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(54) **A DUAL DIRECTIONAL LOG-PERIODIC ANTENNA AND AN ANTENNA ARRANGEMENT**

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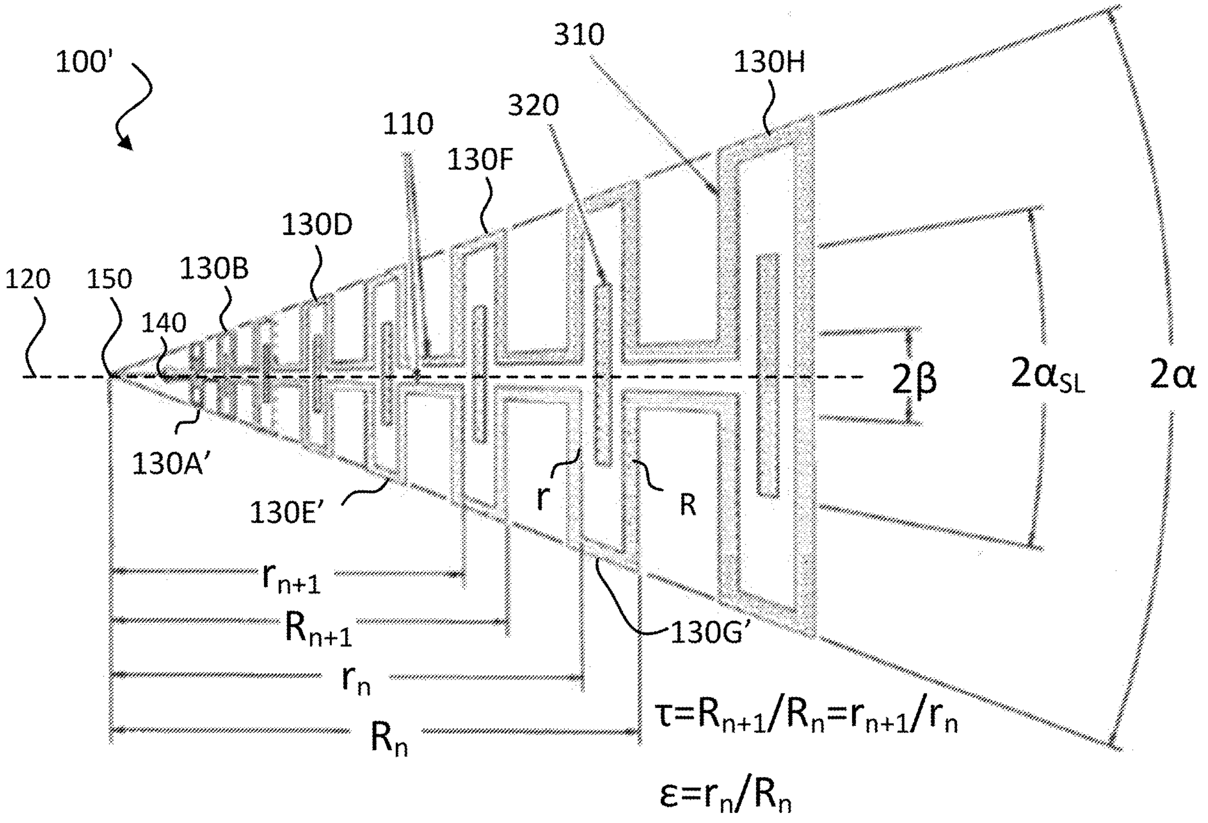
(57) **ABSTRACT**

The invention relates to an antenna. The antenna comprises a feed line having first and second ends on opposite sides of the feed line, wherein a transmission axis is defined as the axis extending between the first and second ends of the feed line. Further, the antenna comprises a plurality of antenna elements arranged along the feed line, protruding from the transmission axis. The antenna also comprises a first port at the first end of the feed line, wherein, at a first part of the antenna, the feed line, from the first port towards a reference point along the transmission axis, comprises antenna elements of gradually increasing length, configured to radiate in a first direction along the transmission axis from the reference point towards the first port during excitation in the first port. Yet further, the antenna comprises a second port at the second end of the feed line, wherein, at a second part of the antenna, the feed line, from the second port towards the reference point along the transmission axis, comprises antenna elements of gradually increasing length, configured to radiate in a second direction along the transmission axis from the reference point towards the second port during excitation in the second port.



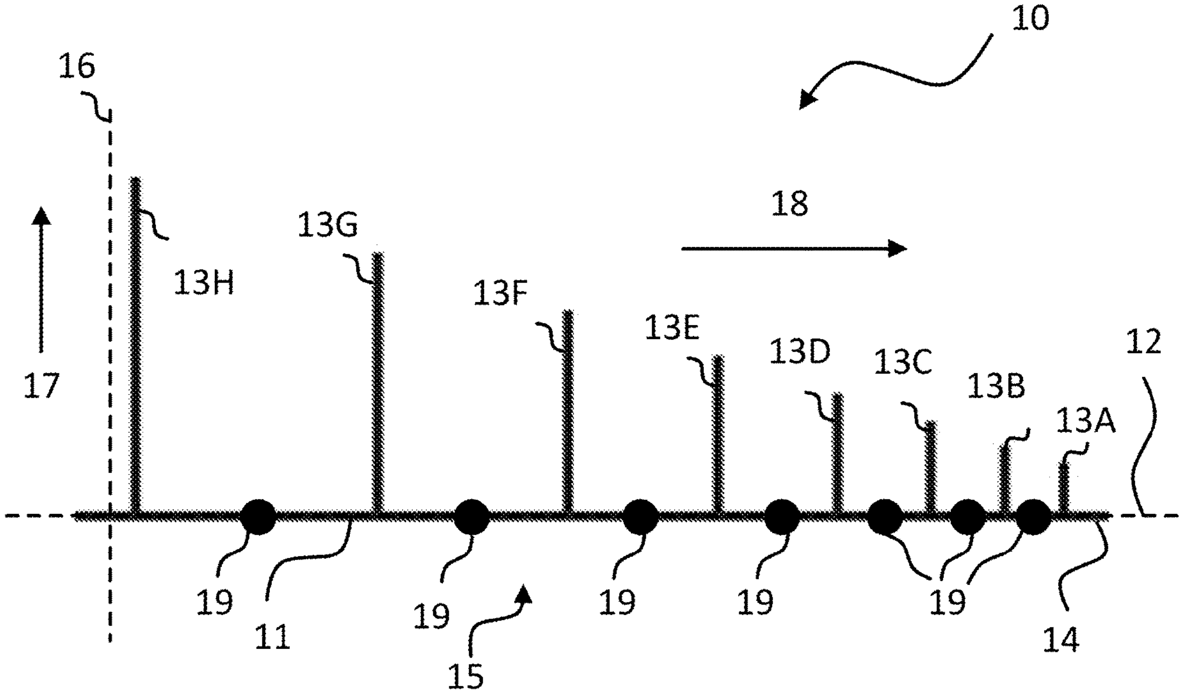

10
16
18
13G
13H
13F
13E
13D
13C
13B
12
13A
17
19
11
19
19
19
19
14
15

FIG. 1

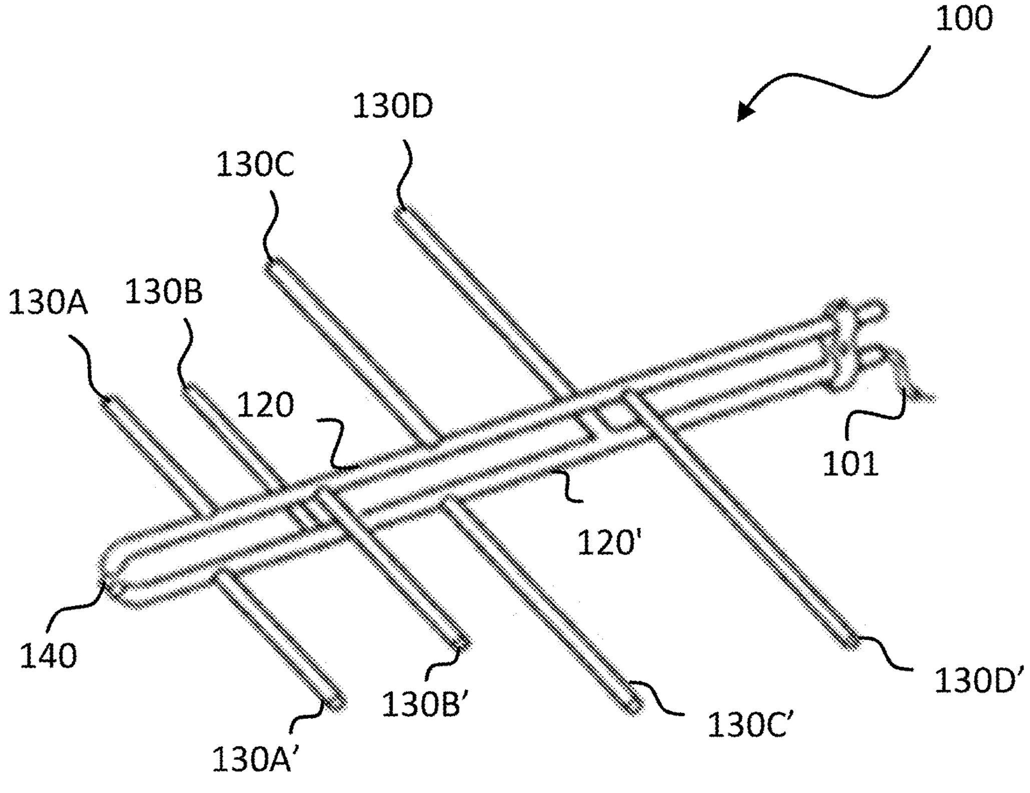

100
130D
130C
130A
130B
120
101
120'
140
130D'
130B'
130C'
130A'

FIG. 2

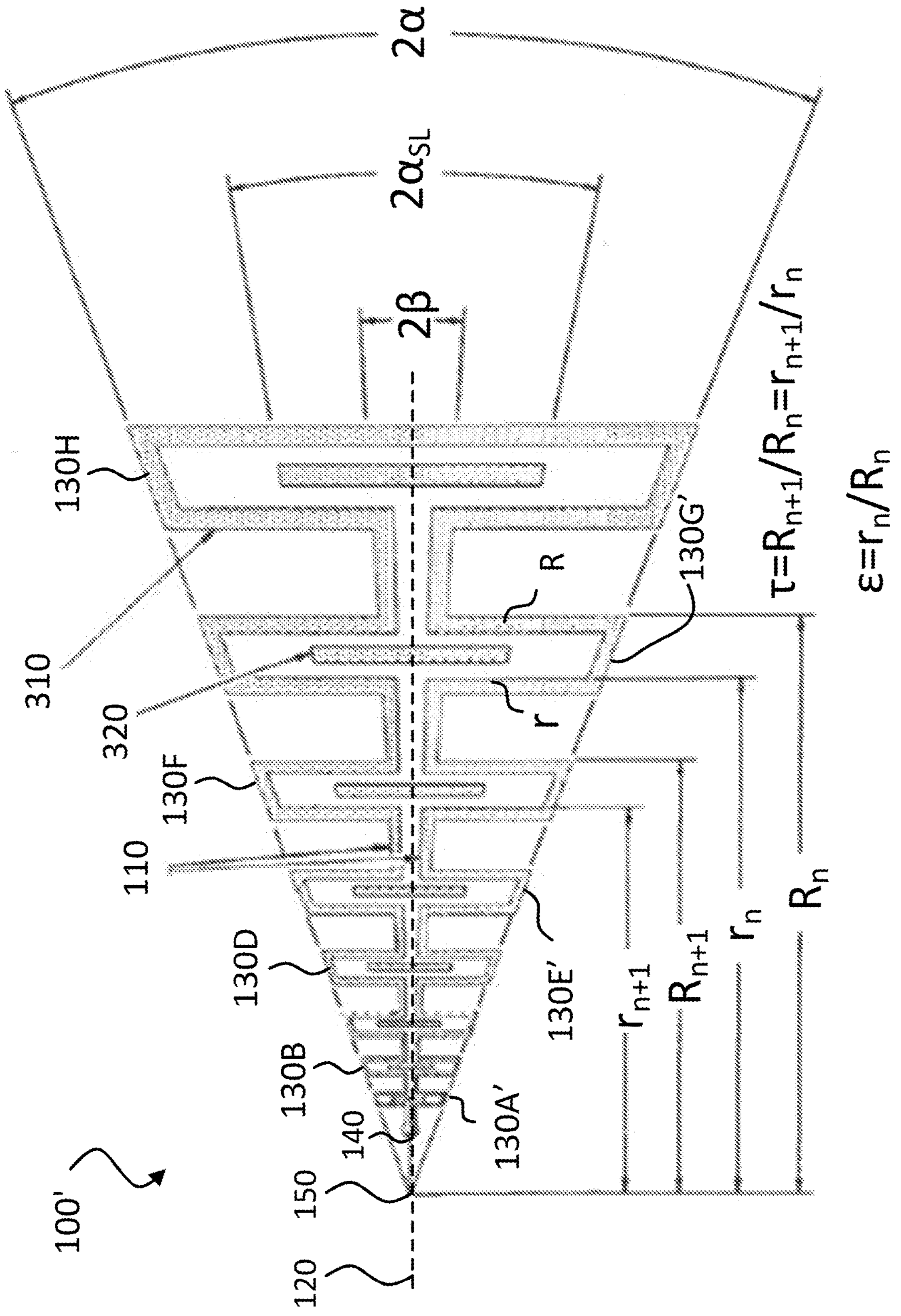
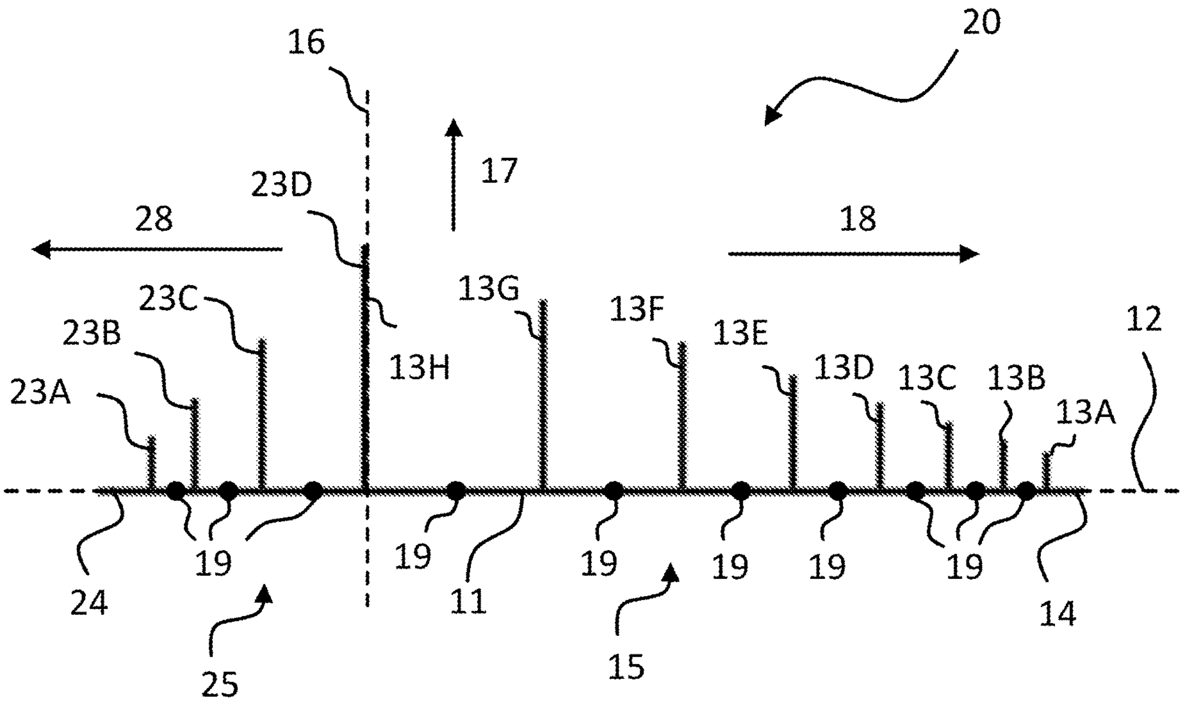
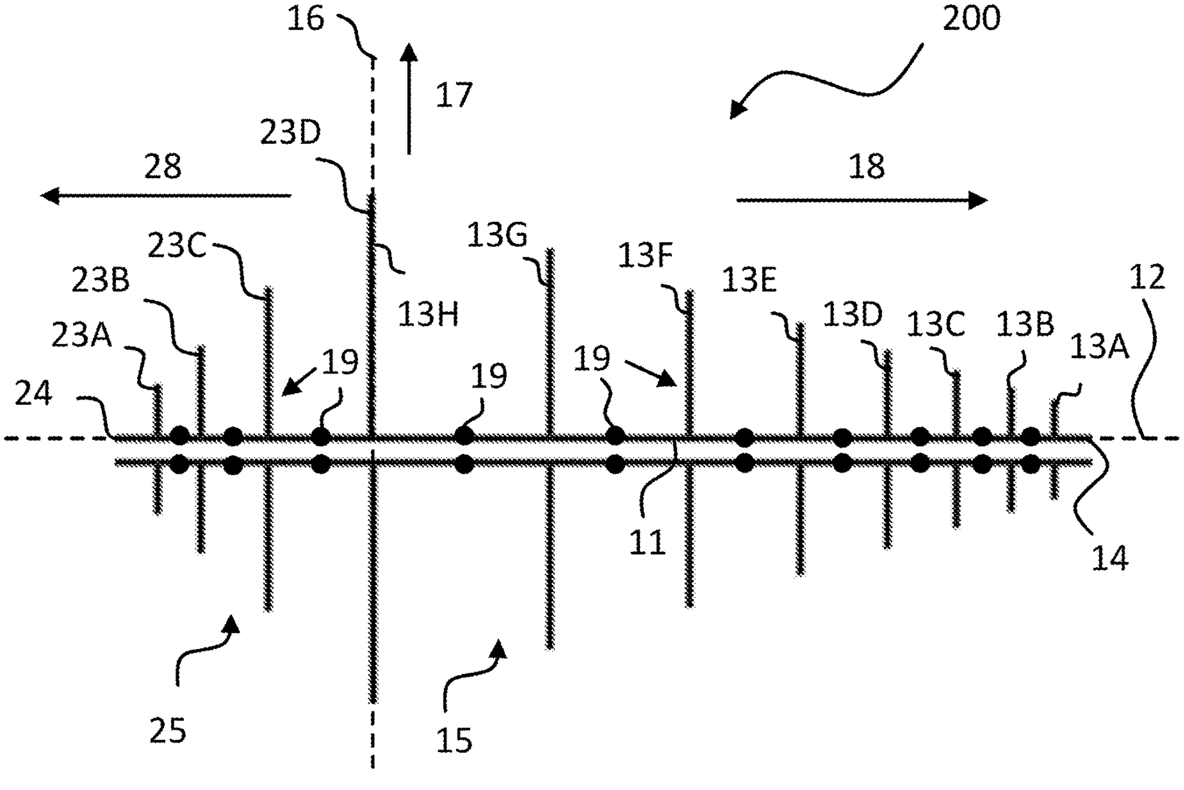

2α
$2\alpha_{SL}$
2β
130H
310
320
130F
110
130D
130B
140
150
100'
120
130A'
130E'
130G'
R
r
r_{n+1}
R_{n+1}
r_n
R_n
$\tau=R_{n+1}/R_n=r_{n+1}/r_n$
$\varepsilon=r_n/R_n$

FIG. 3



16
20
17
23D
28
18
23C
13G
13F
23B
13E
12
13H
13D
13C
13B
23A
13A
19
19
19
19
19
19
19
24
11
14
15
25

FIG. 4



16
200
17
23D
28
18
23C
13G
13F
23B
13E
13H
13D
13C
13B
12
23A
13A
19
19
19
19
24
11
14
25
15

FIG. 5

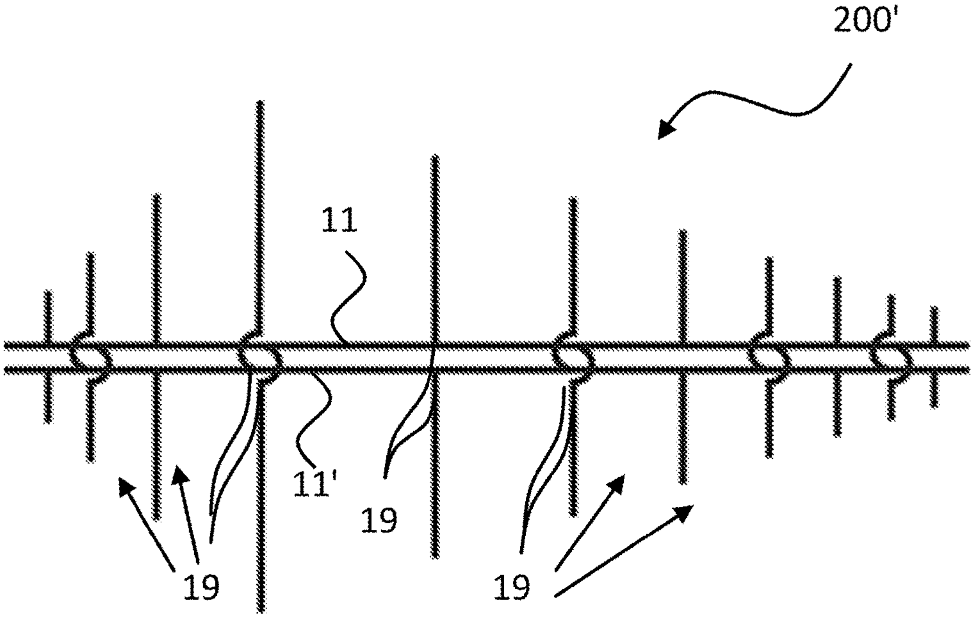

200'
11
11'
19
19
19

FIG. 6

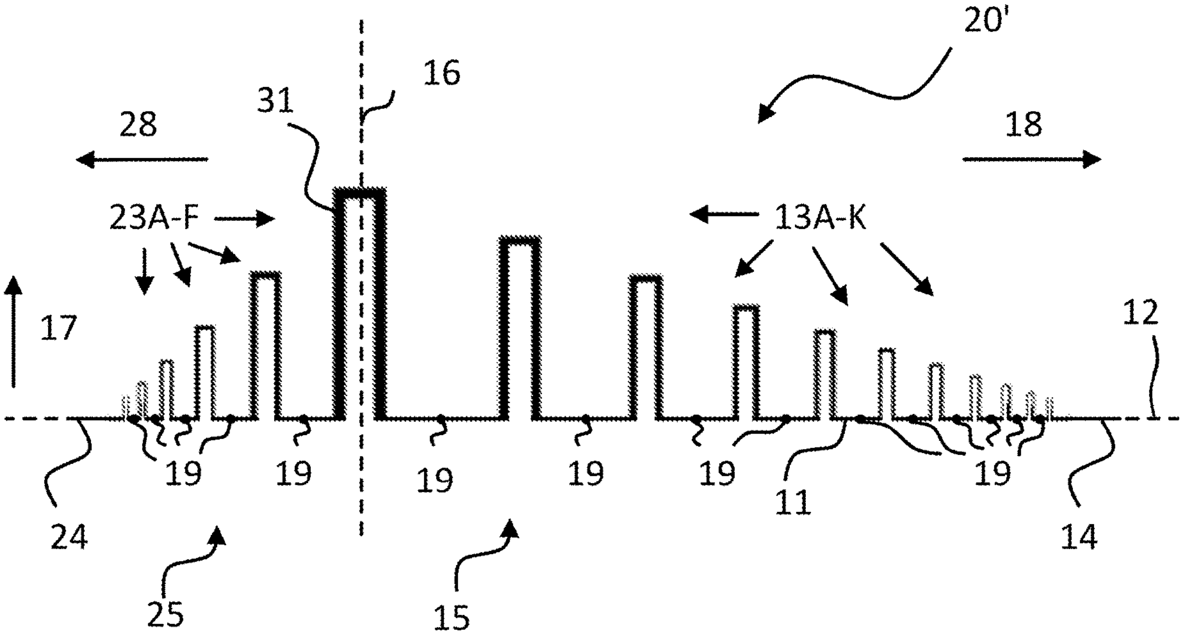

20'
16
31
28
18
23A-F
13A-K
17
12
19
19
19
19
19
11
19
24
14
25
15

FIG. 7

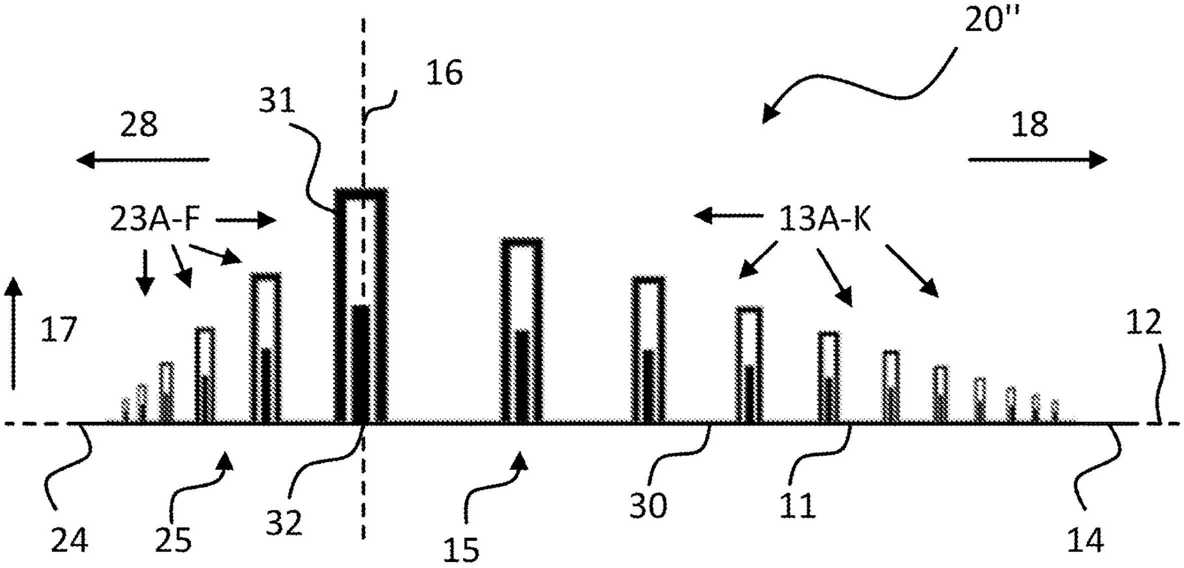

20''
16
31
28
18
23A-F
13A-K
17
12
24
25
32
15
30
11
14

FIG. 8

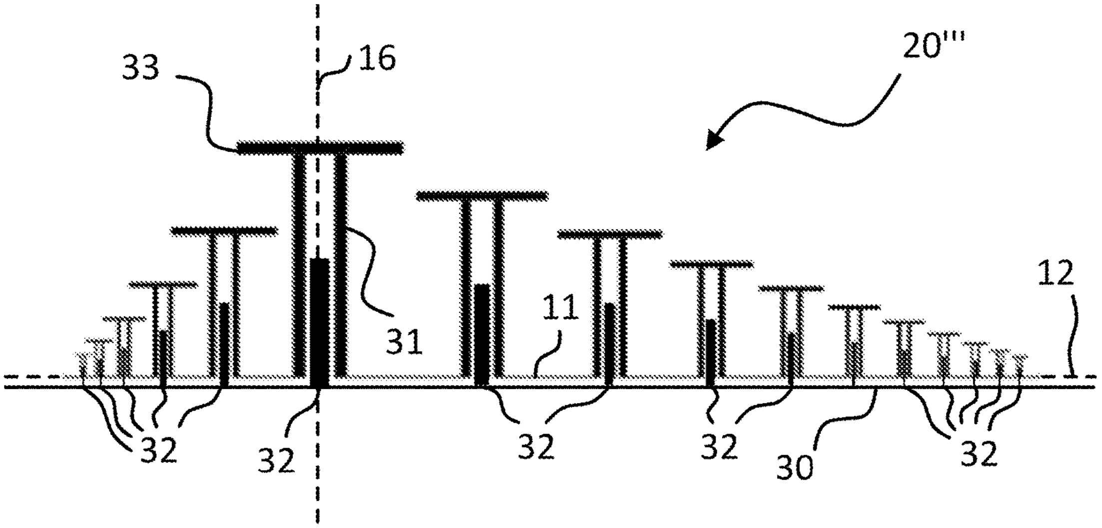

20'''
33
16
31
11
12
32
32
32
32
30
32

FIG. 9

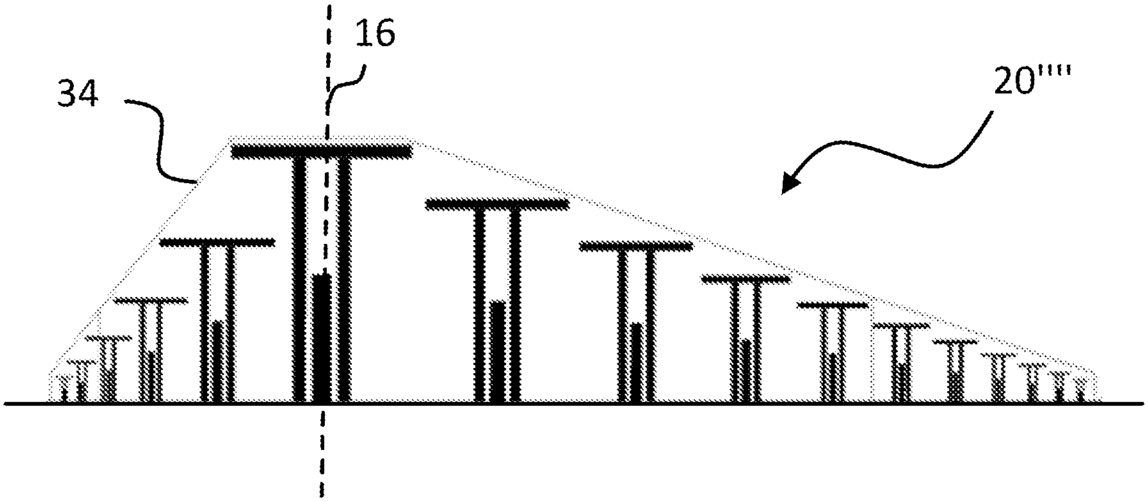


FIG. 10

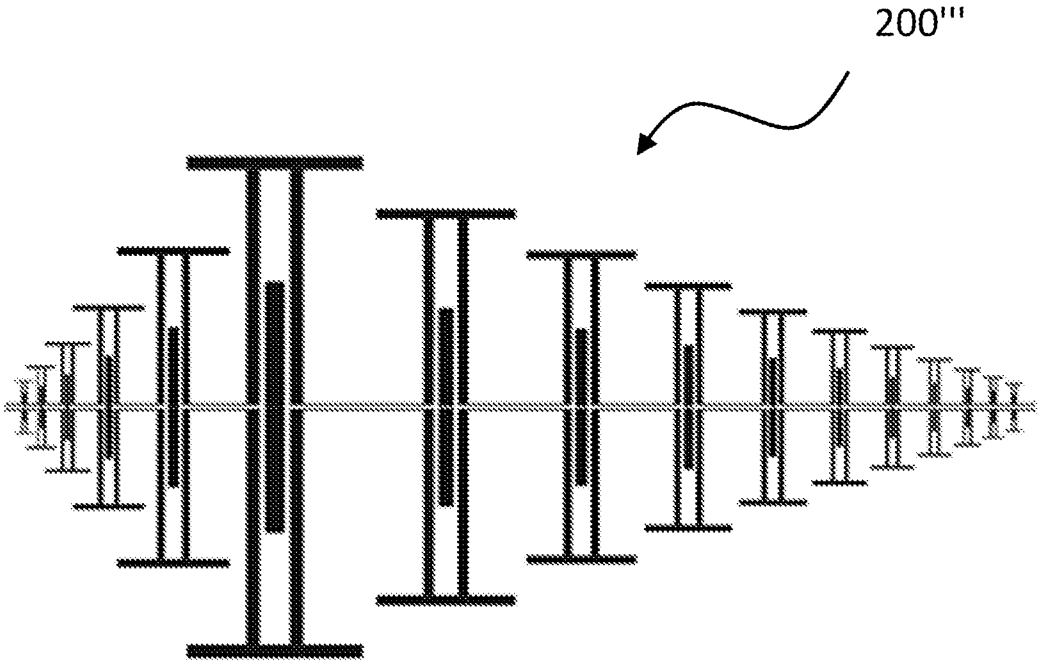


FIG. 11

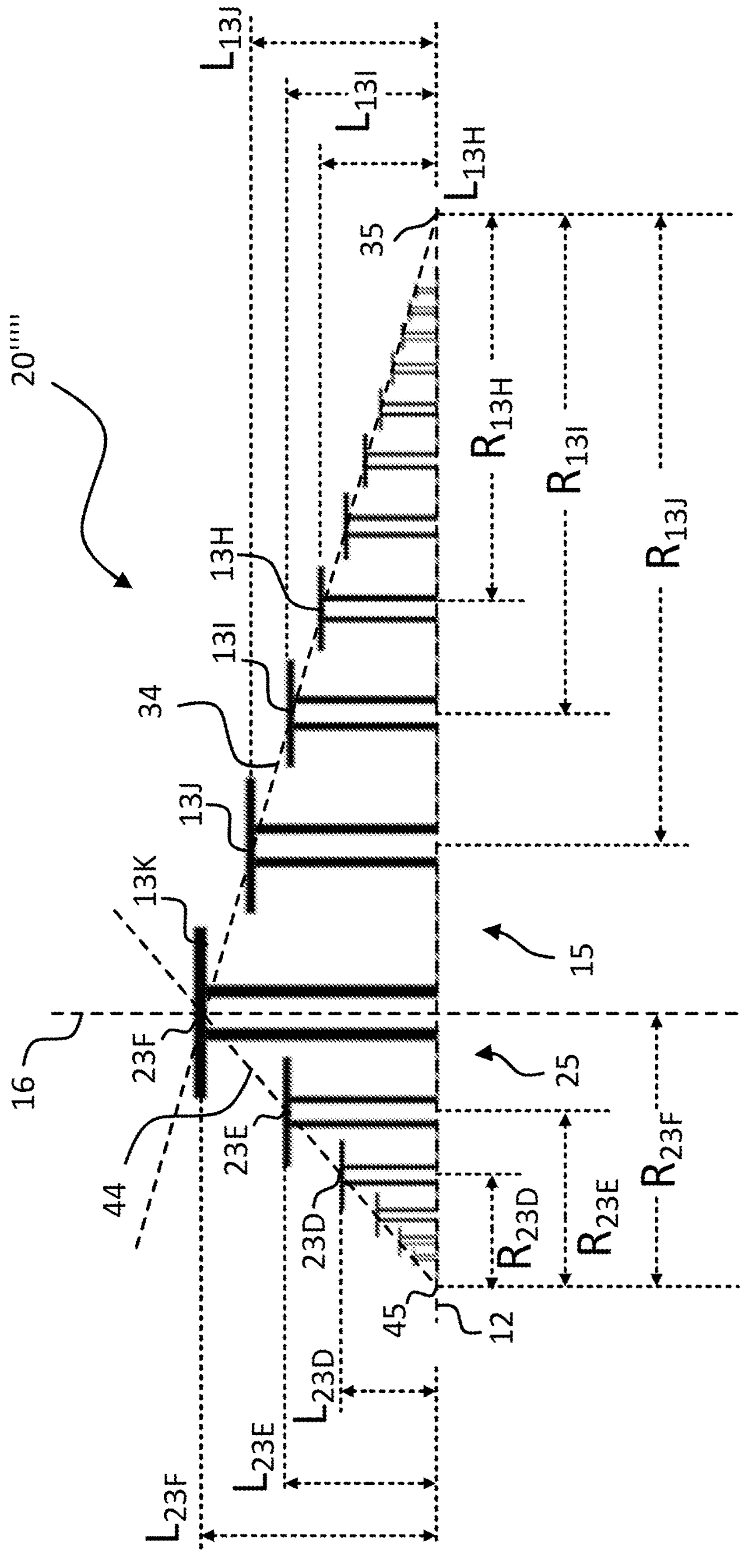

L_{13J}
L_{13I}
L_{13H}
35
20'''''
R_{13H}
R_{13I}
R_{13J}
13H
13I
34
13J
13K
15
16
23F
25
44
23E
23D
R_{23D}
R_{23E}
R_{23F}
45
12
L_{23D}
L_{23E}
L_{23F}

FIG. 12

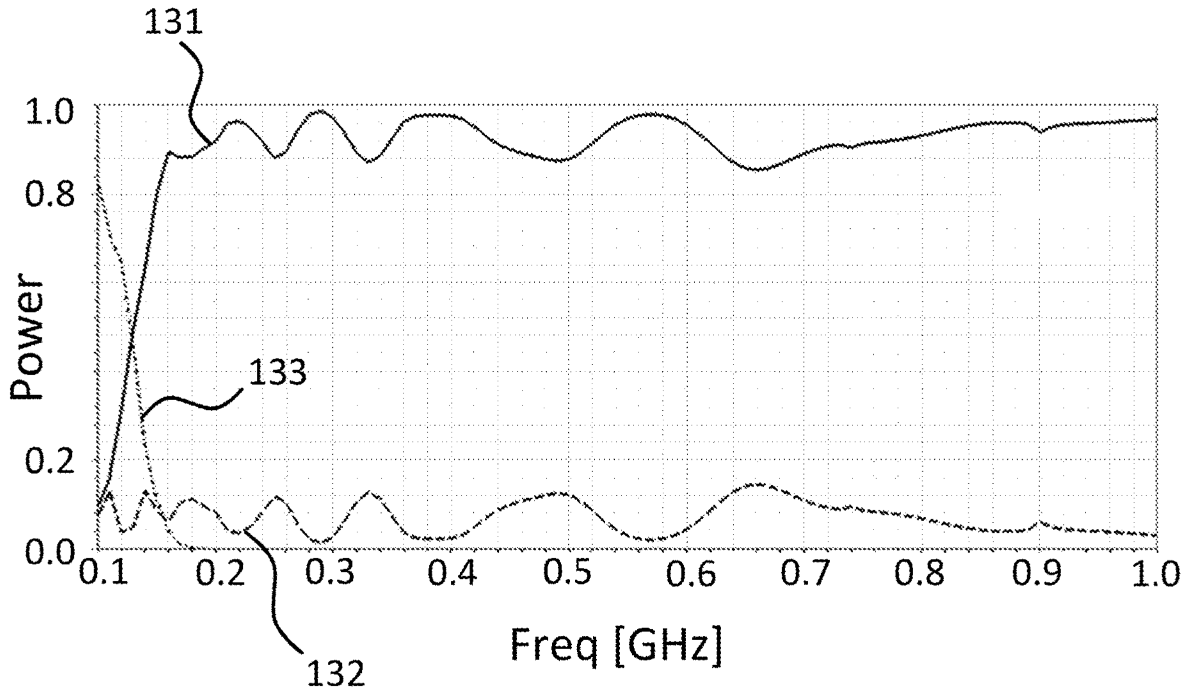

131
133
132
1.0
0.8
0.2
0.0
Power
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Freq [GHz]

FIG. 13

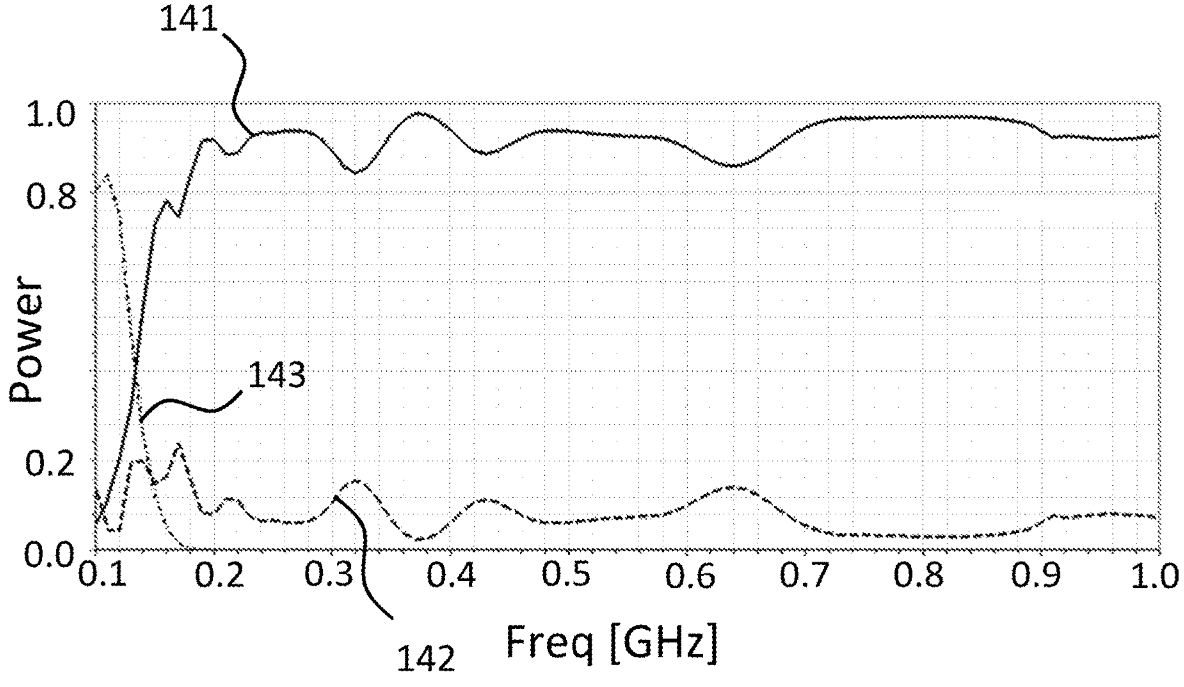

141
143
142
1.0
0.8
0.2
0.0
Power
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Freq [GHz]

FIG. 14

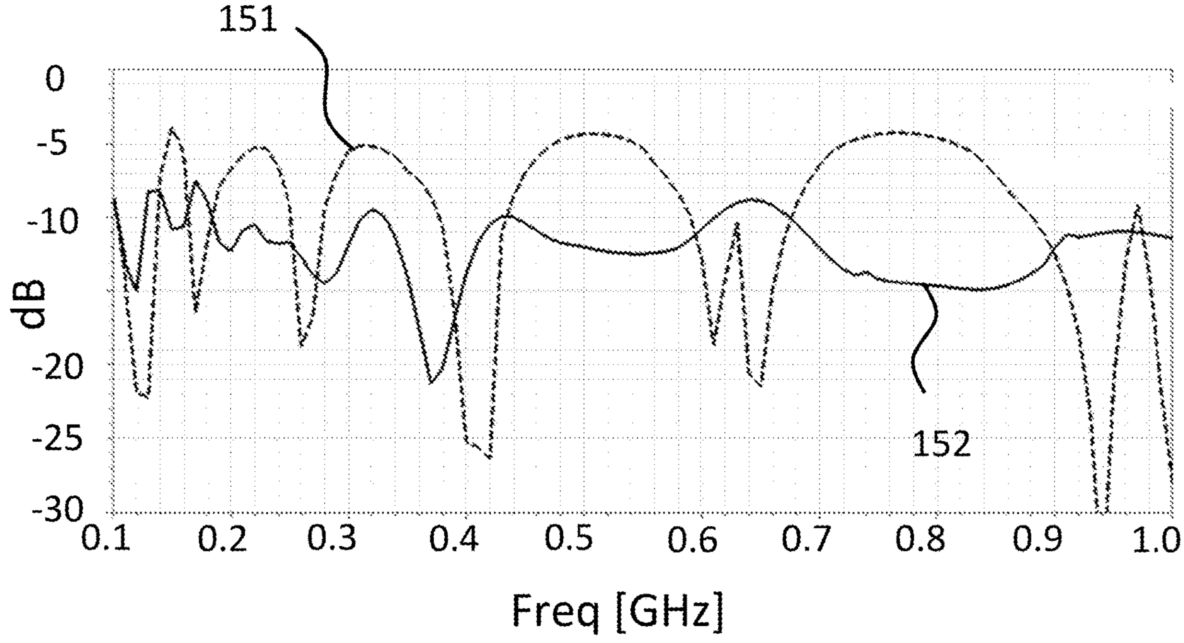

151
152
0
-5
-10
-20
-25
-30
dB
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Freq [GHz]

FIG. 15

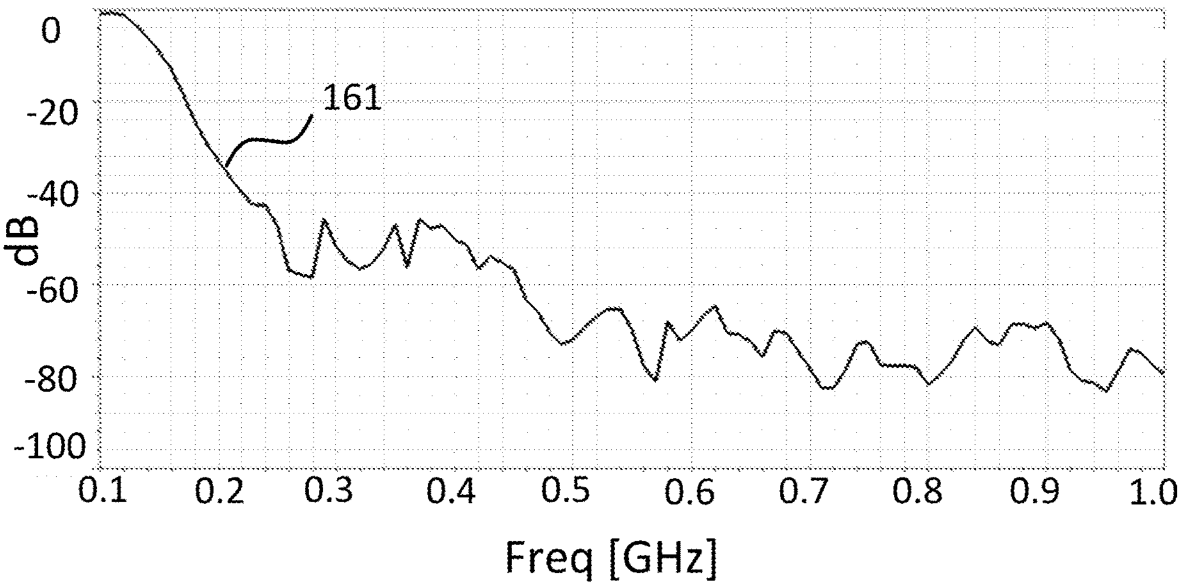

161
0
-20
-40
-60
-80
-100
dB
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Freq [GHz]

FIG. 16

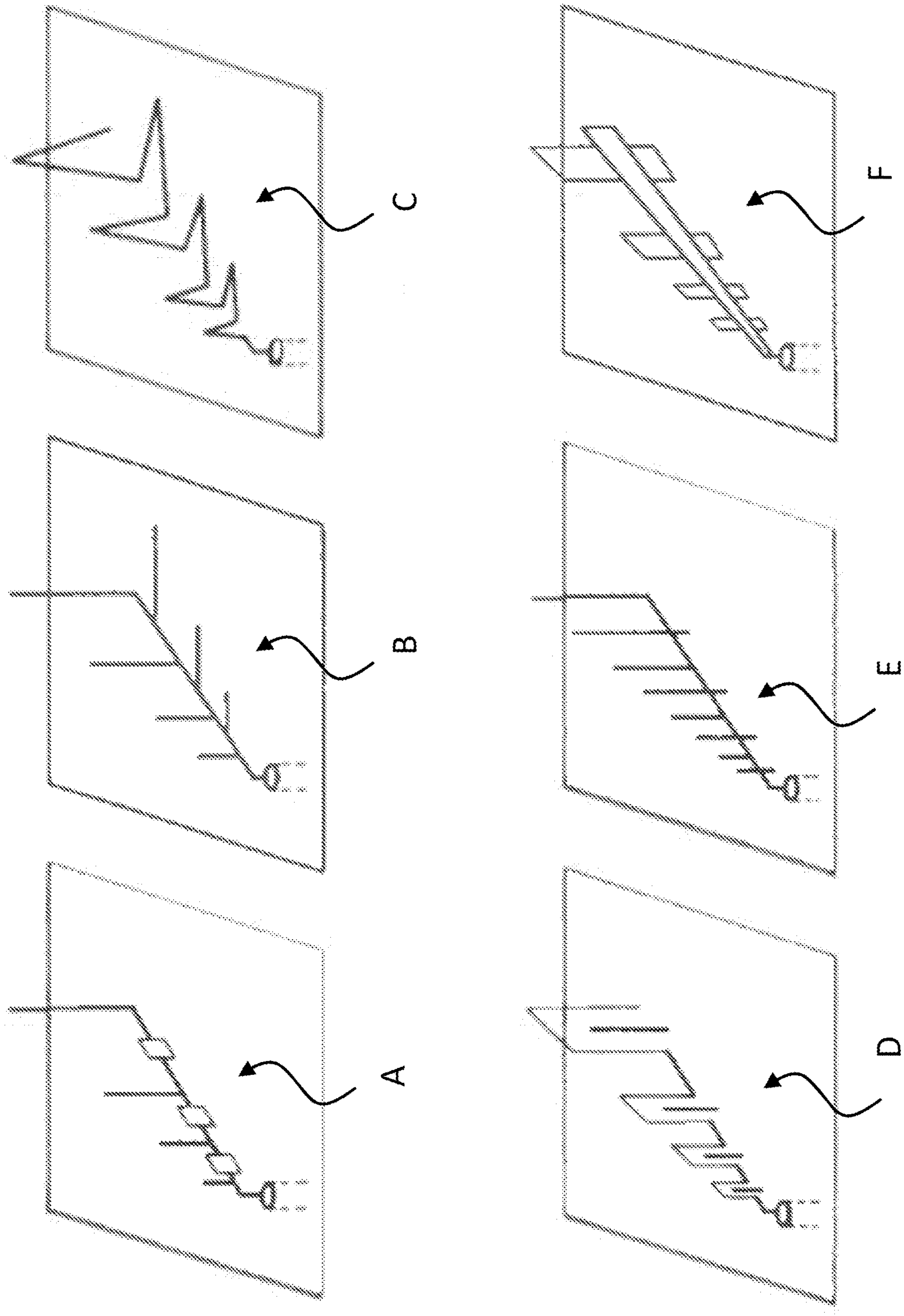


FIG. 17

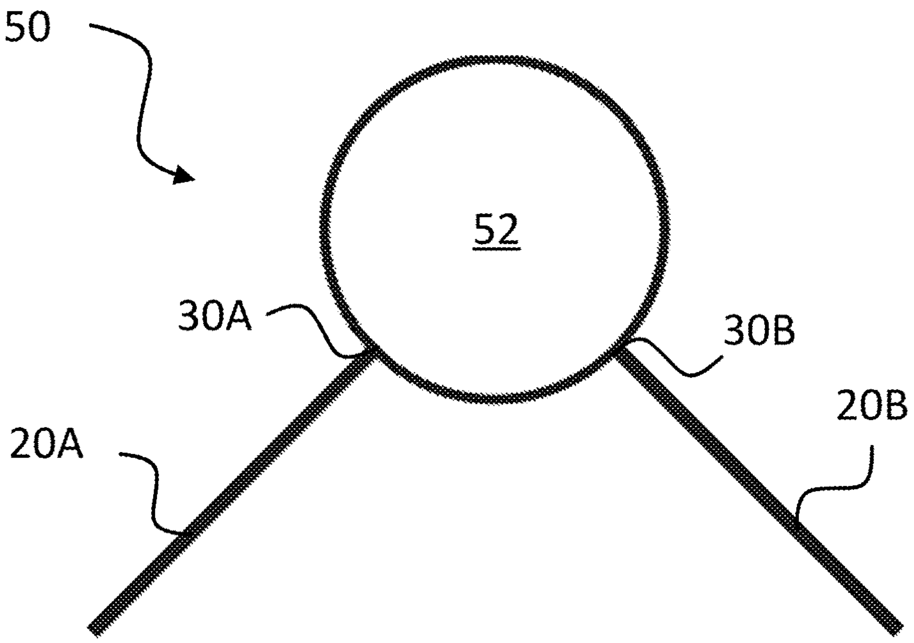


FIG. 18

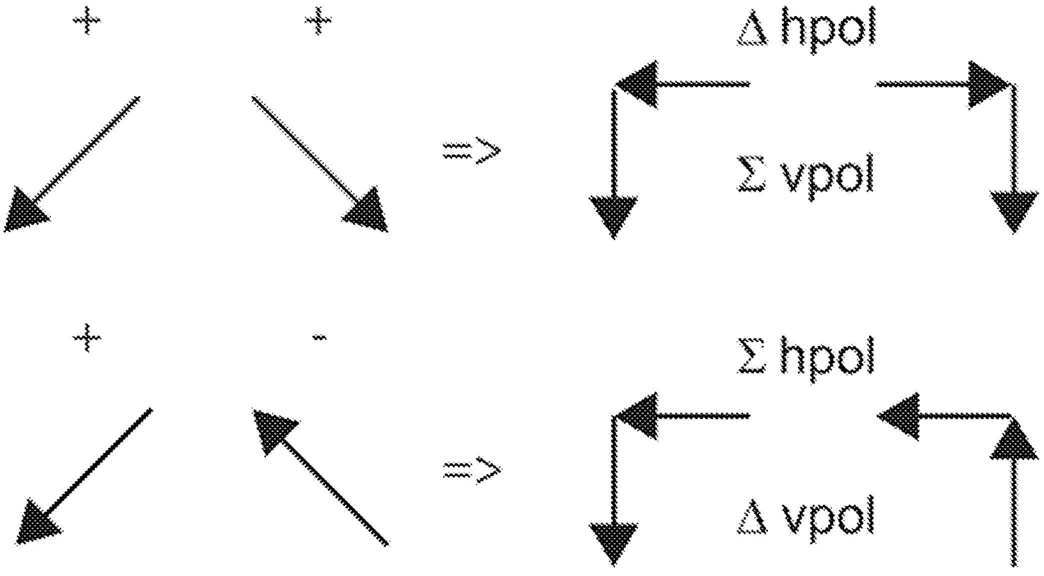


FIG. 20

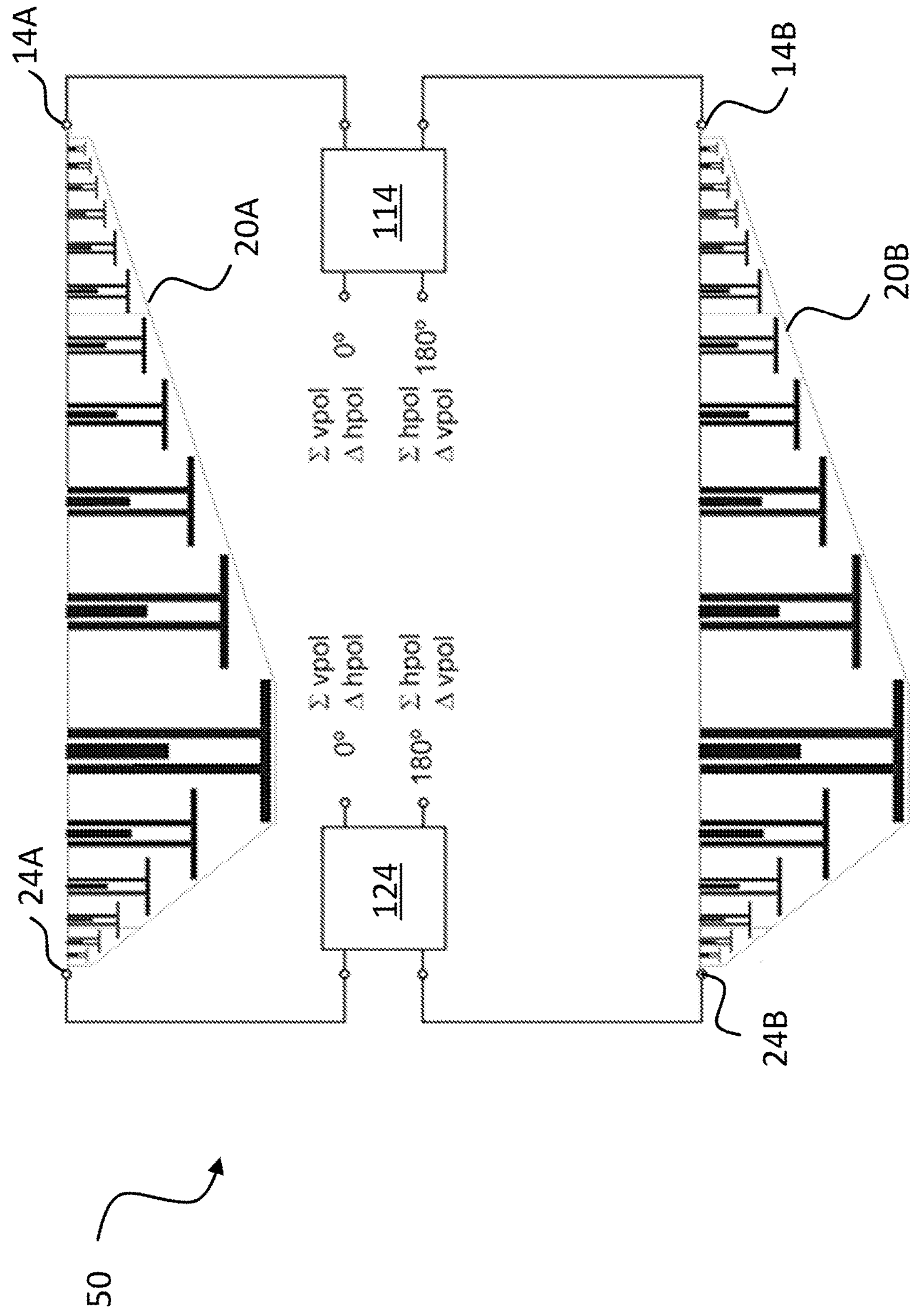

14A
20A
24A
14B
20B
24B
114
124
Σ vpol
Δ hpol
0°
Σ hpol
Δ vpol
180°
Σ vpol
Δ hpol
0°
Σ hpol
Δ vpol
180°
50

FIG. 19

A DUAL DIRECTIONAL LOG-PERIODIC ANTENNA AND AN ANTENNA ARRANGEMENT

TECHNICAL FIELD

[0001] The present disclosure relates to an antenna. Further, the present disclosure relates to an antenna arrangement.

BACKGROUND ART

[0002] A log-periodic antenna is partly defined in the following: If an antenna is mapped onto itself given a scaling of the dimensions with a factor 1/τ, it obtains the same antenna characteristics at frequencies f and τ*f. Antenna characteristics become periodic with respect to the logarithm of the frequency and the period will be |log(τ)|. Antennas designed using these principles are called "log-periodic" antennas. The scaling condition described is a condition necessary but not sufficient to obtain log-periodically varying antenna characteristics. In reality, no antennas are truly "log-periodic". A real antenna is of course truncated at the "large size end" and "small size end", which results in bandwidth limitations. The large size end determines the lower frequency limit and the small size end (usually located near the feed point) determines the higher frequency limit.

[0003] A traditional log-periodic antenna often consists of a series of dipole antenna elements positioned along a support boom lying along an axis. The support boom also acts as a (two conductor) feed line. Consecutive elements along the feed line increase in length seen from the feed point positioned at one end of the feed line. The elements are spaced at intervals following given scaling rules, likewise the length of the elements increase according to these rules of scaling. The dipole elements are resonant at different frequencies in order to cover the whole frequency range of the antenna. Often a traditional antenna also radiates in the "backfire direction", i.e. in the direction opposite to the wave traveling along the feed line, by virtue of "phase reversal" between consecutive elements along the feed line. Such a traditional antenna is often referred to as a log-periodic dipole array antenna.

[0004] There are also monopole versions of log-periodic array antennas. In order to obtain "backfire radiation" in such antennas special measures have to be taken in order to obtain "phase reversal". All monopole antennas require a ground plane. In a practical situation the ground plane does not have to be particularly large, nor even flat.

[0005] CA713169 discloses an antenna structure of the logarithmically periodic type. The structure consists of a longeron to which radiating elements are attached. The lengths of the radiating elements are proportional to their distance from the apex and are trapezoidal or triangular in shape, the radiating elements lying in the planes forming the angle between the arrays.

[0006] Log-periodic arrays are interesting for low frequency electronic warfare applications both for jamming and passive direction finding. However, log-periodic dipole or monopole arrays are bulky and by necessity protrude from the vehicle or construction they are installed on. Their complementary counterpart: log-periodic slot arrays can be made conformal to the surface of a vehicle but on the other hand they require bulky cavities beneath them in order to work; these cavities often also have to be at least partially filled with absorbers, which often is unacceptable in applications requiring high power transmission.

SUMMARY OF THE INVENTION

[0007] The invention relates to an antenna. The antenna comprises a feed line having first and second ends on opposite sides of the feed line, wherein a transmission axis is defined as the axis extending between the first and second ends of the feed line. Further, the antenna comprises a plurality of antenna elements arranged along the feed line, protruding from the transmission axis. The antenna also comprises a first port at the first end of the feed line. At a first part of the antenna, the feed line, from the first port towards a reference point along the transmission axis, comprises antenna elements of gradually increasing length, in a direction perpendicular to the transmission axis, and gradually increasing mutual distance between two consecutive antenna elements along the transmission axis, such that the antenna, by means of the antenna elements located at the first part of the antenna, is configured to radiate in a first direction along the transmission axis from the reference point towards the first port during excitation in the first port. Yet further, the antenna comprises a second port at the second end of the feed line. At a second part of the antenna, the feed line, from the second port towards the reference point along the transmission axis, comprises antenna elements of gradually increasing length, in a direction perpendicular to the transmission axis, and gradually increasing mutual distance between two consecutive antenna elements along the transmission axis, such that the antenna, by means of the antenna elements located at the second part of the antenna, is configured to radiate in a second direction along the transmission axis from the reference point towards the second port during excitation in the second port.

[0008] What is obtained is a dual directional antenna, radiating in two opposite directions when fed in two different ports. The dual directional antenna saves considerable space compared to two separate single directional antennas.

[0009] In one example, phase reversal is implemented between every two consecutive antenna elements. Phase reversal between every two consecutive antenna elements is a necessity to obtain a "backfire radiating" antenna, i.e. an antenna which has a main lobe pointing in the direction opposite to the direction of the wave traveling along the feed line. Phase reversal also increases the directivity, and thereby the gain, of the antenna considerably in comparison to a log-periodic antenna without phase reversal which radiates mainly along the transmission line.

[0010] According to another example, the antenna comprises a ground plane arranged in parallel with the transmission axis and wherein the antenna elements protruding from the transmission axis are protruding away from the ground plane in a direction perpendicular to the ground plane. An advantage of that the ground plane is attached to the antenna is that the antenna will work also without an external surface acting as a ground plane.

[0011] In yet another example, the antenna elements are protruding in a direction perpendicular to the transmission axis. An advantage is that the antenna is easy to produce if the antenna elements are protruding in a direction perpendicular to the transmission axis. Further, less space in the directions along the transmission axis is needed.

[0012] According to further example, each antenna element is formed as a folded antenna element as part of the feed line protruding from the transmission axis. An advantage is that phase reversal is inherent in the meander-line constituting the elements. Thus, the folded antenna elements are suitable for the design of an antenna with the main lobe in the "backfire" direction.

[0013] According to another example, each antenna element further comprises a parasitic element protruding from the ground plane into the folded antenna element. The parasitic element is configured to tune phase progression and element excitation along the feed line and to improve phase reversal between every two consecutive antenna elements. With the parasitic element the radiation resistance of the elements can be tuned. The parasitic element provides an additional feature which improves the performance of the antenna element in terms of optimisation, stabilisation and sensitivity to tolerances.

[0014] In another example, a reference antenna element is positioned at the reference point along the transmission axis, belonging to both the first part of the antenna and the second part of the antenna, wherein the reference antenna element is the longest antenna element, wherein the reference antenna element together with the antenna elements located at the first part of the antenna are configured to radiate in the first direction during excitation in the first port and wherein the reference antenna element together with the antenna elements located at the second part of the antenna are configured radiate in the second direction during excitation in the second port. An advantage is that less space is required in the directions along transmission line, since the reference antenna element is shared by the first and second parts of the antenna.

[0015] In further example, the antenna elements are T-shaped or disc shaped antenna elements. An advantage is that capacitive loading is achieved which results in that each antenna element has a shorter length than the corresponding antenna elements without capacitive loading, i.e. not being T-shaped or disc shaped.

[0016] In a yet further example, at the first part of the antenna, an imaginary first straight line can be formed between the centre of the top of each antenna element, such that the extension of the imaginary first straight line crosses the extension of the transmission axis at a first vertex, and wherein, at the second part of the antenna, an imaginary second straight line can be formed between the centre of the top of each antenna element, such that the extension of the imaginary second straight line crosses the extension of the transmission axis at a second vertex.

[0017] Further, at the first part of the antenna, the relation between the length of each antenna element and its distance to the first vertex is constant, and the distance between each consecutive antenna element and the first vertex, starting from the first vertex, increases with a first constant factor τ_1 for each consecutive antenna element, and wherein at the second part of the antenna, the relation between the length of each antenna element and its distance to the second vertex is constant, and the distance between each consecutive antenna element and the second vertex, starting from the second vertex, increases with a second constant factor τ_2 for each consecutive antenna element. An advantage is that a dual directional log-periodic antenna is obtained.

[0018] According to one example, each of the first part of the antenna and the second part of the antenna comprises at least three antenna elements, preferably at least five antenna elements, more preferably at least seven antenna elements. An advantage of more antenna elements is that the gain increases and reflection losses decrease.

[0019] According to another example, each of the antenna elements is a monopole. An advantage is that attachment of the antenna to a surface is facilitated.

[0020] According to a further example, each of the first part and the second part of the antenna is essentially log-periodic. Further, the antenna is easier to produce than if strictly log-periodic. Moreover it can be tuned over narrow-band regions in the otherwise general broadband designed antenna.

[0021] In another example, each of the first part and the second part of the antenna is a Log-Periodic Folded Monopole Array Antenna, LPFMA.

[0022] In yet another example, the antenna is designed to operate between 0.15 GHz and 1.0 GHz. An advantage is that considerable space is saved by using a dual directional antenna in this frequency spectrum. The space saved along the transmission axis is approximately 15% to 20% compared to having two separate antennas. This is very valuable when the antennas mounted to a vehicle.

[0023] Further, the invention relates to an antenna arrangement. The antenna arrangement comprises an elongated member and first and second antennas. Each of the antennas is attached to a respective surface along the elongated member. Each respective surface is arranged to constitute at least part of the ground plane for the first and second antennas, respectively. The antenna elements are protruding away from the respective surface, such that the transmission axes of the first and second antennas are parallel to each other and such that the antenna elements of the first antenna are protruding in a direction inclined to the antenna elements of the second antenna. An advantage is that arbitrary polarisation states can be obtained in the main beam directions (along the transmission axis) when combining the two dual directional antennas.

[0024] In one example, the first port of the respective antenna are connected to each other via a first 180° hybrid, such that each respective first port can be operated either in phase or 180° out of phase, and the second port of the respective antenna are connected to each other via a second 180° hybrid, such that each respective second port can be operated either in phase or 180° out of phase. Thus four different types of patterns are obtained. An advantage is that these patterns can be combined and compared to each other for passive direction finding purposes. By amplitude comparisons, unwanted signals can be blocked and only measurements in the angular range giving uniqueness allowed. The prerequisite is that polarisation discrimination can be made, e.g. linear vertical, linear horizontal or circular. Another advantage is that the system also can be used for polarization matched jamming (linear vertical or horizontal) given that some polarization discrimination can be made.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The disclosure will be further described with reference to the accompanying drawings:

[0026] FIG. **1** illustrates a schematic drawing of a log-periodic monopole antenna according to prior art.

[0027] FIG. **2** shows an example of a log-periodic dipole antenna according to prior art.

[0028] FIG. **3** illustrates a log-periodic folded slot or dipole array with parasitic elements according to prior art.

[0029] FIG. **4** shows a schematic drawing of a dual directed log-periodic monopole antenna.

[0030] FIG. **5** shows a schematic drawing of a dual directed log-periodic dipole antenna.

[0031] FIG. **6** illustrates a schematic drawing of an example of a dual directed log-periodic dipole antenna with an example of phase reversal between the antenna elements.

[0032] FIG. **7** shows an example of a dual directed folded monopole antenna.

[0033] FIG. **8** illustrates an example of a dual directed folded monopole antenna with parasitic elements.

[0034] FIG. **9** shows an example of a dual directed monopole antenna with parasitic elements and T-shaped antenna elements.

[0035] FIG. **10** illustrates an example of a dual directed folded monopole antenna embedded in dielectric.

[0036] FIG. **11** illustrates an example of a dual directed dipole antenna.

[0037] FIG. **12** shows the geometry of a dual directed log-periodic monopole antenna.

[0038] FIG. **13** illustrates performance of a single directed folded monopole antenna.

[0039] FIG. **14** shows performance of the dual directed folded monopole antenna of FIG. **9**.

[0040] FIG. **15** illustrates reflection in a first port and in a second port of the antenna of FIG. **9**.

[0041] FIG. **16** shows transmission between a first port and a second port of the antenna of FIG. **9**.

[0042] FIG. **17** shows symmetric log-periodic monopole antennas with phase reversal.

[0043] FIG. **18** schematically illustrates an antenna arrangement comprising two antennas being inclined to each other being mounted on an elongated body.

[0044] FIG. **19** shows how the ports of the antennas are connected to each other via two 180° hybrids.

[0045] FIG. **20** illustrates how signals from two orthogonal polarized antennas are summed in the forward direction when connected to a 180° hybrid.

DETAILED DESCRIPTION

[0046] In this disclosure the term “antenna” includes the terms “antenna array” and “array”. FIG. **1** illustrates a schematic drawing of a log-periodic monopole antenna **10** according to prior art. The antenna **10** comprises a feed line **11** having first and second ends on opposite sides of the feed line **11**. A transmission axis **12** is defined as the axis extending between the first and second ends of the feed line **11**. Further, the antenna **10** comprises a plurality of antenna elements **13**A, **13**B, **13**C, **13**D, **13**E, **13**F, **13**G, **13**H arranged along the feed line **11**, protruding from the transmission axis **12**. The antenna **10** also comprises a port **14** at the first end of the feed line **11**, wherein a part **15** of the antenna **10**, from the port towards a reference point **16** along the transmission axis **12**, comprises antenna elements **13**A-H of gradually increasing length, in a direction **17** perpendicular to the transmission axis **12**, and gradually increasing mutual distance between two consecutive antenna elements **13**A-**13**B, **13**B-**13**C, **13**C-**13**D, **13**D-**13**E, **13**E-**13**F, **13**F-**13**G, **13**G-**13**H along the transmission axis **12**. Further, between each antenna element phase reversal **19** is implemented in order to make the antenna radiate in a first direction **18**, the “backfire” direction, increase the directivity, and thereby the gain, of the antenna **10**. The dot **19** is an abstract symbolisation of phase reversal which can be implemented in different ways. Thereby the antenna **10**, by means of the antenna elements **13**A-H and the phase reversals **19**, is configured to radiate in the first direction **18** along the transmission axis **12** from the reference point **16** towards the port **14** during excitation in the port **14**.

[0047] The first log-periodic antenna was reported in literature during the 1950’s. The most common form of log-periodic antenna, the Log-Periodic Dipole Array (LPDA) is presented in FIG. **2**. Referring to FIG. **2**, the antenna **100** is fed from the left side via a coaxial line **101**, the coaxial line feeds a two-conductor line **120**, **120'** via a port **140**. The antenna **100** comprises four monopole antenna elements **130**A, **130**B, **130**C, **130**D protruding in a first direction, perpendicular to the two-conductor line **120**, **120'**, every second antenna element **130**A, **130**C from the upper two-conductor line **120** and every second antenna element **130**B, **130**D from the lower two-conductor line **120'**. Similarly, the antenna **100** comprises four monopole antenna elements **130**A', **130**B', **130**C', **130**D' protruding in a second direction, perpendicular to the two-conductor line **120**, **120'**, opposite of the first direction, every second antenna element **130**A', **130**C' from the lower two-conductor line **120** and every second antenna element **130**B', **130**D' from the upper two-conductor line **120'**. Elements **130**A and **130**A' together constitute a dipole, elements **130**B and **130**B' together constitute a dipole and so on. In this way, phase reversal is obtained by alternating the position of each dipole half along the two-conductor line. A wave progresses down the two-conductor line **120**, **120'** and encounters the successive dipole pairs **130**A-**130**A', **130**B-**130**B', **130**C-**130**C', **130**D-**130**D' down the line and radiates. The phasing of the successive elements **130** is such that it radiates to the left towards the port **140**. The main beam maximum occurs in the so called backfire direction (to the left) because of the phase reversal between consecutive dipoles. If the phase reversals are not included, radiation will mainly occur close to the end-fire direction, to the right, meaning radiation from shorter elements successively illuminating longer elements to the right causing scattering and blockage producing scalloped patterns and erratic impedance behaviour. This is called end effect and has been observed many times.

[0048] An attempt to explain the basic operation of this type of log-periodic antenna is given in the following: Say that the dipole pairs are located at points $x=0$, $x=p_1$, $x=p_2$ and $x=p_3$ and so on. A wave which propagates along the two-conductor line (given TEM-conditions and harmonic time dependence $e^{i\omega t}$) will have a phase of 0, e^{-ikp_1}, e^{-ikp_2} and e^{-ikp_3}. By observing the radiation integrals, one can see that constructive addition occurs in the end-fire direction, i.e., backfire direction $-\hat{x}$, if dipoles placed at these positions are excited with phase 0, e^{ikp_1}, e^{ikp_2} and e^{ikp_3}. This is, within certain limits, the case regardless of positions but if the antenna is to appear as log-periodic, scaling condition must of course be fulfilled. By reversing the phase at consecutive positions of the dipole-pairs, the condition above is satisfied. The phase reversal is obtained by alternating the position of each dipole half along the two-conductor line as can be seen in FIG. **2**. Usually log-periodic antennas are not log-periodic in every aspect. As can be seen in FIG. **2**, the feed line is not scaled from antenna element to antenna element, nor is the dipole width, but the most essential dimensions are the dipole lengths and the consecutive distances between elements and a vertex in front of the antenna, which are both scaled by the same factor.

[0049] In FIG. **3**, yet another type of log-periodic antenna is shown, a log-periodic folded slot array **100'** with parasitic slot elements **320**. The antenna **100'** comprises eight antenna elements **130**A-**130**H, protruding in a direction, perpendicular to the transmission axis **120**, and eight antenna elements **130**A'-**130**H', protruding in a direction, perpendicular to the transmission axis **120**, in the opposite direction of the eight antenna elements **130**A-**130**H. Further, a feed line **110** of which the main extension is arranged almost parallel, but diverging with a small angle β in relation to the transmission axis **120**, is connected to a port **140**.

[0050] The feedline **110** also constitutes each of the antenna elements **130**A-H. For each antenna element **130**A-H, the feedline **110** protrudes perpendicular to the transmission axis **120** until the feedline **110**, **310** reaches the extension of a line by an angle α to the transmission axis **120** from a vertex **150**. Thereafter, the feedline **110**, **310** follows the extension of the line by an angle α to the transmission axis **120** for a distance $R_{n+1}-r_{n+1}$. Then, the feedline **310** turns back, perpendicular to the transmission axis **120** until the feedline **310** reaches the extension of the feedline **110**, directed by an angle β to the transmission axis **120** from the vertex **150**.

[0051] Each consecutive antenna element **130**A-H, starting from the port **140**, increases with the factor τ. The factor τ is calculated by measuring the distance from each of two consecutive antenna elements **130**A-H to the vertex **150**. In one example, the distance from each of two consecutive antenna elements **130**A-H to the vertex **150** is measured at a first leg, r, of each antenna element, seen from the port **140**. In another example, the distance from each of two consecutive antenna elements **130**A-H to the vertex **150** is measured at a second leg, R, of each antenna element **130**A-H, seen from the port **140**. The relation between the factor t and the distance from each of two consecutive antenna elements **130**A-H to the vertex **150** is explained by:

$$\tau=R_{n+1}/R_n=r_{n+1}/r_n;$$

where n is the current antenna element **130**A-H, seen from the port **140**.

[0052] Further, the width of each antenna element **130**A-H is dependent of the distance from the current antenna element **130**A-H to the vertex **150**. This relation is given by the factor ε: $\varepsilon=r_n/R_n$.

[0053] The feedline **110**, **310** forms antenna elements **130**A-H, **130**A'-H' on both sides of the transmission axis **120** such that a slot dipole antenna is formed.

[0054] Within each antenna element **130**A-H a parasitic slot element **320** is provided. The parasitic slot element **320** extends, on both sides of the transmission axis **120**, from the transmission axis **120** to the extension of the line by an angle α_{SL} to the transmission axis **120** from the vertex **150**. The relation between the angle α, α_{SL}, β is given by: $\alpha>\alpha_{SL}>\beta$, $\alpha>>\beta$. The parasitic slot element **320** provides an extra design parameter by which the phase progression along the line and phase excitation of the elements along the line can be tuned when elements are resonant; the phase reversal is inherent in the antenna element due to the meander type of feed line exhibited. This antenna is symmetrical with respect to the transmission axis **120** and a plane orthogonal to the elements, which gives interesting properties. It can also easily be implemented as its self-complementary counterpart, a folded version with parasitic elements. Since its self-complementary folded dipole version also is symmetrical with respect to the transmission axis **120** and a plane which is orthogonal to the elements and in which the transmission axis lies, the self-complementary log-periodic folded dipole array can easily be turned into a log-periodic folded monopole array version by "cutting it into half" at the transmission axis **120** and by adding a conducting ground plane at the plane of symmetry giving a virtual symmetry.

[0055] FIG. **4** shows a schematic drawing of a dual directed log-periodic monopole antenna. The dual directed antenna of FIG. **4** describes a development of the single directed antenna of FIG. **1**. The antenna **20** comprises a feed line **11** having first and second ends on opposite sides of the feed line **11**, having first and second ends on opposite sides of the feed line **11**. A transmission axis **12** is defined as the axis extending between the first and second ends of the feed line **11**. Further, the antenna **20** comprises a plurality of antenna elements **13**A, **13**B, **13**C, **13**D, **13**E, **13**F, **13**G, **13**H arranged along the feed line **11**, protruding from the transmission axis **12**. The antenna **20** also comprises a first port **14** at the first end of the feed line **11**. A first part **15** of the antenna **20**, seen from the first port **14** towards a reference point **16** along the transmission axis **12**, comprises antenna elements **13**A-H of gradually increasing length, in a direction **17** perpendicular to the transmission axis **12**, and gradually increasing mutual distance between two consecutive antenna elements **13**A-**13**B, **13**B-**13**C, **13**C-**13**D, **13**D-**13**E, **13**E-**13**F, **13**F-**13**G, **13**G-**13**H along the transmission axis **12**. Further, between each antenna element phase reversal **19** is implemented in order to make the antenna radiate in the "backfire direction" **18**, increase the directivity, and thereby the gain, of the antenna **20**. The dot **19** in FIG. **4** is an abstract symbolisation of phase reversal which can be implemented in different ways. Thereby the antenna **20**, by means of the antenna elements **13**A-H located at the first part **15** of the antenna **20**, and the phase reversals **19**, is configured to radiate in a first direction **18** along the transmission axis **12** from the reference point **16** towards the first port **14** during excitation in the first port **14**. The first part **15** of the antenna **20** may also be expressed as the first part **15** of antenna **20**.

[0056] Yet further, the antenna **20** comprises a second port **24** at the second end of the feed line **11**. A second part **25** of the antenna **20**, seen from the second port **24** towards a reference point **16** along the transmission axis **12**, comprises antenna elements **23**A, **23**B, **23**C, **23**D of gradually increasing length, in a direction **17** perpendicular to the transmission axis **12**, and gradually increasing mutual distance between two consecutive antenna elements **23**A-**23**B, **23**B-**23**C, **23**C-**23**D along the transmission axis **12**. Further, between each antenna element, phase reversal **19** is implemented in order to make the antenna radiate in a second direction **28**, the "backfire direction", increase the directivity, and thereby the gain, of the antenna **20**. Thereby the antenna **20**, by means of the antenna elements **23**A-D located at the second part **25** of the antenna **20**, and the phase reversals **19**, is configured to radiate in the second direction **28** along the transmission axis **12** from the reference point **16** towards the second port **24** during excitation in the second port **24**. Hence, a dual directional antenna is obtained, radiating in two opposite directions. The second part **25** of the antenna **20** may also be expressed as the second part **25** of antenna **20**. The dual directional antenna saves considerable space compared to two separate single directional antennas.

[0057] The antenna elements **13**A-H, **23**A-D do not necessarily have to protrude in a direction **17** perpendicular to the transmission axis **12**. The antenna elements **13**A-H, **23**A-D may protrude by any angle or form with respect to the transmission axis **12** as long as the antenna is configured to radiate in the directions **18**, **28** along the transmission axis **12**. However, the length of each antenna element is defined as the length of the antenna element in direction **17** perpendicular to the transmission axis **12**. Still, in one example, as shown in FIG. **4**, the antenna elements **13**A-H, **23**A-D are protruding in a direction **17** perpendicular to the transmission axis.

[0058] Usually a log periodic dipole, monopole or slot array has one feed point and is designed to radiate in one direction (preferably the "backfire direction"). This disclosure describes an essentially log periodic monopole (or dipole) array antenna designed to radiate in two opposite directions by virtue of two different ports on opposite sides of a common transmission line with elements gradually increasing in length from each port towards a point in between the ports along the transmission line. Thus, implementing phase reversals between elements, "backfire radiation" can be obtained when the antenna is fed in either port. This arrangement means that considerable space can be saved compared to having two one port antennas looking in opposite directions.

[0059] FIG. **5** shows a schematic drawing of a dual directed log-periodic dipole antenna **200**. The upper part of the dipole antenna **200** incorporates all features and references signs of the monopole antenna **20** of FIG. **4**. Additionally, FIG. **5** comprises a mirrored lower part of the upper monopole antenna array thus forming a log-periodic dipole antenna **200**, which also incorporates all features of the monopole antenna **20** of FIG. **4**. Hence, a dual directed log-periodic dipole antenna **200** can be schematically drawn from two mirrored dual directed log-periodic monopole antennas **20**.

[0060] FIG. **6** illustrates a schematic drawing of an example of a dual directed log-periodic dipole antenna **200'** with a particular implementation of phase reversal **19** between each antenna element. FIG. **6** incorporates all features and references signs of the monopole antenna **20** of FIG. **4** and the dipole antenna of FIG. **5**. Phase reversals **19** are introduced by coupling every second monopole antenna element, pointing in the same direction **17**, along the transmission axis **12** to the upper feed line **11** and every second monopole antenna element to the lower feed line **11'**. However, this solution has the drawback that the antenna cannot be cut into two symmetrical halves along the transmission axis **12**, since every second antenna is coupled to the upper feed line **11** and every second antenna element to the lower feed line **11'**. This is the principle used to obtain phase reversal in the antenna pictured in FIG. **2**.

[0061] FIG. **7** shows an example of a dual directed folded monopole antenna **20'**. Each antenna element **13**A-K, **23**A-F is formed as a folded antenna element **31** as part of the feed line **11** protruding from the transmission axis **12**. Thus, the feed line **11** constitutes the folded antenna element **31**. Seen from any of the two ports **14**, **24**, every consecutive antenna element along the transmission axis **12** increases in length, in the direction **17**, and in width, along the transmission axis **12**. The relations between the antenna elements have been described in detail in relation to FIG. **3** and will be further described in relation to FIG. **12**. FIG. **8** illustrates an example of a dual directed folded monopole antenna **20"** with parasitic elements. The antenna **20"** comprises a ground plane **30** arranged in parallel with the transmission axis **12**. All essentially log-periodic monopole antennas need a ground plane **30** in order to function. The ground plane **30** may be constituted by the metallic surface or body to which the antenna **20"** is attached, such as a vehicle, an aircraft, a construction or a building, and/or may be rigidly attached to the antenna **20"**.

[0062] In one example, the antenna elements **13**A-K, **23**A-F protruding from the transmission axis **12**, are protruding away from the ground plane **30** in the direction **17** perpendicular to the ground plane **30**.

[0063] Further, in this example, each antenna element comprises a parasitic element **32** protruding from the ground plane **30** into the folded antenna element **31**. The parasitic element **32** must not touch the folded antenna element **31**. With the parasitic element **32**, the radiation resistance of the elements can be tuned. The parasitic elements **32** provide an additional feature which improves the performance of the folded antenna elements **31** in terms of optimisation, stabilisation and sensitivity to tolerances. The parasitic elements **32** make the design more robust. The parasitic element **32** is configured to tune phase progression and element excitation along the feed line.

[0064] An array of log-periodic monopole arrays mounted on an aircraft constitutes a challenge from aerodynamic point of view. Thus there is a desire to reduce the size of the monopoles as much as possible in order to reduce the protrusions.

[0065] FIG. **9** shows an example of a dual directed monopole antenna **20'''** with parasitic elements **32** and T-shaped antenna elements **33**. The antenna elements **13**, **23** are T-shaped or disc shaped antenna elements **33**. The T-shaped or disc shaped antenna elements **33** introduces capacitive top-loading which result in that each antenna element is shorter in the direction **17**, perpendicular to the transmission axis **12**, but also that each antenna element **33** is wider in the direction parallel to the transmission axis **12**. Thus, the size of the capacitive top-loading can be chosen to optimise the available space in the direction **17**, perpendicular to the transmission axis **12**, and in the direction parallel to the transmission axis **12**.

[0066] Further, the space between the transmission axis **12** and the ground plane **30** has been enlarged in FIG. **9** in order to show that the parasitic elements **32** and only the parasitic elements **32** are in contact with the ground plane **30**.

[0067] FIG. **10** illustrates another example of a dual directed folded monopole antenna **20''''** embedded in dielectric material **14**. FIG. **10** incorporates all reference signs from FIGS. **7-9**. The dielectric material **14** makes the antenna **20''''** more robust. Hence, the feed line **11** and the folded antenna elements **31** can be made thinner than without the dielectric material **14**. Preferably, there is no dielectric between the feed line and the ground plane.

[0068] FIG. **11** illustrates an example of a dual directed dipole antenna **200'''**. FIG. **10** incorporates all reference signs from FIGS. **7-9** and shows that by mirroring any of FIGS. **7-9** over the transmission axis **12**, a dual directed dipole antenna **200'''** can be constructed.

[0069] FIG. **12** shows the geometry of a dual directed log-periodic monopole antenna **20'''''**. At the first part **15** of the antenna **20'''''**, an imaginary first straight line **34** can be formed between the centre of the top of each antenna element **13**A-**13**K such that the extension of the imaginary first straight line **34** crosses the extension of the transmission axis **12** at a first vertex **35**, and wherein, at the second part **25** of the antenna **20**"", an imaginary second straight line **44** can be formed between the centre of the top of each antenna element **23**A-**23**F such that the extension of the imaginary second straight line **44** crosses the extension of the transmission axis **12** at a second vertex **45**.

[0070] At the first part **15** of the antenna **20**"", the relation between the length L**13**A-L**13**K of each antenna element **13**A-**13**H and its distance R**13**A-R**13**K to the first vertex **45** is constant, and the distance R**13**A-R**13**K between each consecutive antenna element **13**A-**13**K and the first vertex **45**, starting from the first vertex **45**, increases with a first constant factor τ_1 . . . , R**13**I/R**13**H, R**13**J/R**13**I, . . . for each consecutive antenna element **13**A-**13**K.

[0071] Hence, the first constant factor τ_1 can be described by:

$$\tau_1=R_{13B}/R_{13A}=R_{13I}/R_{13H}=R_{13J}/R_{13I}=R_{13K}/R_{13J}$$

[0072] The relation by of the length L**13**A-L**13**K of each antenna element **13**A-**13**H and its distance R**13**A-R**13**K to the first vertex **35** is constant by a factor I_1. Hence, the relation between the length L**13**A-L**13**K of each antenna element **13**A-**13**H can be described by

$$I_1*\tau_1=L_{13B}/L_{13A}=L_{13I}/L_{13H}=L_{13J}/L_{13I}=L_{13K}/L_{13J}$$

[0073] Similarly, at the second part **25** of the antenna **20**"", the relation between the length L**23**A-L**23**F of each antenna element **23**A-**23**F and its distance R**23**A-R**23**F to the second vertex is constant, and the distance between each consecutive antenna element and the second vertex, starting from the second vertex, increases with a second constant factor τ_2 . . . , R**23**E/R**23**D, R**23**F/R**23**E, . . . for each consecutive antenna element.

[0074] Hence, the second constant factor τ_2 can be described by:

$$\tau_2=R_{23B}/R_{23A}=R_{23E}/R_{23D}=R_{23F}/R_{23E}$$

[0075] The relation by of the length L**23**A-L**13**F of each antenna element **23**A-**23**F and its distance R**23**A-R**23**F to the second vertex **45** is constant by a factor I_2. Hence, the relation between the length L**23**A-L**13**F of each antenna element **23**A-**23**F can be described by

$$I_2*\tau_2=L_{23B}/L_{23A}=L_{23E}/L_{23D}=L_{23F}/L_{23E}$$

[0076] The relation between factor I_1 and I_2 can be visually seen in FIG. **12** by the slope of the imaginary first straight line **34** and the imaginary second straight line **44**.

[0077] According to an example, the reference antenna element **13**K, **23**F is positioned at the reference point **16** along the transmission axis **12**, belonging to both the first part **15** of the antenna and the second part **25** of the antenna **20**"", wherein the reference antenna element **13**K, **23**F is the longest antenna element, wherein the reference antenna element **13**K, **23**F together with the antenna elements **13**A-**13**K, located at the first part **15** of the antenna **20**, are configured to radiate in the first direction **18** during excitation in the first port **14** and wherein the reference antenna element **13**K, **23**F together with the antenna elements **23**A-**23**F, located at the second part **25** of the antenna **20**, are configured radiate in the second direction **28** during excitation in the second port **24**. Thus, an advantage of the configuration of having a reference antenna element **13**K, **23**F belonging to both the first part **15** of the antenna and the second part **25** of the antenna **20**"" is that the antenna **20**"", which is one antenna with two ports, will be considerably smaller than two separate one port antennas both having a largest element equal in size to element **23**F, **13**K and one antenna having a length R**13**K from its vertex to the middle of the largest element and the other antenna having a length R**23**F from its vertex to the largest element.

[0078] The antenna is particularly designed to operate between 0.15 GHz and 1.0 GHz. The antenna **20**, wherein the first part **15** is an eleven antenna element Folded Monopole Array Antenna, LPFMA, having a size of 1420 mm×430 mm and wherein the second part **25** is a six antenna element, Folded Monopole Array Antenna, LPFMA, having a size of 600 mm×430 mm, wherein the longest element is shared by the first part **15** and the second part **25**, the dual directional antenna **20** will be about 1790 mm×430 mm.

[0079] Hence, the dual directional essentially log-periodic antenna saves considerable space in comparison to two single directional essentially log-periodic antennas.

[0080] FIG. **13** illustrates performance of a single directed folded monopole antenna **10** comprising 11 antenna elements **13**A-K, as the first part **15** of the antenna **20**. The solid line **131** represents power radiated; the evenly dashed line **132** represents reflection loss; and the unevenly dashed line **133** represents transmission loss. FIG. **14** shows performance of the dual directed folded monopole antenna **20** of FIG. **9** comprising 16 antenna elements **13**A-K, **23** A-F, as the first and second parts **15**, **25** of the antenna **20**, wherein the antenna element **13**K/**23**F is in common for the first and second parts **15**, **25**. The solid line **141** represents power radiated; the evenly dashed line **142** represents reflection loss; and the unevenly dashed line **143** represents transmission loss. The lines **131**/**141**, **132**/**142**, **133**/**143** of FIGS. **13** and **14** virtually look the same. It has also been found that radiation patterns virtually look the same in both cases (but it is not shown here). The antenna elements **23** A-F at the second part **25** only affects the antenna elements **13**A-K at the first part **15** to some extent at lower frequencies, below 200-300 MHz. It is also found that the antenna elements **13**A-K at the first part **15** affects the antenna elements **23** A-F at the second part **25** somewhat more but not to a significant extent; the second part **25** can still be used as auxiliary antenna for reception but not for broad band high power transmission.

[0081] FIG. **15** illustrates reflection in a first port and in a second port of the antenna of FIG. **9** by 20 log |S11| (solid) and 20*log |S22| (dashed). FIG. **16** shows transmission between a first port and a second port of the antenna of FIG. **9** by "leakage", 20 log |S12|=20 log |S21|.

[0082] FIG. **17** shows different versions of symmetric single directional log-periodic monopole antennas on a surface constituting a ground plane. All of those versions could be adjusted into a dual directional log-periodic monopole antenna and are covered by this disclosure. The following text is taken from Johnson & Jasik "Antenna Engineering Handbook", Symmetric Log-Periodic Structures, page 14-41-14-42, FIG. **14-36**. Many applications require a vertically polarized frequency-independent antenna over the ground plane with a height of about $\lambda/4$ at the low-frequency cut-off. One-half of a symmetric structure can be fed against the ground plane. The problem is how to obtain the extra 180° phase shift between adjacent radiating elements which comes naturally with asymmetric elements. FIG. **17** shows several techniques for accomplishing this, but most are quite sensitive designs. Version A shows an LP monopole array fed by a transmission line over ground. The blocks represent 1:1 transformers with a phase reversal. This is not a sensitive design, but the cost and losses of the transformers may be prohibitive. If the transformers are not included, backfire radiation does not occur in the active region and broadband performance is not obtained. The monopole and zigzag elements may be bent along their centrelines and fed against the ground plane, as illustrated in version B and C. Half the monopole elements act like open-circuited transmission lines whose lengths must be adjusted within a few percent to obtain frequency-independent performance. The shunt transmission lines may be replaced by series LC circuits. The shunt loading produces the extra phase delay required for backfire radiation. The bent zigzag studied by Greiser and Mayes achieves the extra delay by the portions of the line lying over the ground plane. This antenna design is less sensitive than the bent-monopole antenna. Another scheme studied by Greiser is the trapezoidal-type zigzag with parasite monopoles placed as shown in version D. Barbano introduced parasitic monopoles between the elements of a monopole array as illustrated in version E to achieve backfire radiation. The height of the parasitic element is approximately the geometric mean of the adjacent driven-element heights and must be adjusted to within 1 percent of the required height. Another technique devised by Wickersham using capacitive coupling to trapezoidal-sheet monopoles, is shown in version F. FIG. **18** illustrates an antenna arrangement **50** comprising two antennas **20**A, **20**B being inclined in respect to each other. The antenna arrangement **50** comprises an elongated member **52** and first and second antennas **20**A, **20**B. Each of the antennas is attached to a respective surface **30**A, **30**B along the elongated member. Each respective surface is arranged to constitute at least part of the ground plane **30** for the first and second antennas **20**A, **20**B, respectively, and wherein the antenna elements **13**A-K, **23**A-F are protruding away from the respective surface, such that the transmission axes **12**A, **12**B of the first and second antennas **20**A, **20**B are substantially parallel to each other and such that the antenna elements (**13**A-K)A, (**23**A-F)A of the first antenna **20**A are protruding in a direction inclined to the antenna elements (**13**A-K)B, (**23**A-F)B of the second antenna **20**B. In one example, the antenna elements (**13**A-K)A, (**23**A-F)A of the first antenna **20**A are protruding in a direction substantially orthogonal to the antenna elements (**13**A-K)B, (**23**A-F)B of the second antenna **20**B.

[0083] FIG. **19** shows how the ports **14**A, **24**A, **14**B, **24**B of the antennas **20**A, **20**B of the antenna arrangement **50** are connected to each other via two 180° hybrids **114**, **124**. A 180° hybrid often comprises passive components. Each 180° hybrid **114**, **124** comprises two input ports and two output ports. When the 180° hybrid **114**, **124** is being fed in the port denoted 0°, and the port denoted 180° is terminated (in a matched load), the signal at a given frequency is split equal in amplitude between the remaining two ports and the signals are also in phase. The isolation between the two ports denoted 0° and 180° is high, thus only little current is driven through the matched load. When the 180° hybrid **114**, **124** is being fed in the port denoted 180°, and the port denoted 0° is terminated, the signal at a given frequency is also split equal in amplitude between the remaining two ports but the signals are 180° out of phase. The isolation between the two ports denoted 0° and 180° is high, thus only little current is driven through the matched load. The first port **14**A, **14**B of the respective antenna **20**A, **20**B are connected to each other via a first 180° hybrid **114**, such that each respective first port **14**A, **14**B can be operated either in phase or 180° out of phase, and the second port **24**A, **24**B of the respective antenna **20**A, **20**B are connected to each other via a second 180° hybrid **124**, such that each respective second port **24**A, **24**B can be operated either in phase or 180° out of phase.

[0084] FIG. **20** illustrates how signals from two orthogonal polarized antennas are summed in the first (forward) direction **18** or the second (backward) direction **28** when connected to a 180° hybrid. When considering port 0°, a sum type of pattern is obtained for linear vertical polarisation, Σvpol, and a difference type is obtained for horizontal polarisation, Δhpol. When considering port 180°, a difference type of pattern is obtained for vertical polarisation, Δvpol, and a sum type is obtained for horizontal polarisation, Σhpol. Given the four accessible ports of the first and second 180° hybrids **114**, **124** in FIG. **19** and given that dual direction log-periodic array antennas **20** are mounted on an elongated object as in FIG. **20**, signals received in the four different ports can be combined and processed in different ways to e.g. determine direction of an incoming signal (i.e. for passive direction finding). Typically so called monopulse quotients can be formed using the antennas pointing forward in order to determine the position of an object in a forward sector. The backward pointing antennas can be used to set thresholds and to "block" unwanted signals from entering the system in order to only use monopulse quotients in the angular range of uniqueness. Difference patterns obtained using forward antennas can also be used for this purpose. The prerequisite is that some polarisation discrimination can be made, e.g. linear vertical, linear horizontal or circular. The system can also be used for polarization matched jamming (linear vertical or horizontal) given that some polarization discrimination can be made.

1. An antenna (**20**; **20**'; **20**''; **20**'''; **20**'''';**20**'''''; **200**; **200**'; **200**''') comprising;

- a feed line (**11**) having first and second ends on opposite sides of the feed line, wherein a transmission axis (**12**) is defined as the axis extending between the first and second ends of the feed line;
- a plurality of antenna elements (**13**A, **13**B, **13**C . . .) arranged along the feed line, protruding from the transmission axis;
- a first port (**14**) at the first end of the feed line, wherein, at a first part (**15**) of the antenna, the feed line, from the first port towards a reference point (**16**) along the transmission axis, comprises antenna elements (**13**A, **13**B, **13**C . . .) of gradually increasing length, in a direction (**17**) perpendicular to the transmission axis, and gradually increasing mutual distance between two consecutive antenna elements (**13**A-**13**B, **13**B-**13**C . . .) along the transmission axis, such that the antenna, by means of the antenna elements located at the first part of the antenna, is configured to radiate in a first direction (**18**) along the transmission axis from the reference point towards the first port during excitation in the first port;

characterized in that the antenna further comprises:

- a second port (**24**) at the second end of the feed line, wherein, at a second part (**25**) of the antenna, the feed line, from the second port towards the reference point along the transmission axis, comprises antenna elements (**23**A, **23**B, **23**C . . .) of gradually increasing length, in a direction (**17**) perpendicular to the transmission axis, and gradually increasing mutual distance between two consecutive antenna elements (**23**A-**23**B, **23**B-**23**C . . .) along the transmission axis, such that the antenna, by means of the antenna elements located at the second part of the antenna, is configured to radiate in a second direction (**28**) along the transmission axis from the reference point towards the second port during excitation in the second port.

2. The antenna according to claim **1**, wherein phase reversal (**19**) is implemented between every two consecutive antenna elements.

3. The antenna according to claim **1**, wherein the antenna comprises a ground plane (**30**) arranged in parallel with the transmission axis and wherein the antenna elements protruding from the transmission axis are protruding away from the ground plane in a direction (**17**) perpendicular to the ground plane.

4. The antenna according to claim **1**, wherein the antenna elements are protruding in a direction (**17**) perpendicular to the transmission axis.

5. The antenna according to claim **1**, wherein each antenna element is formed as a folded antenna element (**31**) as part of the feed line protruding from the transmission axis.

6. The antenna according to claim **5**, wherein each antenna element further comprises a parasitic element (**32**) protruding from the ground plane into the folded antenna element.

7. The antenna according to claim **1**, wherein a reference antenna element (**13**H, **23**D) is positioned at the reference point along the transmission axis, belonging to both the first part of the antenna and the second part of the antenna, wherein the reference antenna element is the longest antenna element, wherein the reference antenna element together with the antenna elements located at the first part of the antenna are configured to radiate in the first direction during excitation in the first port and wherein the reference antenna element together with the antenna elements located at the first part of the antenna are configured radiate in the second direction during excitation in the second port.

8. The antenna according to claim **1**, wherein the antenna elements are T-shaped or disc shaped antenna elements (**33**).

9. The antenna according to claim **1**, wherein, at the first part of the antenna, an imaginary first straight line (**34**) can be formed between the centre of the top of each antenna element, such that the extension of the imaginary first straight line crosses the extension of the transmission axis at a first vertex (**35**), and wherein, at the second part of the antenna, an imaginary second straight line (**44**) can be formed between the centre of the top of each antenna element, such that the

extension of the imaginary second straight line crosses the extension of the transmission axis at a second vertex (**45**).

10. The antenna according to claim **9**, wherein, at the first part of the antenna, the relation between the length (. . . , Li**3**H, L**131**, L**13**J, . . .) of each antenna element and its

distance (. . . , R**13**H, R**131**, Ri**3**J, . . .) to the first vertex is constant, and the distance between each consecutive antenna element and the first vertex, starting from the first vertex, increases with a first constant factor T_1 (. . . , R**131**/R**13**H/Ri**3***j*/Ri**3***i*, . . .) for each consecutive antenna element, and

wherein at the second part of the antenna, the relation between the length (. . . , I-**23**D/L**23**E/I-**23**E, . . .) of each antenna element and its distance (. . . , R**23**D/R**23**E/R**23**E/ . . .) to the second vertex is constant, and the distance between each consecutive antenna element and the second vertex, starting from the second vertex, increases with a second constant factor t_2 (. . . , R**23**E/R**23**D/R**23**F/R**23**E> . . .) for each consecutive antenna element.

11. The antenna according to claim **1**, wherein each of the first part of the antenna and the second part of the antenna comprises at least three antenna elements, preferably at least five antenna elements, more preferably at least seven antenna elements.

12. The antenna according to claim **1**, wherein each of the antenna elements is a monopole.

13. The antenna according to claim **1**, wherein each of the first part and the second part of the antenna is essentially log-periodic.

14. The antenna according to claim **1**, wherein each of the first part and the second part of the antenna is a Log-Periodic Folded Monopole Array Antenna, LPFMA.

15. The antenna according to claim **1**, wherein the antenna is designed to operate between 0.15 GHz and 1.0 GHz.

16. An antenna arrangement (**50**) comprising an elongated member (**52**) and first and second antennas (**20**A, **20**B) according to claim **1**, wherein each of the antennas is attached to a respective surface (**30**A, **30**B) along the elongated member, wherein each respective surface is arranged to constitute at least part of the ground plane for the first and second antennas, respectively, and wherein the antenna elements are protruding away from the respective surface, such that the transmission axes of the first and second antennas are parallel to each other and such that the antenna elements of the first antenna are protruding in a direction inclined to the antenna elements of the second antenna.

17. The antenna arrangement according to claim **16**, wherein the first port of the respective antenna (**14**A, **14**B) are connected to each other via a first 180° hybrid (**114**), such that each respective first port can be operated either in phase or 180° out of phase, and the second port of the respective antenna (**24**A, **24**B) are connected to each other via a second 180° hybrid (**124**), such that each respective second port can be operated either in phase or 180° out of phase.

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