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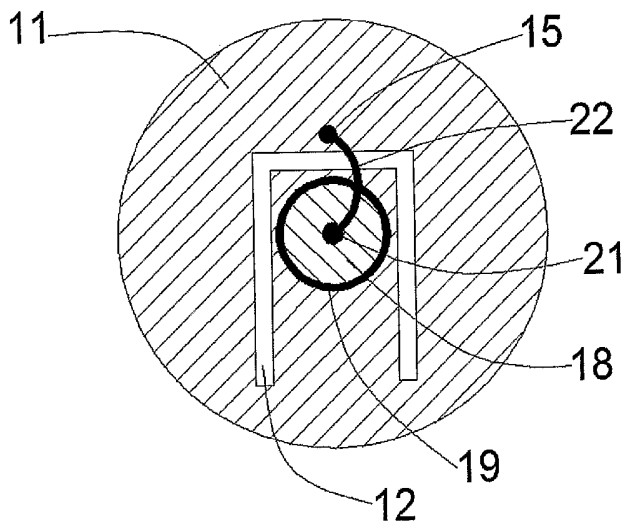
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ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: PATCH ANTENNA



(57) Abstract: Antenna for a wireless communication system with an antenna element of conductive material, located a distance from a ground plane of electrical conductive material, where the antenna element connects by ground and radio signal and where the antenna element has at least one hole. Antennas of this type emit an omni directional electromagnetic field with polarisation perpendicular to the ground plane. The antenna can replace whip antennas with one having less height and more robust design.



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Technical field

The present invention concerns an antenna for wireless communications placed a distance away from a ground plane. The invention concerns also whip antennas that are omni directional all round its axis with a polarizations vector along its axis.

State of the art and background of the invention

The purpose of an antenna is to convert wire bound signals to electromagnetic signals propagating in the ambient media. The design of the antenna determines the properties of this conversion. Important parameters are antenna gain, efficiency, directivity, polarisation, bandwidth and not least physical size. The requirements of a wireless communications system determine the requirements of the antenna and by that what type of antenna to be used.

Because wireless communication are used in more and more situations and products, focus on both their size and cost is increasing. By analysing what parameters are important for a specific system, the antenna can be optimised for this application. When more application uses wireless communication indoors both aesthetical requirements and radio requirements, due to the large attenuation and reflections of radio signals in walls for instance, apply.

Simple and small antennas have by that become attractive, due to both their decreased production cost and that they easily can be deployed in both stationary and mobile installations. Plane antennas that can be placed directly on objects such as walls have become very common.

Within radio communication the whip antenna is the most common type of antenna. It is omni directional, meaning having the same electromagnetic field strength around the antenna axis.

When the antenna is mounted on a unsymmetrical object the

radiation diagram will change and the whip antenna will not be fully omni directional. A whip antenna can have different electrical length and therefore have different radiation diagram, a $\frac{1}{2}$ -wave whip and a $\frac{1}{4}$ -wave whip on a big ground plane have the ideal antenna gain of 2.15 dB in a plane

perpendicular to the whips direction of elongation. They have also the same polarisation as the direction of elongation. If a whip is placed vertical, its polarisation also will be vertical. The most common whip antennas are $\frac{1}{4}$ -wave and $\frac{1}{2}$ -wave antennas. A $\frac{1}{4}$ -wave antenna corresponds to one of the half of a

$\frac{1}{2}$ -wave dipole. To get it to function it needs to be mounted on a ground plane preferable having a diameter exceeding one wave length. A $\frac{1}{4}$ -wave whip has an impedance of approximate 38 ohms at frequency of resonance when mounted on a big ground plane.

A $\frac{1}{4}$ -wave whip is therefore ground plane dependent and it is

necessary to adapt the antenna or the electronics so that the antenna and radio transmitter/receiver match each other to be able to function in efficient manner and giving maximal range.

A $\frac{1}{2}$ -wave whip is differently designed and it has the electrical length of $\frac{1}{2}$ wave length. Therefore it is

independent and shall not be mounted on a ground plane. It can resemble a dipole where's connects from one side. In practice the antenna and its radiation diagram to be influenced of a ground plane in the ambient. A big drawback with the $\frac{1}{2}$ -wave whip is that they becomes fairly long, at 2.4 GHz the whip

needs to be approximate 70 mm long to have the electrical length of $\frac{1}{2}$ -wavelength.

One type of planar antenna is the so called patch antenna. It consist of a layer or surface of an electrically conductive material with a very small thickness compared to other dimensions, that is placed a distance, which is small compared to the wavelength, above and in parallel with a ground plane. The signal to be emitted is coupled to the antenna element and the ground plane is coupled to the return conductor of the signal or ground. Since the antenna has a ground plane on one side, this side can be placed on objects without appreciably affecting its function and performance. The drawback is that its surface becomes relatively large. The sides of a conventional quadric patch antenna correspond to approximately $\frac{1}{2}$ wavelength of the lowest frequency that can be emitted, witch for an antenna for 1 GHz corresponds to 17 cm. That results in it becoming unwieldy and large, in particular for frequencies below 1 GHz. However, there are some existing methods to reduce the size of a patch antenna.

One way is to connect another electrical conductor between the antenna element and ground. This type of antennas usually is called PIFA antennas (Planar Inverted F Antenna).

A PIFA antenna connects both with the radio signal and ground. These connect at the antenna elements edge which also is the edge of the ground plane. The frequency of the antenna, the resonance frequency, is determined by the length of the antenna. The antennas electrical length shall approximate be $\frac{1}{4}$ of the wavelength at wanted frequency.

To adapt the antenna for the radio transmitter/receiver the distance between the connection spot for the radio signal and ground be increased or decreased so the system impedance of 50 ohms are attained. A common PIFA antenna has two properties that make it not useable as replacement for whip antennas.

Then the antenna in general had to be connected at the edge of the ground plane it will be affected by the placement of the antenna. If the connections are placed more central on the ground plane, the antenna is difficult to be adapted to 50
5 ohms which usually is the common impedance for an antenna. A PIFA antenna gives also a polarisation along the ground plane. It is then perpendicular to the polarisation from whip
antennas. This is the most important reason that a common PIFA not can be used as replacement for whip antennas. This
10 invention solves the problem of polarisation and impedance match of a PIFA antenna.

To be able to generate an electromagnetic field that both are omni directional and having a polarisation perpendicular to
15 the ground plane, the antenna have to radiate the radio signal with a certain group of modes, the TM_{0x} modes. The mode giving the lowest frequency is the TM₀₂ mode. By shape the antenna element in correct manner this mode can be emitted with good efficiency.

20

Previous known embodiments is described in "A Circular Patch Antenna for Radio LAN's" by Y. J. Gou m. fl. They use a circular disc that is connected by one conductor a portion away from the antenna centre. By their method the antenna
25 becomes approximate 2 times as big as in the current invention.

Another embodiment is described in "Shorting-Pin Loaded Annular ring Microstrip Antenna" by Guangping Zhou where a
30 circular disc with a central placed hole with a radius half of the disc radius is used. Two ground conductors and one conductor to the radio transmitter or receiver is used as electrical connections. The distance between the signal and closest ground conductor controls the impedance match and the

distance to the ground conductor further away gives the resonance frequency. This antenna has also a diameter of $\frac{1}{4}$ wave length but needs two electrical conductors that connect between the antenna element and its ground plane at two
5 separate spots.

A general description of circular antennas is described In "Two-Port Higher Mode Circular Microstrip Antennas" by Rodney G. Vaughan. He describes the different modes of radiation and
10 adjusts the resonance frequency by changing the diameter of a central located ground conductor.

Description of the invention

15 The present invention give an antenna with similar properties as $\frac{1}{4}$ wave whips but have substantial less length and is independent of a ground plane. The antenna have an integrated ground plane with a well defined distance to the antenna element which does that the antenna can be placed on arbitrary
20 objects. One spot on the antenna element connects with an electrical conductor to the radio transmitter/receiver and another spot on the antenna element connects with one or several electrical connector/s to the ground plane. The antenna is consequently short circuit to ground which decrease
25 problem with electro static discharge.

One antenna element shapes as a circular disc of electrically conductive material which is placed a portion from and parallel to a ground plane which is equally size or bigger
30 than the antenna element. Two different spots on the antenna element connect by electrical conductors where one spot joins to the ground plane and the other spot joins to the radio transmitter/receiver. The antenna element shall have a

diameter that corresponds to the electrical length of around $\frac{1}{4}$ wave length at the present frequency. The antenna element shall have at least one hole with arbitrary shape, size and placement.

- 5 The connection to the antenna can be model as a transmission line with impedance between 10 and 300 ohms. The transmission line can have different embodiments, common types is coaxial line and pair line. Placement of the transmission line benefits to be perpendicular to the antenna element plane and
- 10 at a position near the central spot and connects to the underlying ground plane with its radio transmitter or receiver.

- The antenna element does not need to have the physical
- 15 diameter of $\frac{1}{4}$ wavelengths. The antenna element can be modified to decrease the physical size with preserved electrical length. Exemplification of this is to fold the outer edge or to shape the antenna with more than one folding. It's an advantage that the modification of the antenna elements shape
- 20 is performed circularly around the central spot.

- With help of different size, position and shape of the hole/s in the antenna element the antenna impedance can be adjusted. Small holes in the antenna element will not appreciable affect
- 25 the antenna property. To obtain a significant change of the antenna impedance ought the holes circumference to exceed $1/8$ wavelength. A hole with significant size benefits to be placed in such way that the electrical connection of the radio signal is placed on one side of the hole and the electrical
- 30 connection to the ground plane is placed near a position on opposite side to the same hole.

It is not necessary to shape the antenna element with circular shape to obtain the desirable properties that gives similar

radiation as whip antennas. The antenna element can in fact have arbitrary geometrical shape and give the desirable properties if the geometrical centre of gravity of the connections spots on the antenna element from one or more
5 electrical conductors from the ground plane, essentially coincident on or near the antenna elements geometrical centre of gravity, and that the antenna element may contain at least one hole with arbitrary shape and placement and a circumference exceeding the electrical length of one tenth
10 wavelength of emitted or received radio signal.

Often only a single conductor is used for the connection of ground between the ground plane and the antenna element. The connection spot on the antenna element shall then essentially
15 coincident or be located near the antenna elements geometrical centre of gravity. If more spots on the antenna element are connected to ground shall the total centre point of all ground connections on the antenna element be taken into account so the "geometrical centre of gravity" of all ground connections
20 on the antenna element essentially coincident or is placed near the antenna elements geometrical centre of gravity.

In the case of a coaxial conductor whose ground connects around the whole conductor shall the coaxial conductors centre
25 essentially coincident or be placed near the antenna elements geometrical centre of gravity.

The antenna elements geometrical centre of gravity calculates from the whole elements extension in one plane. If one of the
30 edges is bended or folded, it shall be unfolded so the whole antenna element is flat to determine the geometrical centre of gravity.

The impedance match can be obtained by placing the coupling spot of the signal from radio transmitter or receiver on correct position on the antenna element. The impedance match can be simplified by placing a hole in such way that the
5 currents have to elapse a longer way between the signal coupling point and the antenna elements ground connection.

It is in general appropriate that the connections between the ground plane and antenna element is placed perpendicular to
10 the ground plane.

To obtain desirable properties the connection of the signal from the ground plane up to the antenna element can be modelled as a transmission line with impedance between 10 and
15 300 ohms. It can be modelled with coaxial shape or as pair conductor. A pair conductor can both have circular and plane shapes. The transmission line can also consist of more than two electrical conductors.

20 **Description of drawings**

Figure 1 illustrates a cross section of the circular antenna element with a present hole and where the connection spots for ground and radio signal are placed on opposite sides of the
25 hole.

Figure 2 illustrates a cross section of the circular antenna element whose edge is folded to decrease the physical size. The radio signal passes through the hole and connects on
30 opposite side of the connection of ground.

Figure 3 view the antenna element from above with a central placed hole where a central placed transmission line of

coaxial type connects by two electrical conductors to separate directions from the centre of the hole.

Figure 4 illustrates a antenna element with a hole in none centre position but with a central placed transmission line of coaxial type where the two conductors are connected at separate directions in the view from the hole centre.

Figure 5 illustrates an antenna element similar to the one in figure 4 but from a side view.

Figure 6 illustrates an antenna element that connects by two connectors on separate sides of a rectangular hole.

Figure 7 illustrates a circular antenna element with connections by coaxial conductors where the coaxial conductor s centre is placed in the antenna elements centre and where the ground connection to the antenna element occur around the whole outer conductor

Figure 8 illustrates a square shaped antenna element.

Figure 9 illustrates a square shaped antenna element with out cut.

Figure 10 illustrates an antenna element with different shape.

Figure 11 illustrates a hole with different shape.

Figure 12 illustrates an antenna element which connects by pair conductors.

Preferred embodiments

With reference to figure 1 a cross section across the antenna elements centre (11) at a distance (20) mainly parallel to a ground plane (10) where the ground plane have arbitrary shape and is equally or bigger size than the antenna element is illustrated. The antenna element and the ground plane is separated by an electrical insulator that can consist of air, plastics, ceramics or other types of insulators. A hole (12) with arbitrary shape is placed in the circular antenna element and its position, size and shape will affect the impedance of the antenna. The antennas resonance frequency is determined by the antenna size. To the antenna element is the signal (13) from radio transmitter or receiver connected by one or more electrical conductor/s (14) to the same spot (15) on the antenna element. To the antenna element is also one or more electrical conductor/s (16) connected from the ground plane to the same spot (17).

The antenna element can also be shaped with folded edges to decrease its physical size but keep its electrical size and thereby the same function as the antenna element in figure 1 attain. Figure 2 illustrates a cross section of an antenna element that has edges folded towards the ground plane. The length on the part of folding that are perpendicular to the ground plane (24) and the antenna elements plane ought not exceed the antennas radius. Figure 2 illustrates how a hole (12) has placed at a position from the antenna centre and connection of radio signal (15) and ground (17) is placed at separate sides of the centre of the hole. Figure 3 view the antenna element from above and the electrical signals connects to the antenna element by a transmission line of coaxial type where the outer conductor (19) connects to connection spot (17) and where the inner conductor (21) connects by electrical

conductor to connection spot (15) on antenna element. The conductors in the coaxial cable are insulated by an electrical insulator.

5 Figure 4 illustrates how the electrical connection can be done from a central placed transmission line of coaxial type where the hole (12) in the antenna element is not in central position. Figure 5 illustrates a side view of figure 4. The mid conductor in the coaxial cable (21) connects to connection
10 point (15) by a electrical conductor (22) that essentially are located in the same plane as the antenna element.

Figure 6 illustrates the antenna element with a rectangular hole (12). The signals from radio transmitter/receiver and the
15 ground plane, connects at the two spots (15) and (17) respective. The size of the hole and its shape determine the antennas impedance. The hole can have arbitrary shape to reach the same properties and are in line with present invention.

20 Figure 7 illustrates a circular antenna element (11) with connection by coaxial conductor where the coaxial conductors centre is located in the antenna elements centre and where the ground connection to the antenna element is performed around the whole outer conductor (19)

25

Figure 8 illustrates a square antenna element (11) with a hole (12) and where connection is performed by a central located coaxial conductor. Connection of ground is done in same manner as in figure 7 and by that the connection to ground on the
30 antenna element is performed around the antenna elements geometrical centre of gravity a geometrical centre of gravity of all connection spots between ground and the antenna element that coincident with the antenna elements geometrical centre of gravity is obtained. This model offer the same desired

antenna property as if the ground connection is concentrated at one spot and located in the antenna elements centre of gravity and is within the scope of present invention. If the connection to ground is distributed over an area or sector or
5 if several discrete connection points are applied it is the geometrical centre of gravity of the ground connections that essential shall coincident with the antenna elements geometrical centre of gravity.

- 10 Figure 9 and 10 illustrates two different geometrical embodiments of the antenna element (11). The antenna elements geometrical shape can be arbitrary and are within the scope of present invention when remaining conditions are fulfilled.
- 15 Figure 11 and 12 illustrates alternative shapes of the hole in the antenna element. The holes geometrical shapes are arbitrary and are within the scope of present invention when any of the holes have an electrical length exceeding one tenth of wavelength. The electrical and physical length can differ
20 and depends of what effective dielectric constant that the electromagnetic field is affected by. If the effective dielectric constant by example is four, the electrical length will be two times the physical length. Figure 12 also illustrates connection by pair conductor that connects on
25 either side of the hole (12) where ground connections (17) are located in the antenna elements geometrical centre of gravity. A virtual line between the radio transmitter or receiver connection spot on the antenna element (15) and the antenna elements geometrical centre of gravity consequently will cross
30 the hole (12). The antenna element does not need to be flat, it can have folded edges. However, the geometrical centre of gravity is determined by the antenna elements total unfolded area.

The antenna embodiment and its ground plane can be realized in number of ways and can have different types of electrical insulators that separate them. Common isolators are air, different substrates for printed circuit boards, plastics or ceramics. Common electrical conductive material for antenna and ground plane embodiments is copper, silver, different alloys containing mentioned substances.

The coaxial transmission line to the antenna element can be an electrical coaxial connector of arbitrary type. Example of coaxial connectors is SMA, FME, BNC, TNC, SMB, etc.

The radio signal can, as the man skilled in the art realizes, be connected to the antenna element with direct or indirect coupling. By direct coupling an electrical connector is understood, and by indirect coupling a capacitive or inductive or a combination of both is understood.

The antenna can also, as the man skilled in the art realizes, be used in systems including several antennas for example systems to enhance antenna gain, achieving space or polarisation diversity, or for systems applying MIMO techniques, meaning that nodes in wireless systems containing more antennas both for transmitting and receiving.

As the man skilled in the art realizes, the antenna can be used within one or more frequency bands at the same time or at different occasions. The antenna can use different modes of operation which will emit different radiation pattern. It is obvious that the same antenna can operate efficient at other frequencies and use other, higher order of modes or resonance frequencies on the same antenna. The present invention concerns not to a specific mode or resonance, but includes them all.

As also the man skilled in the art realizes, a parasitic element, for example one or more extra layers of electric conductive material at a distance from the antenna element. The parasitic element can be shaped to increase the bandwidth
5 of the antenna or to obtain an efficient antenna at another frequency band. The parasitic element can also be used for impedance matching.

Claims

- 1) An antenna for a wireless communications system with an essential circular antenna element of an electrically conductive material where said antenna element have a diameter of essentially equal to or less than $\frac{1}{4}$ wavelength, located at a distance from and essentially perpendicular to a ground plane of electrically conductive material, **characterised in** that the antenna element have at least one hole of arbitrary shape, location and size and that one or more electrical conductors from the ground plane are connected to one spot on the antenna element and that one or more electrical conductors from the radio transmitter/receiver are connected to another spot on the antenna element.
- 2) An antenna according to claim 1, **characterized in** that the connection conductors are located essentially perpendicular to said plane and in vicinity of the centre of the antenna element.
- 3) An antenna according to claim 2, **characterized in** that the connection conductors are embodiment as a transmission line with impedance between 10 and 300 ohms.
- 4) An antenna according to claim 3, **characterized in** that the transmission line is coaxial.
- 5) An antenna according to claim 3, **characterized in** that the transmission line consist of a coaxial connector of arbitrary type.
- 6) An antenna according to claim 1, **characterized in** that the transmission line is embodiments as two essentially parallel conductors.
- 7) An antenna according to any of claims 1-6, **characterised in** that the hole in the antenna element is

located so it cut a virtual straight line between the two connection spots on said antenna element.

8) An antenna according to any of claims 1-7,
characterised in that the hole in the antenna element has
5 a circumference exceeding $1/8$ wavelength.

9) An antenna according to any of claims 1-8,
characterised in that the outer edge of the antenna
element is folded and that the width of said fold is less
than the circularly antenna elements radius.

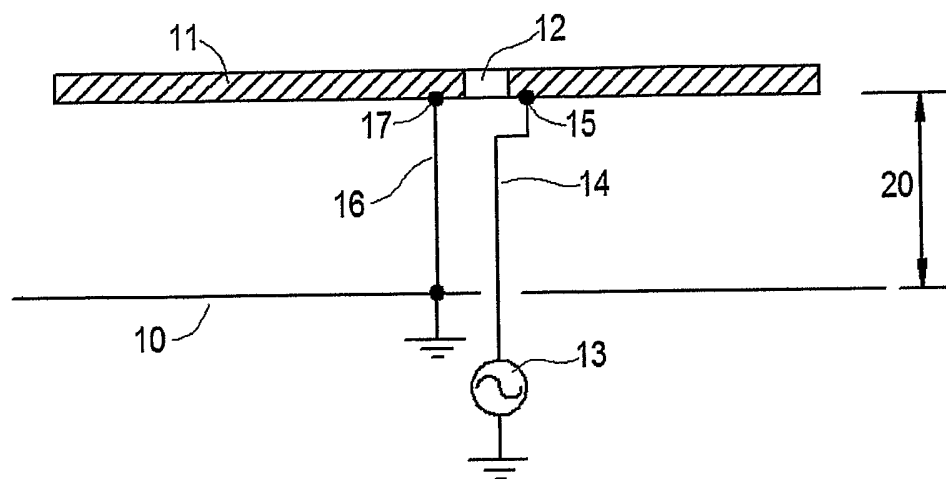
10) An antenna for a wireless communications system with
an antenna element of electrically conductive material
located a distance from a ground plane of electrically
conductive material, where signal from radio transmitter
or receiver connects by direct or indirect coupling to
15 said antenna element at one or more coupling spots,
characterized in that the geometrical centre of gravity
of one or more electrical conductors connection spots of
ground on the antenna element essentially coincident or
is in vicinity of the antenna elements geometrical centre
20 of gravity and that the antenna element includes at least
one hole with an electrical length of circumference
exceeding one tenth of emitted or received signal.

11) Antenna according to claim 10, **characterized in** that
at least one of said hole intersects by a virtual line
25 between any connection spot on the antenna element from
radio transmitter or receiver and the antenna elements
geometrical centre of gravity.

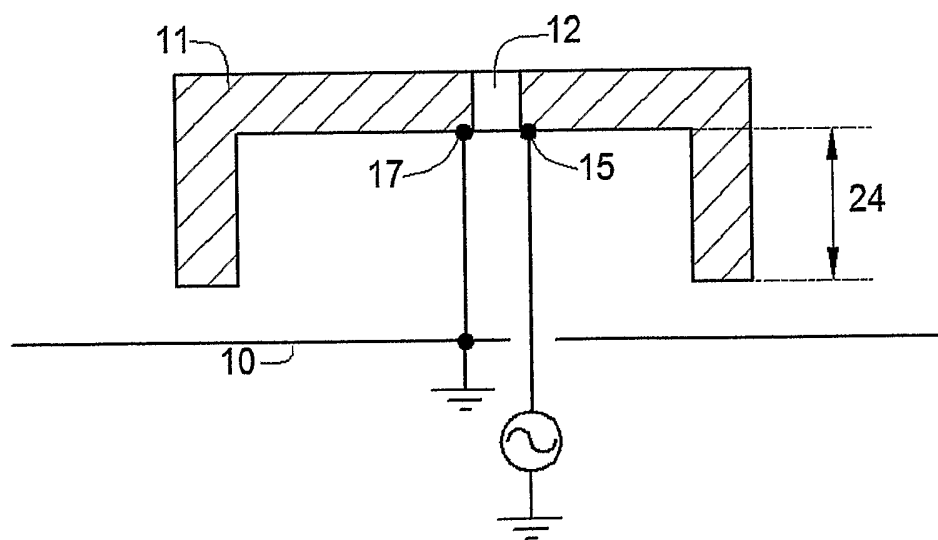
12) Antenna according any of claims 10-11, **characterized
in** that electrical conductors between the ground plane
and the elements geometrical centre of gravity,
30 essentially is perpendicular to said ground plane.

- 13) Antenna according to any of claims 10-12,
characterized in that the connection conductors to the
antenna element embodies a transmission line with
impedance between 10 and 300 ohms.
- 5 14) Antenna according to claim 13, **characterized in** that
the transmission line is coaxial shaped.
- 15) Antenna according to any of claims 10-14,
characterized in that the transmission line is embodied
by parallel conductors.

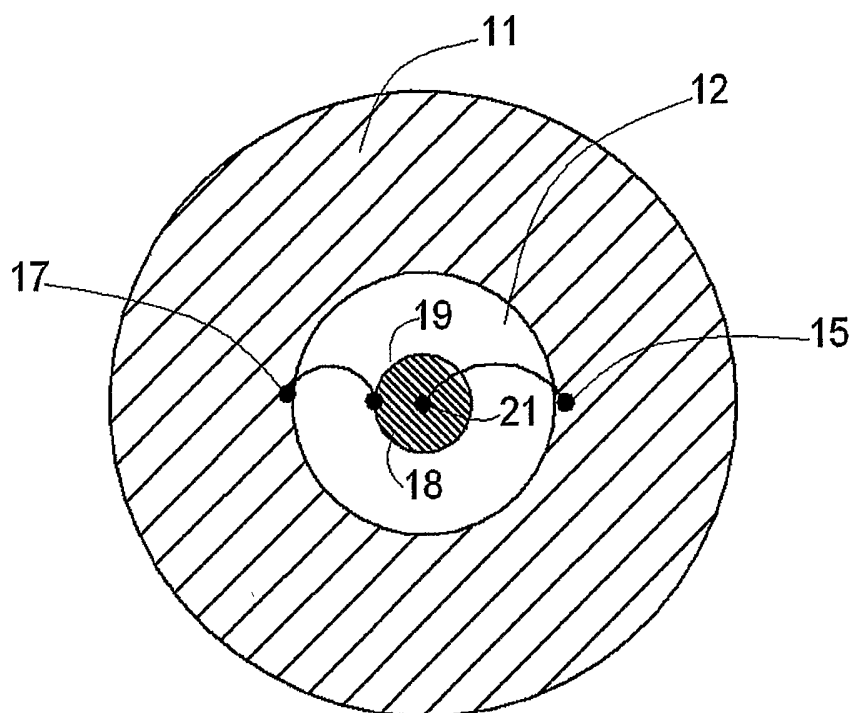
Figur 1



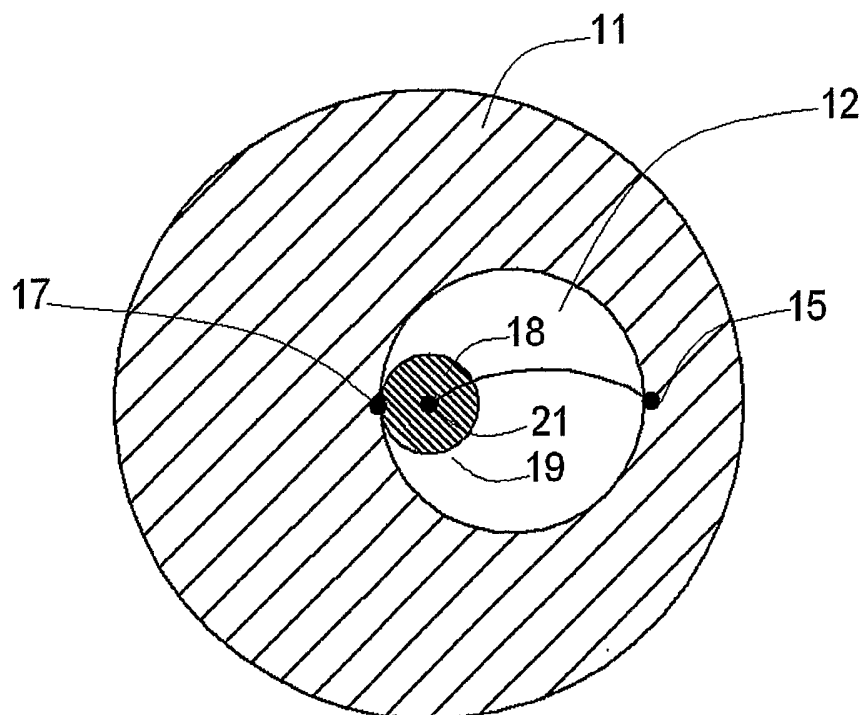
Figur 2



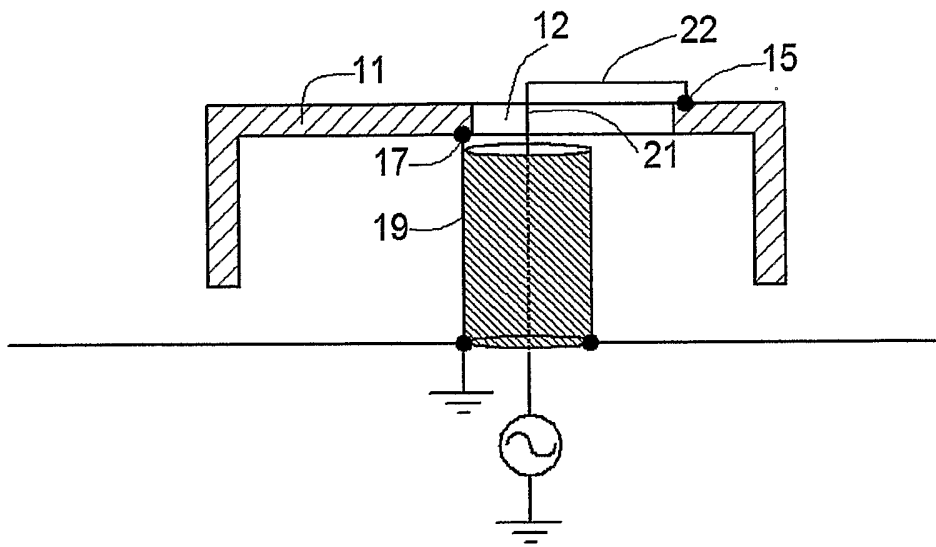
Figur 3



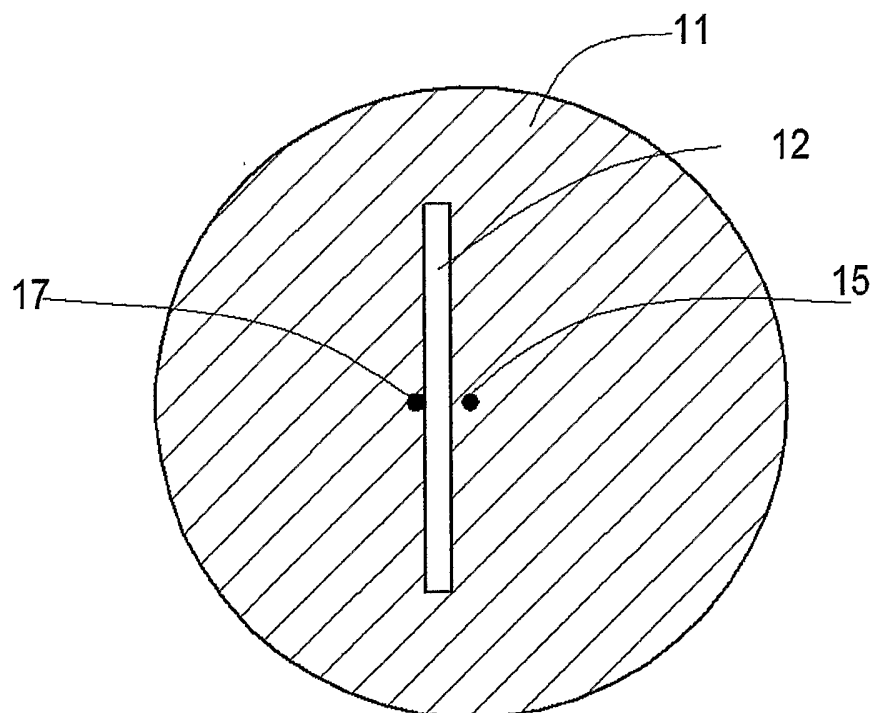
Figur 4



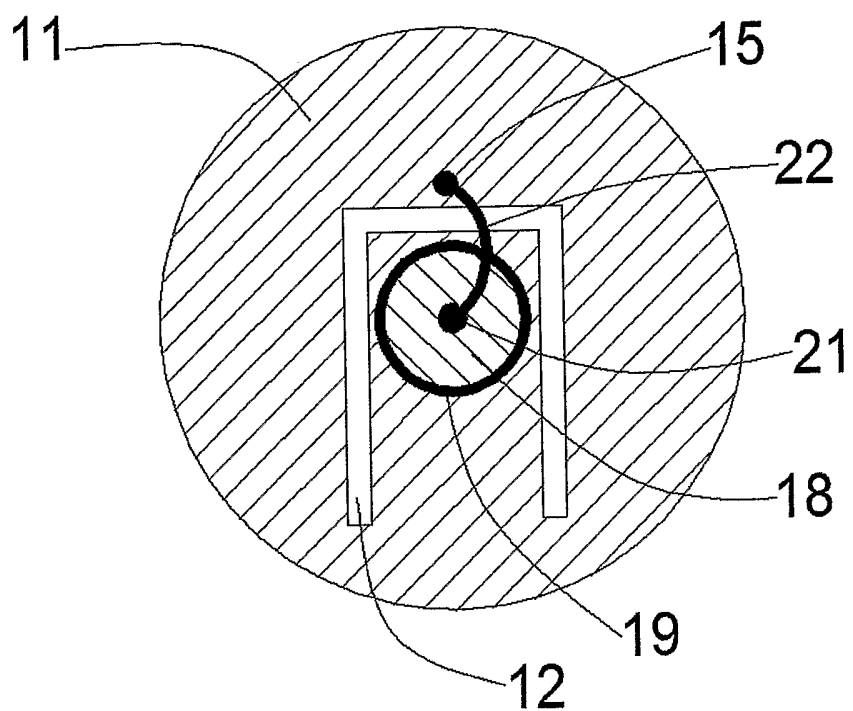
Figur 5



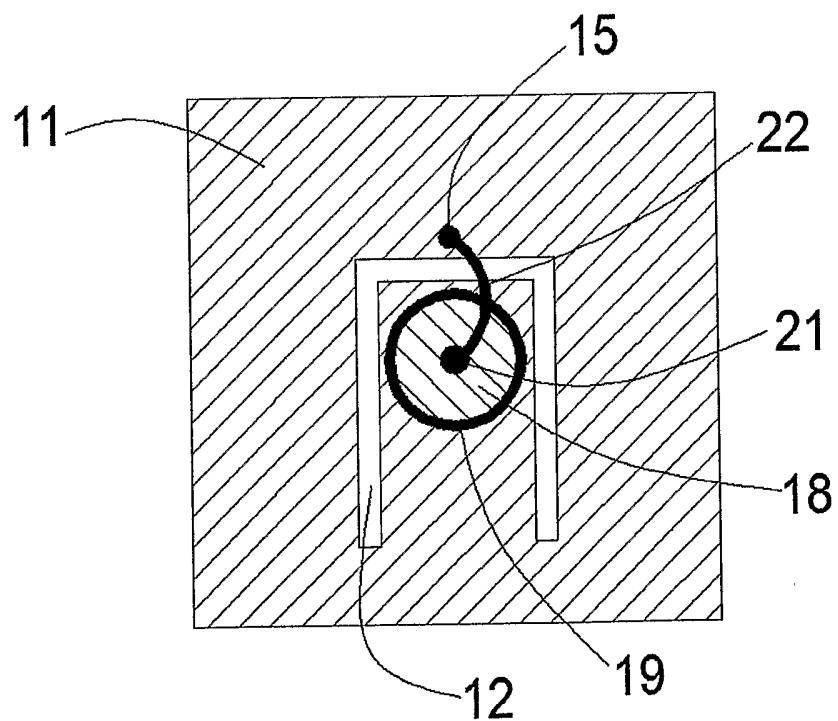
Figur 6



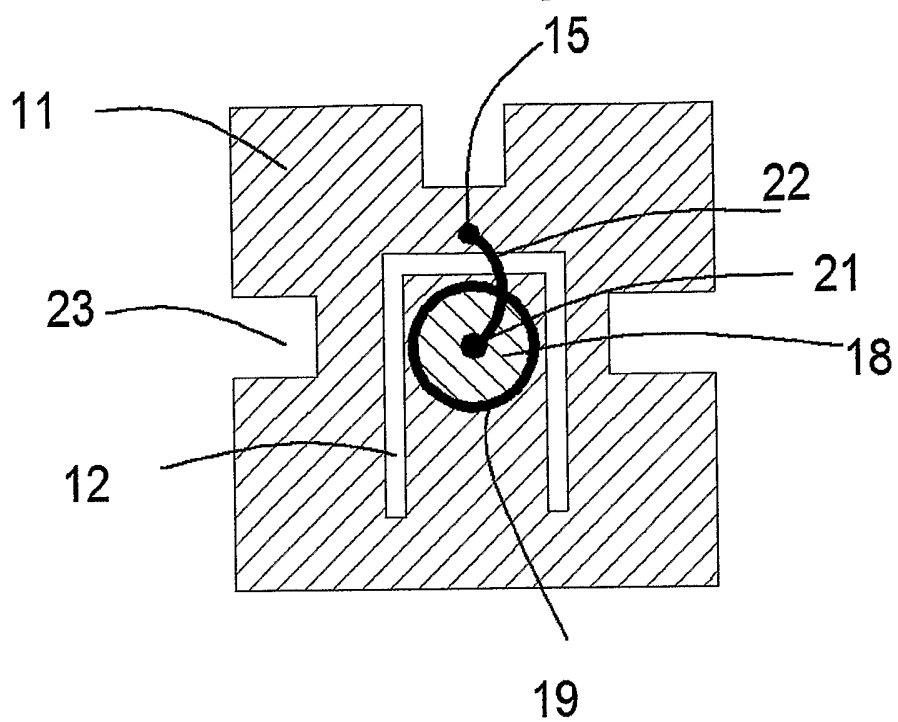
Figur 7



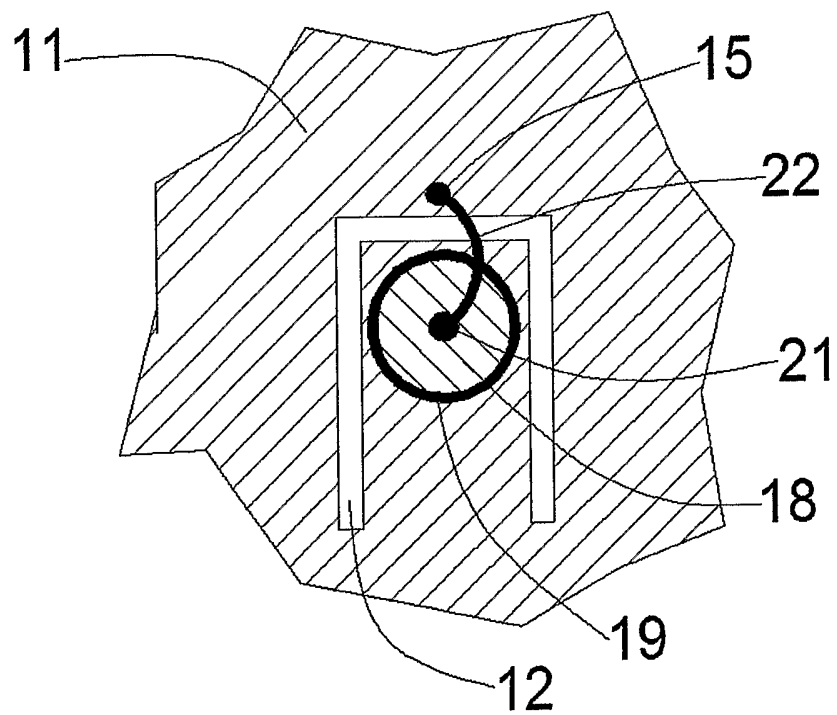
Figur 8



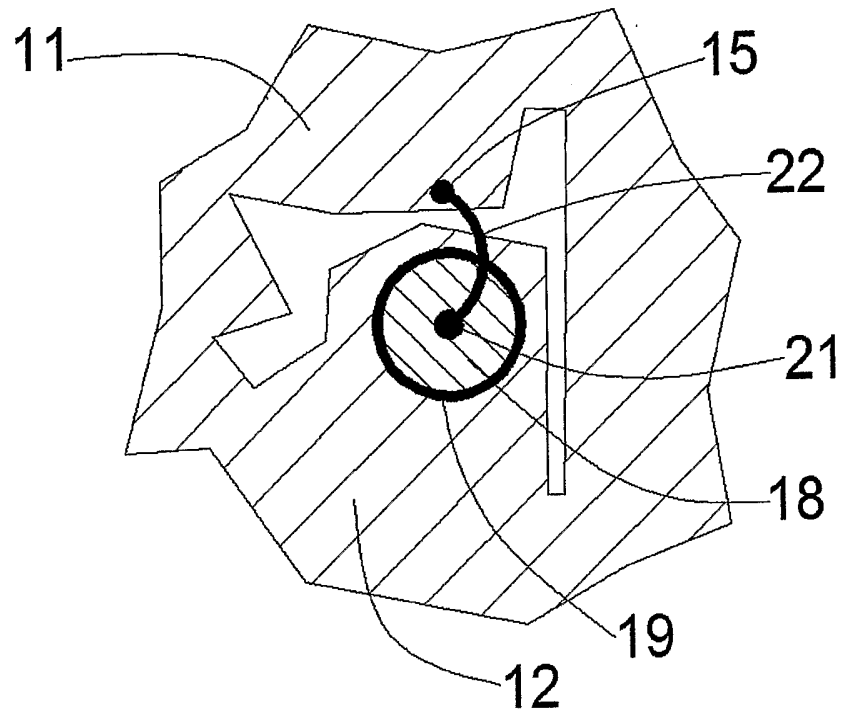
Figur 9



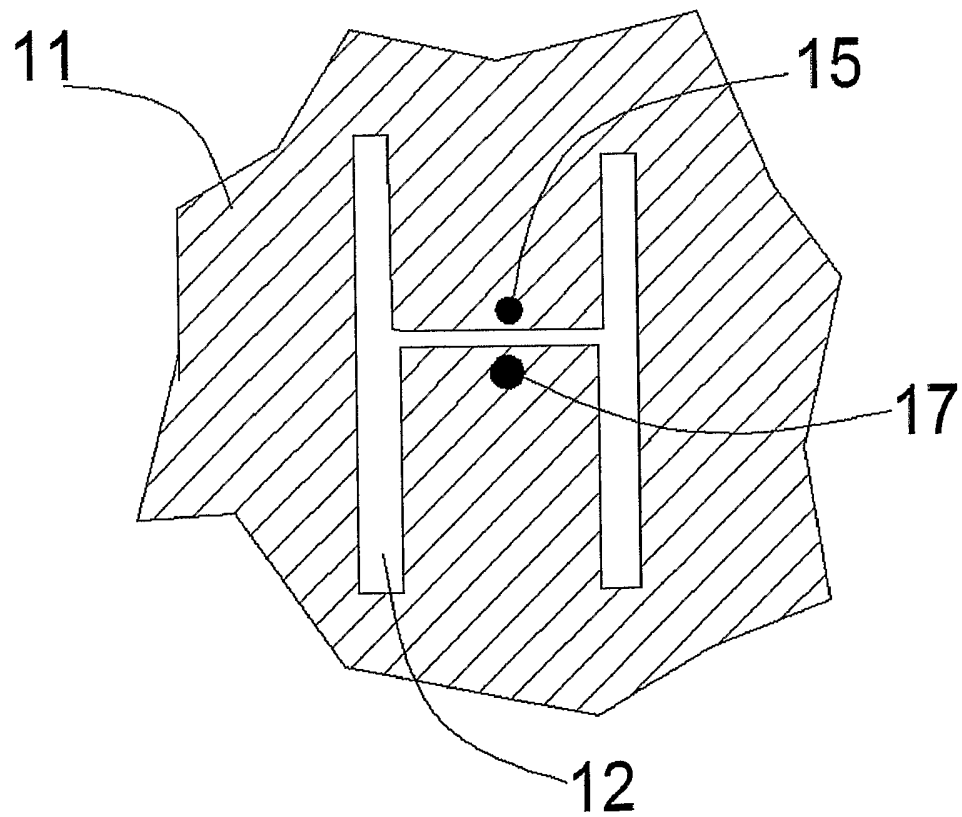
Figur 10



Figur 11



Figur 12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2006/000133

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0278070 A1 (BALL CORPORATION), 17 August 1988 (17.08.1988), figure 3, abstract --	1-15
A	US 20030052825 A1 (BARSUR RAMA RAO ET AL), 20 March 2003 (20.03.2003), figure 2, abstract --	1-15
A	US 6278410 B1 (EZZELDIN SOLIMAN ET AL), 21 August 2001 (21.08.2001), figure 1a, abstract -- -----	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Information on patent family members

04/03/2006

International application No.

PCT/SE2006/000133

EP	0278070	A1	17/08/1988	AT	100971	T	15/02/1994
				CA	1288510	A,C	03/09/1991
				DE	3788954	D,T	05/05/1994
				JP	63169103	A	13/07/1988
				US	4821040	A	11/04/1989

US	20030052825	A1	20/03/2003	IL	160948	D	00/00/0000
				US	6597316	B	22/07/2003
				WO	03026069	A	27/03/2003

US	6278410	B1	21/08/2001	NONE			
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