signals;
  - a resistance connection means (32,33) for connecting each dipole detection unit (11) with said collection terminals (29);
- a processor unit (44) configured for receiving said electric detection signals through said collection terminals (29) and for generating an overall signal, which is responsive to said electromagnetic field;
- an interface means (75,77) for delivering said overall signal,

characterised in that said support element is a two-dimensional flexible support element (10,10',30,70,70') configured for being deformed into a three-dimensional shell support body (20,40,80,80'), **and in that** said dipole elements (9) are arranged on said two-dimensional flexible support element in such a way that, when said support element is deformed into said three-dimensional shell support body (20,40,80,80'), said dipole elements (9) extend along respective directions of three lines (26,26',26") that are substantially orthogonal to one another.

2. A device according to claim 1, wherein said two-dimensional flexible support element (10,10',30) has a perimeter that comprises an arc (18) of a circumference and two portions (19) of respective radial borders of said circumference defining a predetermined central angle (ω), and said three-dimensional shell support body (20,20',40), which is obtained from said two-dimensional flexible support element (10,10',30), comprises a conical surface in which said portions (19) of radial borders are adjacent to each other, in particular said portions (19) of radial borders are connected to each other.

3. A device according to claim 1, wherein a rigid box (2) is provided that contains, supports and protects said three-dimensional shell support body (20,40,80,80'), in particular said rigid box follows the shape of said three-dimensional shell support body.

4. A device according to claim 2, wherein said circumference is an outer circumference, and said perimeter of said two-dimensional flexible support element (10',30) comprises an arc (23) of an inner circumference that is substantially concentric to said outer circumference and has a diameter smaller than the diameter of said outer circumference, said arc (23) of said inner circumference defined between said radial borders of said outer circumference, and said three-dimensional shell support body (20',40) has a frustum-conical shape.

5. A device according to claim 1, wherein said resistance connection means comprises sequences (32,33) of resistances that are arranged on said three-dimensional shell support body (20,20',40) along a path consisting of points where said three-dimensional shell support body (20,40) has a curvature shorter than a predetermined curvature value.

6. A device according to claims 2 and 5, wherein said path is selected from the group consisting of:

- a path arranged substantially along a generatrix (15) of said conical surface;
- a path arranged along a circumference laying in a plane that is orthogonal to the axis of said conical surface;
- a combination of said paths.

7. A device according to claim 1, wherein said three-dimensional shell support body (20,40,80,80') has an overall size (24,27) set between 3 and 5 cm, in particular said overall size (24,27) is about 4 cm.

8. A device according to claim 1, wherein said three-dimensional shell support body (20,20',40) comprises a conical surface that has a height

(24) and/or a base radius (27) that has a length (H,R) set between 3 cm and 5 cm, in particular a length (H,R) of about 4 cm,

9. A device according to claim 1, wherein said conical surface has a height (24) substantially equal to the base radius (27), such that said conical surface has an aperture angle (α) close to a right angle.

10. A device according to claim 2, wherein said dipole elements (9) are arranged with an own central point at a respective reference radial line (17) intermediate between said two portions (19) of radial borders, wherein each reference radial line (17) is arranged at an angular distance (δ) from at least one other reference radial line (17) of about one-third of said central angle (ω) of said two-dimensional flexible support element (10,10',30).

11. A device according to claim 10, wherein each of said dipole elements (9) forms an inclination angle (β) of about 45° with said respective reference radial line (17), so that at least one couple of mutually orthogonal dipole elements (9) is formed on said two-dimensional flexible support element (10,10',30).

12. A device according to claim 1, wherein said two-dimensional flexible support element (70,70') comprises a polygon consisting of at least three polygons, each two of them having a common edge (73,73'), and said three-dimensional shell support body (80,80') comprises at least three faces of a polyhedron, in particular of a pyramid (80) or of a parallelepiped (80').

13. A device (1) according to claim 1, wherein

- said plurality of collection terminals comprises two collection terminals (29), and
- said resistance connection means (32,33) comprises a plurality of sequences of connection resistances (32,33) that are arranged in series with respect to each of said dipole detection units (11) and with respect to said two collection terminals (29),

so that an overall voltage electric signal is formed and delivered to said processor unit (44), said overall voltage electric signal substantially equal to the sum of said electric detection signals and, accordingly, to the square root of said intensity of said electric component.

14. A device (1) according to claim 1 wherein, for each of said dipole detection units (11):

- said plurality of collection terminals comprises a couple of collection terminals;
- said resistance connection means comprises a couple of sequences of connection resistances, each located between a collection terminal of the couple of collection terminals, so that said electric detection signals are directly provided to said processor unit (44), and

said processor unit (44) comprises a signal combination means for combining means said electric detection signals of said dipole detection units (11) to generate said overall signal.

15. A device (1) according to claim 1, wherein said processor unit (44) is arranged on an appendix portion (41) of said two-dimensional flexible support element (30) and of said three-dimensional shell support body (40) at a predetermined separation distance from each of said dipole detection units (11), in particular at a separation distance set between 10 and 400 mm.

16. A device (1) according to claim 15, wherein said appendix portion (41) of said two-dimensional flexible support element (30) maintains an own planar shape in said three-dimensional shell support body (40).

17. A device (1) according to claim 1, wherein said interface means comprises an indication means for indicating said intensity of said electric component, configured for indicating whether at least one intensity predetermined value is exceeded, and for being triggered/switched off by said processor unit (44) according to said overall electric signal,

wherein said indication means is selected from the group consisting of: an indicating optical means (75), indicating acoustic means, indicating vibration means, in particular, said at least one intensity value of said electric component is/are selected from the group consisting of: 1 V/m, 3 V/m, 6 V/m and 20 V/m.

18. A device (1) according to claim 1, wherein said device comprises an electric component intensity value memory means, and said connection means (77) is arranged to connect said memory means with data reading and/or processor external means for reading and/or for processing said at least one intensity value.

Fig. 1

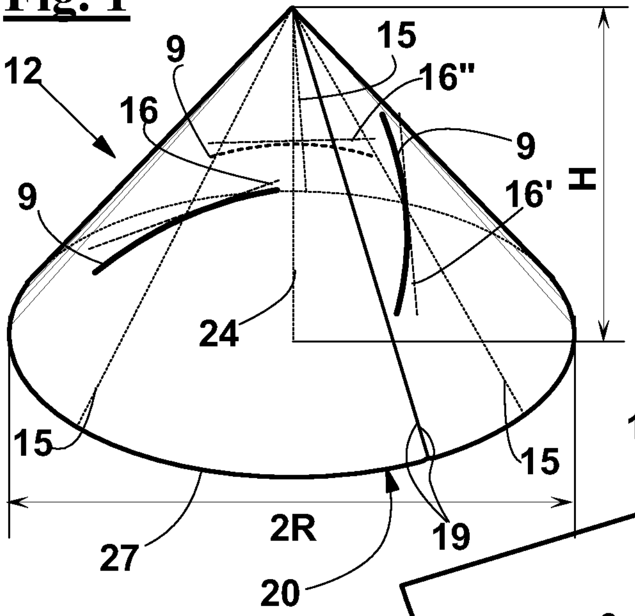


Fig. 2

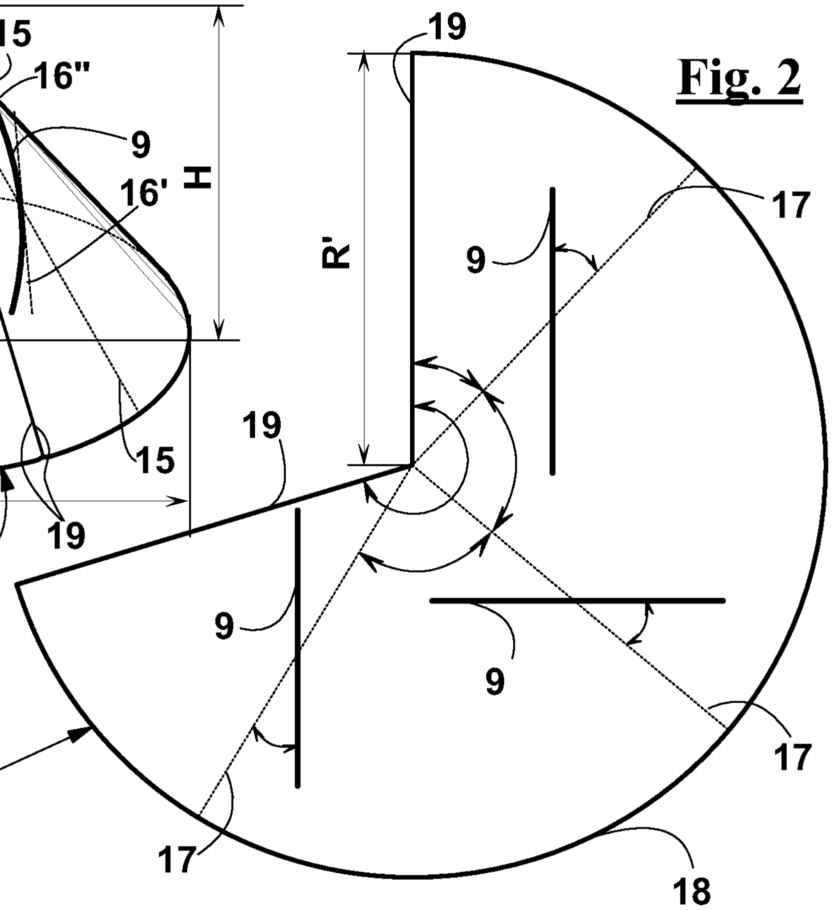


Fig. 1'

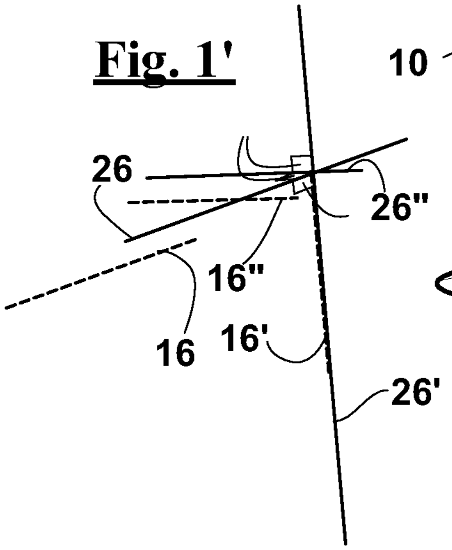


Fig. 3

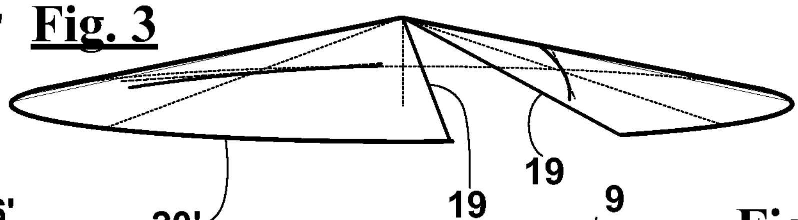


Fig. 4

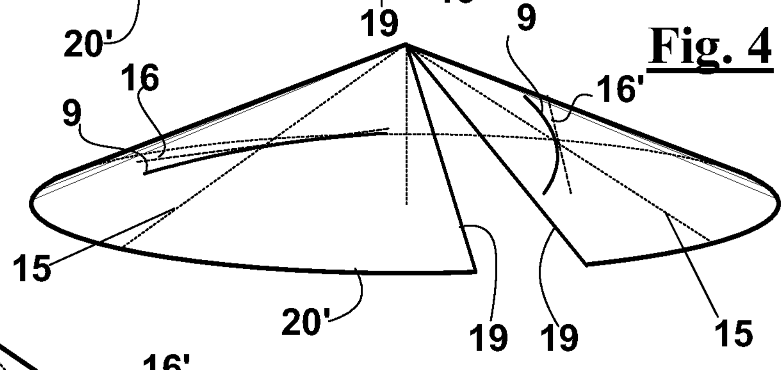
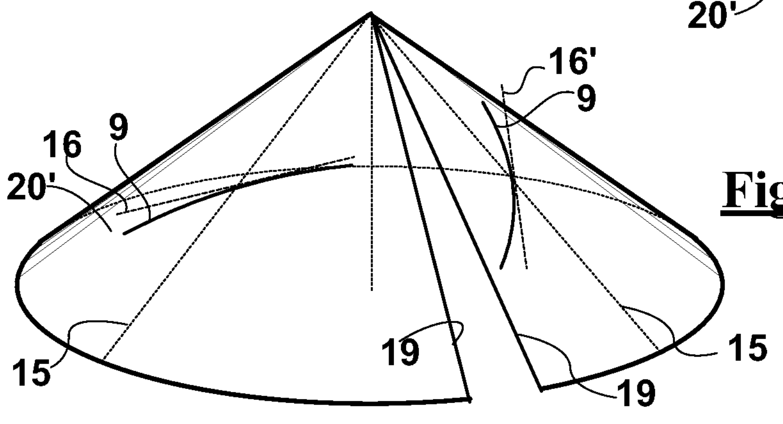


Fig. 5



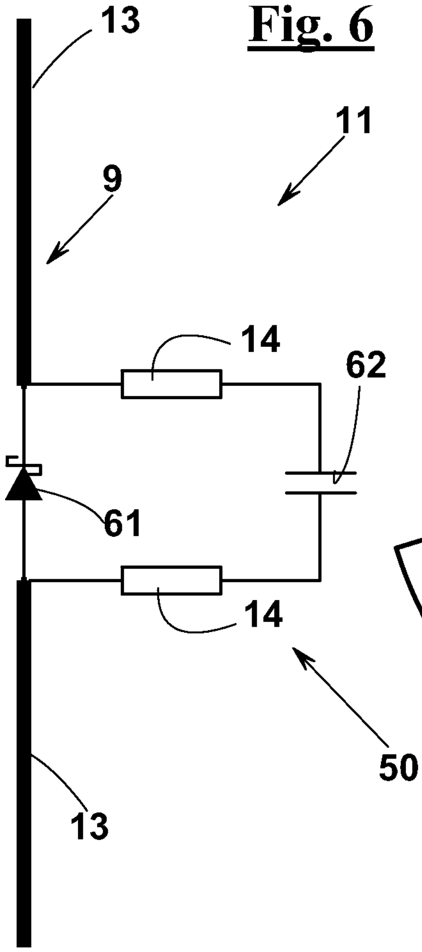


Fig. 6

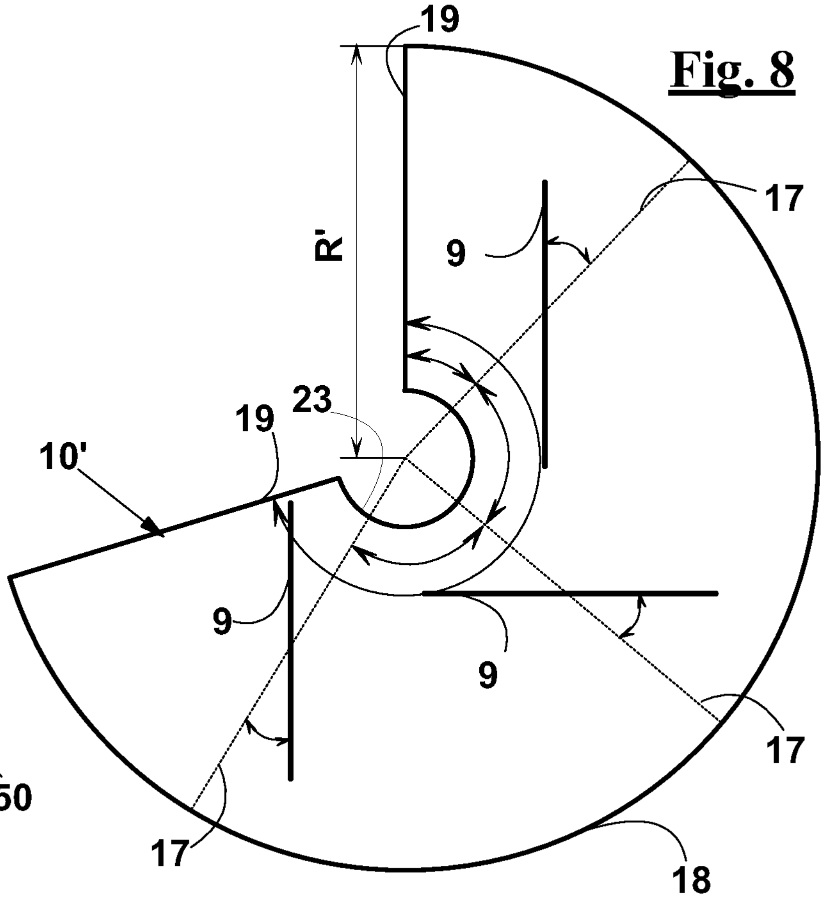


Fig. 8

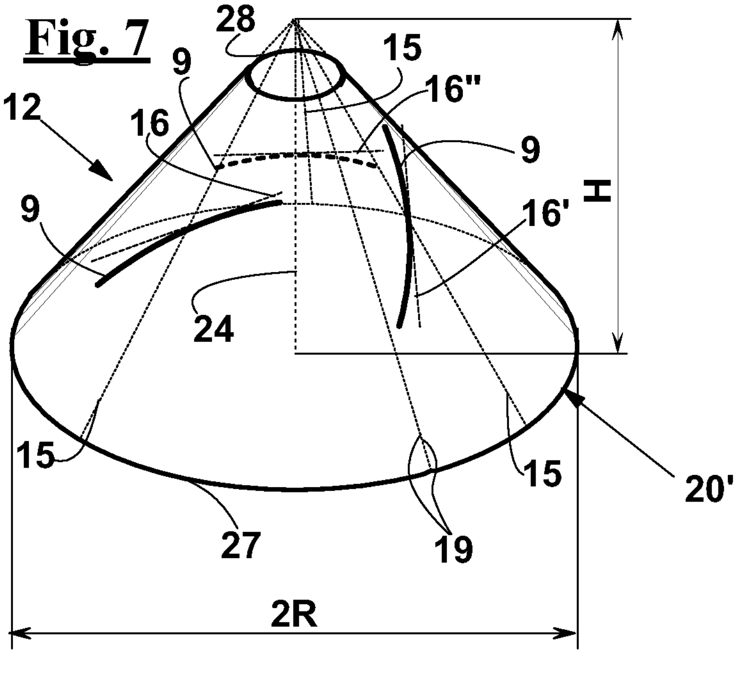


Fig. 7

Fig. 9

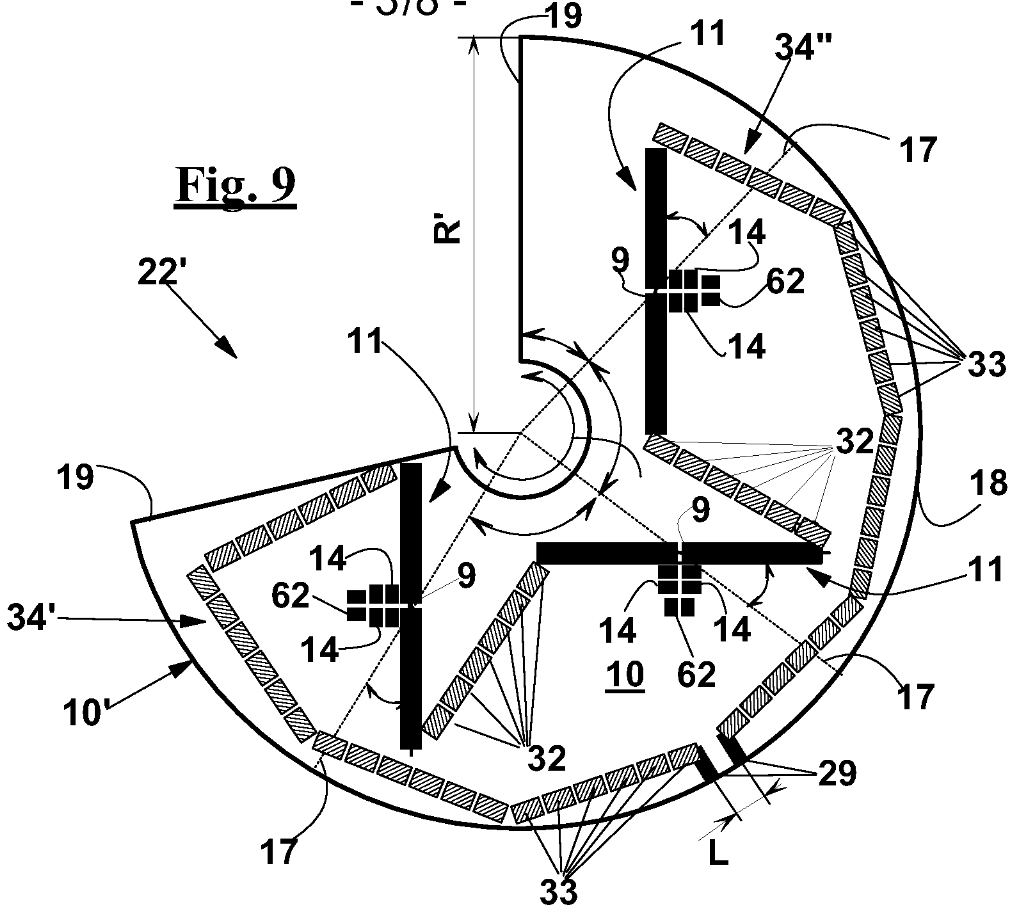

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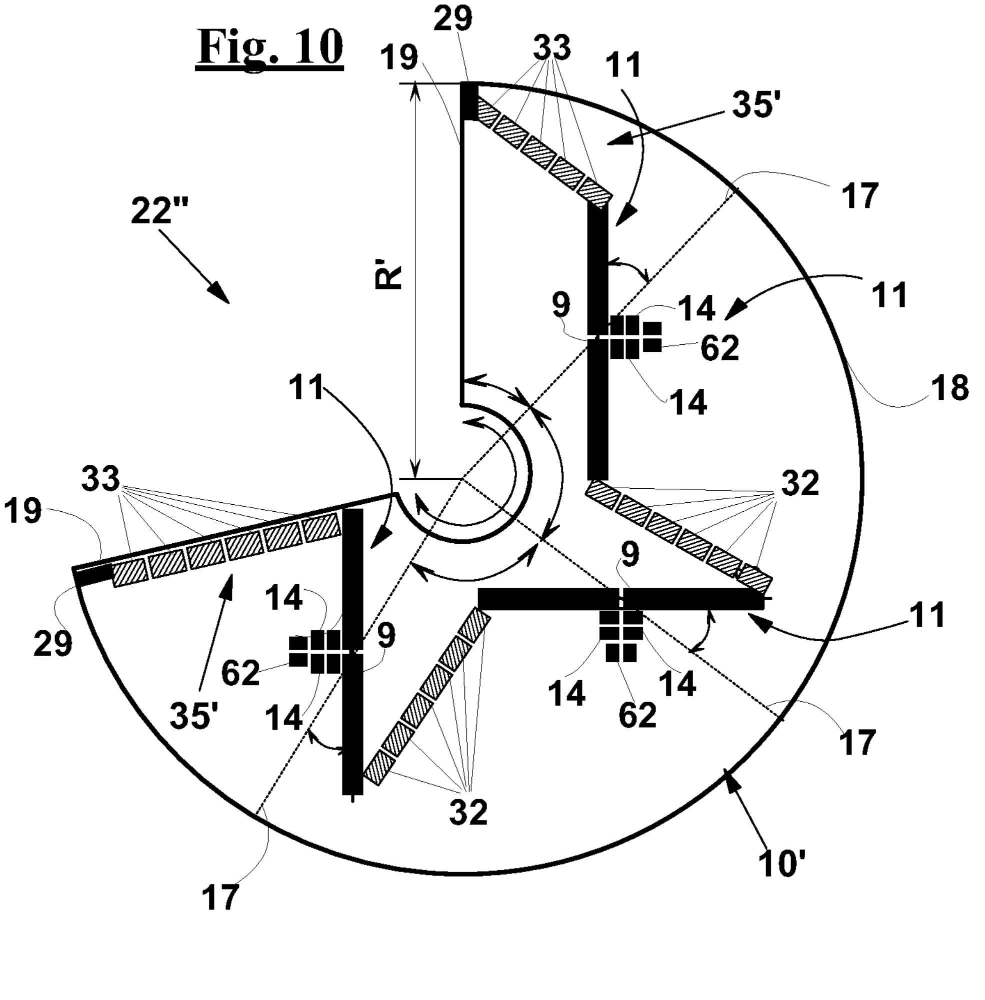
Fig. 10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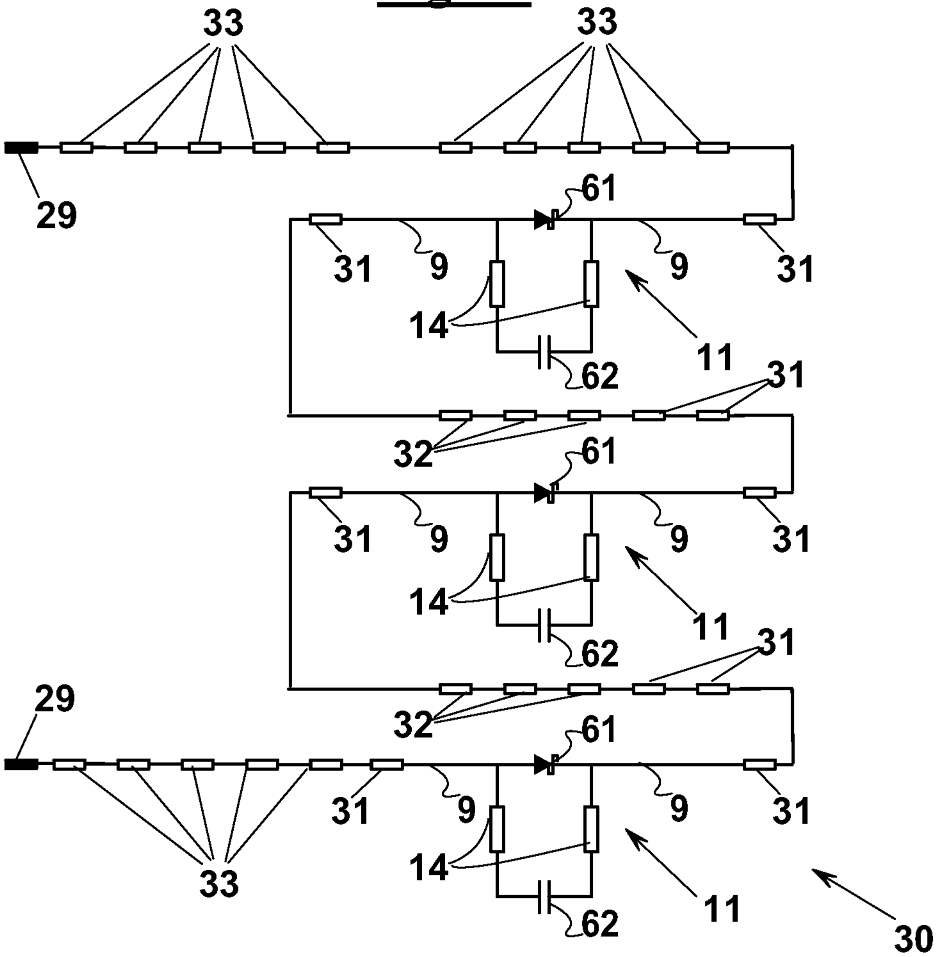
17

Fig. 11


33
33
29
61
31
9
9
31
14
11
62
31
32
61
31
9
9
31
14
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62
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61
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9
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31
33
14
11
62
30

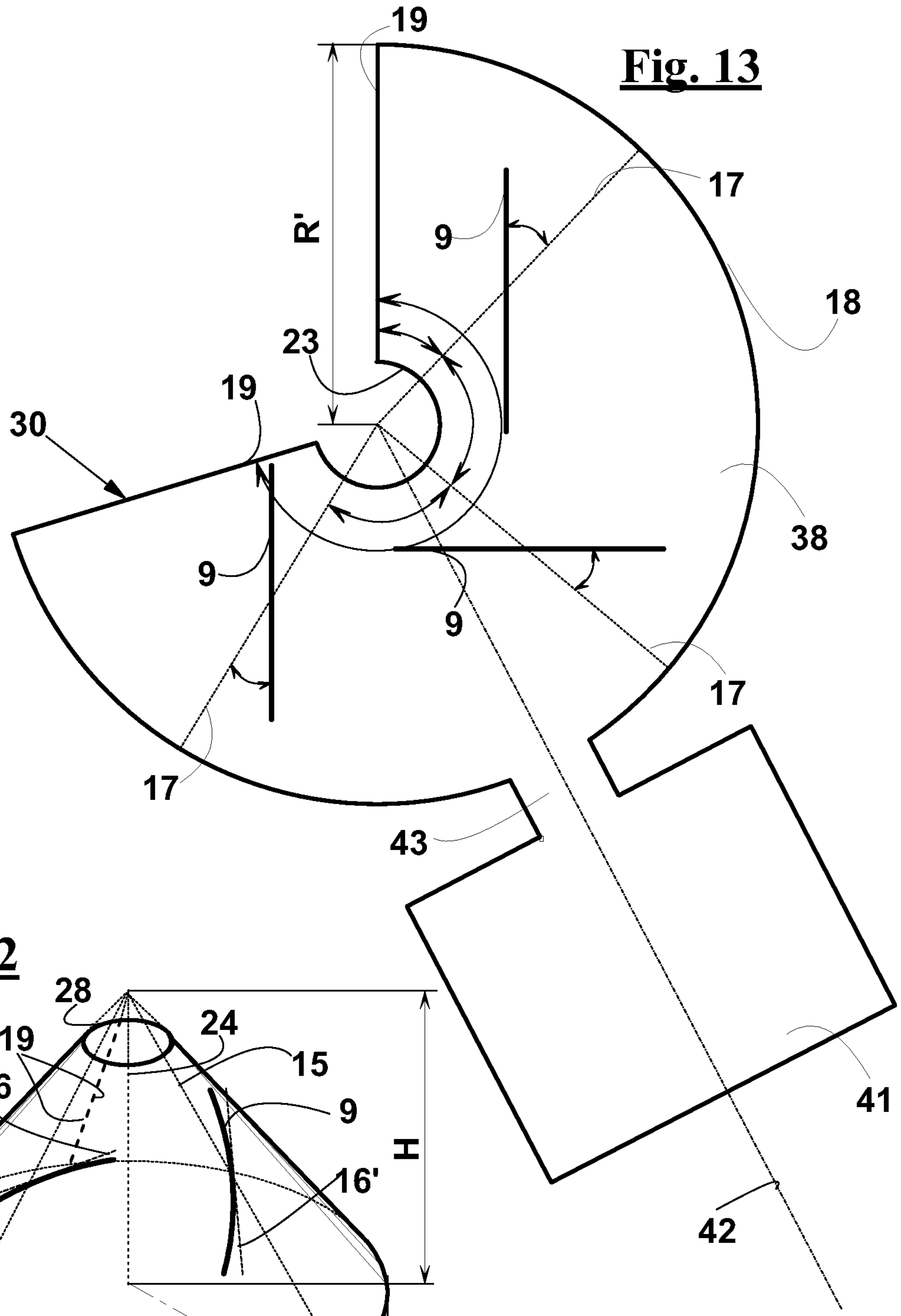
19
R'
17
9
18
23
19
30
38
9
9
17
17
43
41
42

Fig. 13

Fig. 12

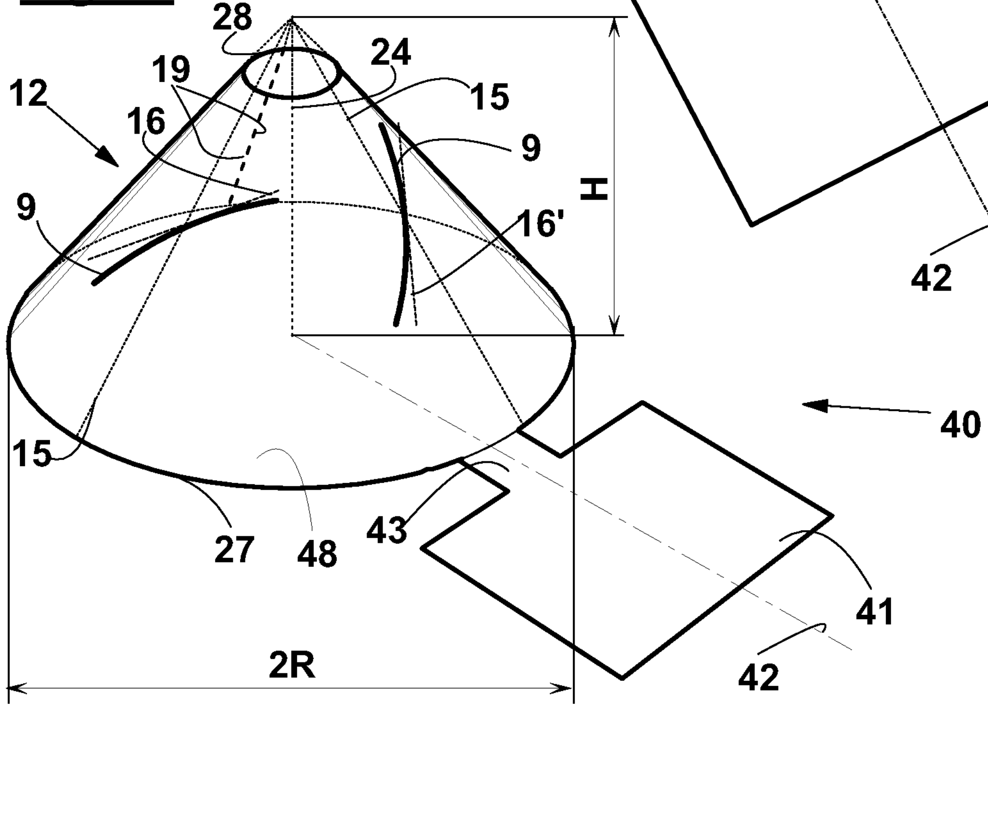
28
24
19
15
12
16
9
9
H
16'
40
15
43
27
48
41
42
2R

Fig. 15

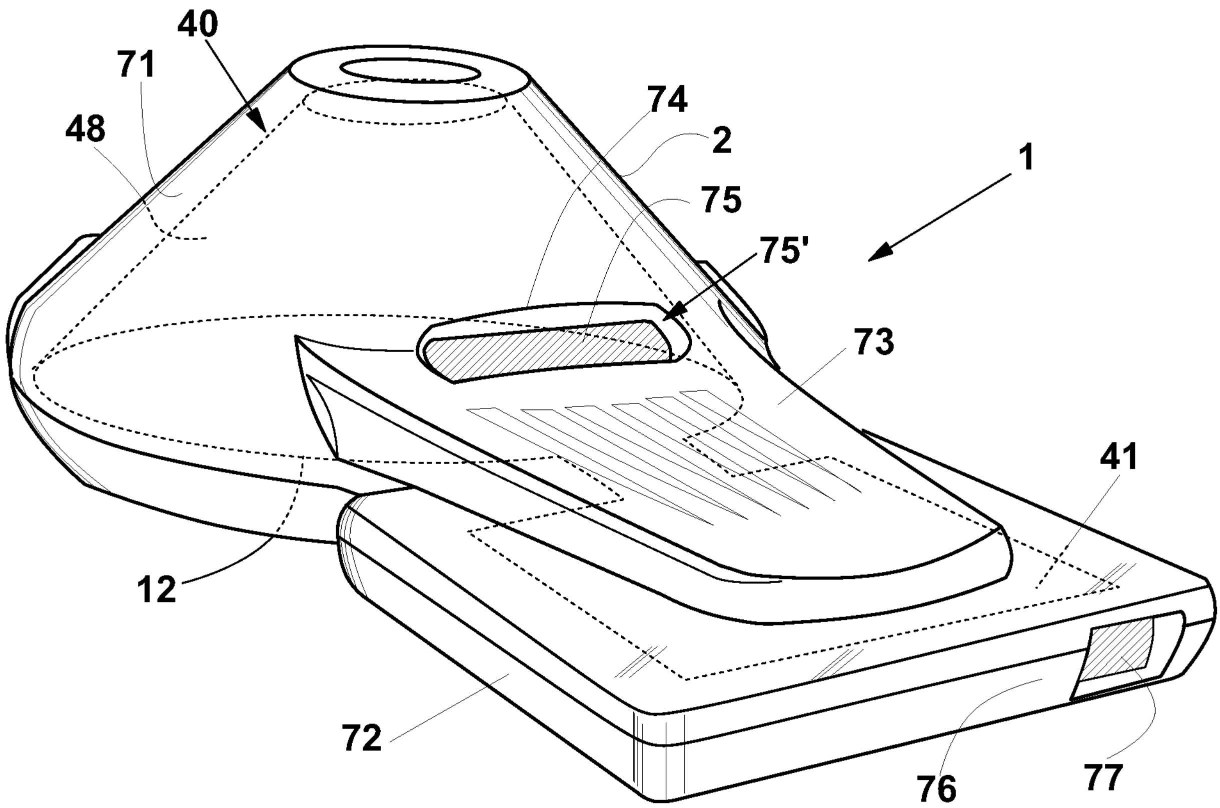
40
71
48
74
2
1
75
75'
73
41
12
72
76
77

Fig. 14

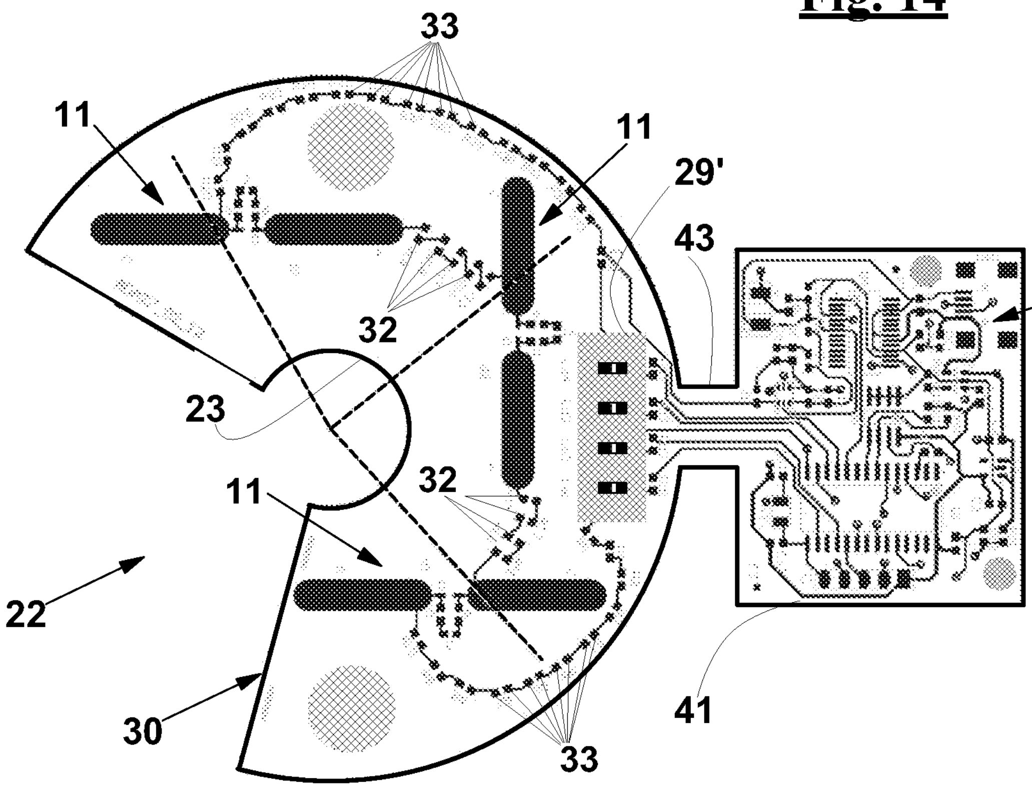
33
11
11
29'
43
44
32
32
23
32
11
22
30
41
33

Fig. 16

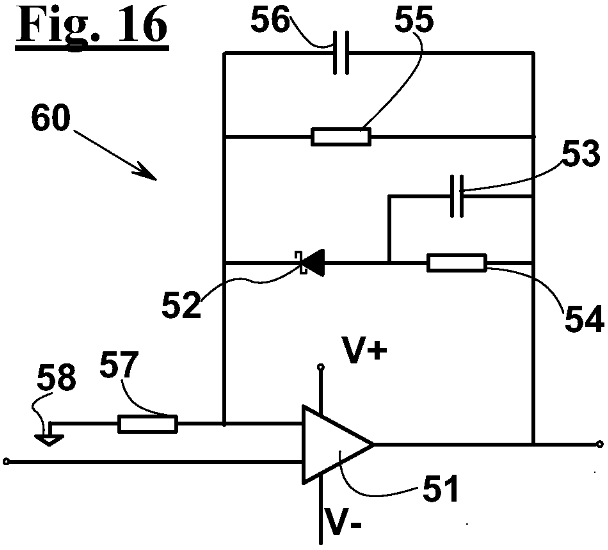

Fig. 17

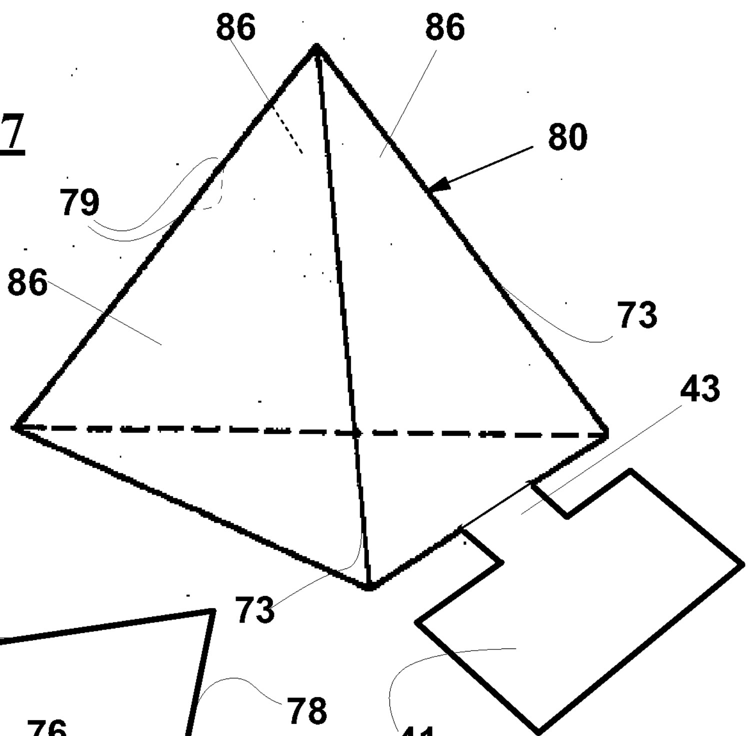

Fig. 18

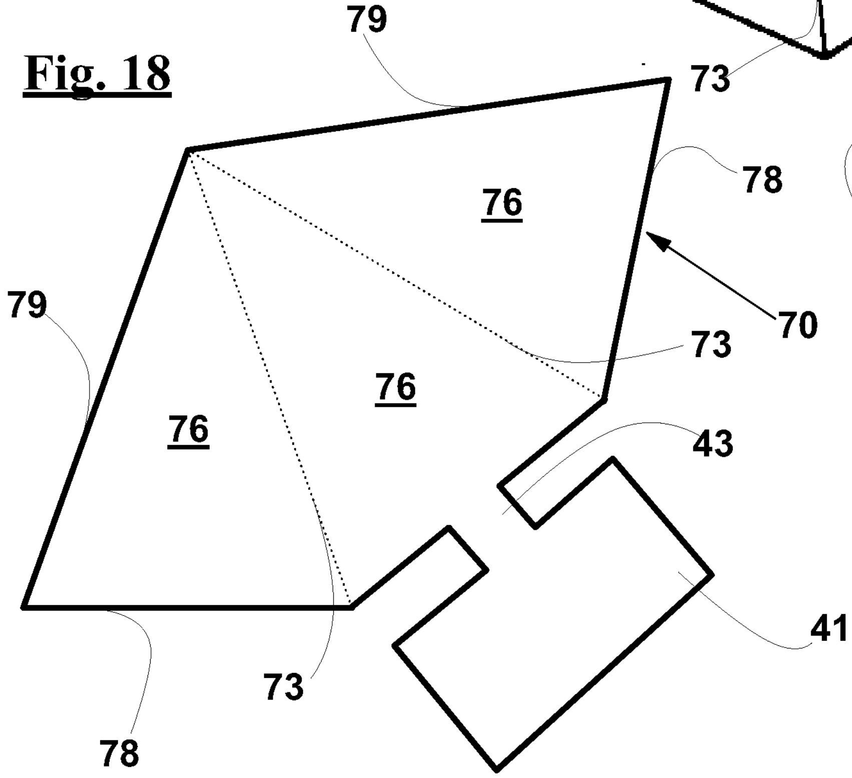

Fig. 19

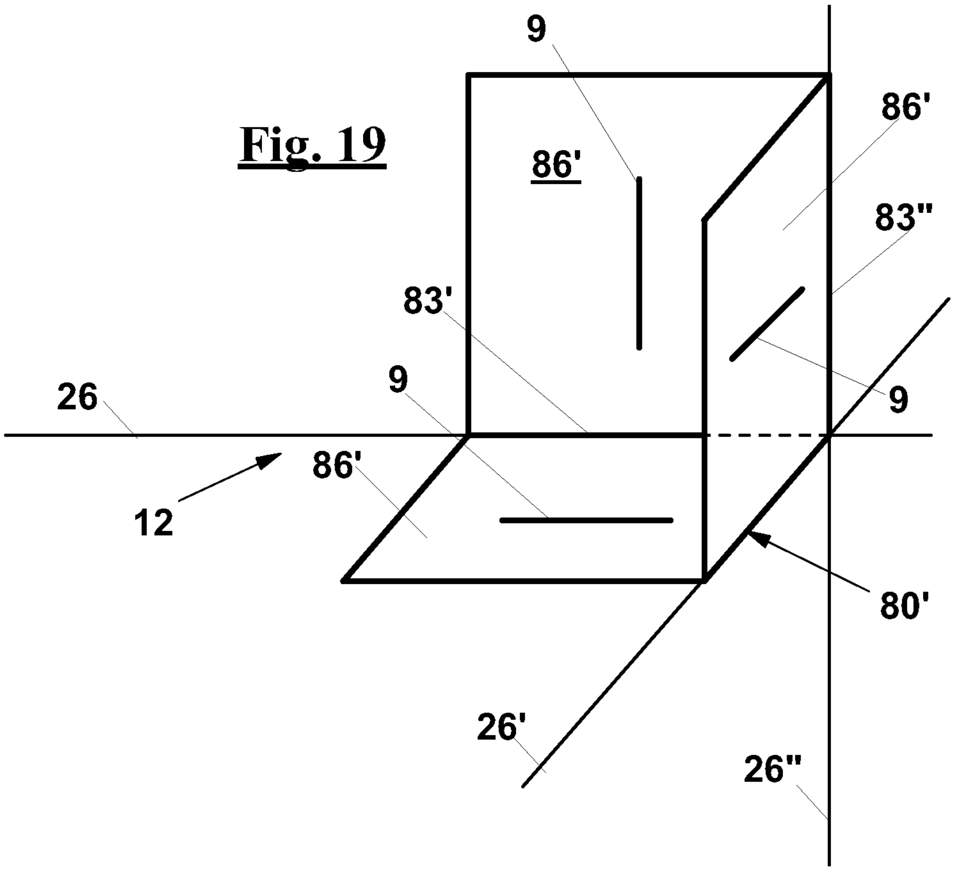

Fig. 20