



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**13.12.2023 Bulletin 2023/50**

(21) Application number: **22382543.1**

(22) Date of filing: **06.06.2022**

(51) International Patent Classification (IPC):  
**H01Q 5/40** (2015.01) **H01Q 9/04** (2006.01)  
**H01Q 19/17** (2006.01) **H01Q 21/08** (2006.01)  
**H01Q 21/20** (2006.01) **H01Q 21/24** (2006.01)  
**H01Q 21/28** (2006.01) **H01Q 25/00** (2006.01)

(52) Cooperative Patent Classification (CPC):  
**H01Q 19/17; H01Q 5/40; H01Q 9/0407;**  
**H01Q 21/08; H01Q 21/20; H01Q 21/24;**  
**H01Q 21/28; H01Q 25/00**

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB**  
**GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO**  
**PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**  
Designated Validation States:  
**KH MA MD TN**

(71) Applicant: **Nokia Solutions and Networks Oy**  
**02610 Espoo (FI)**

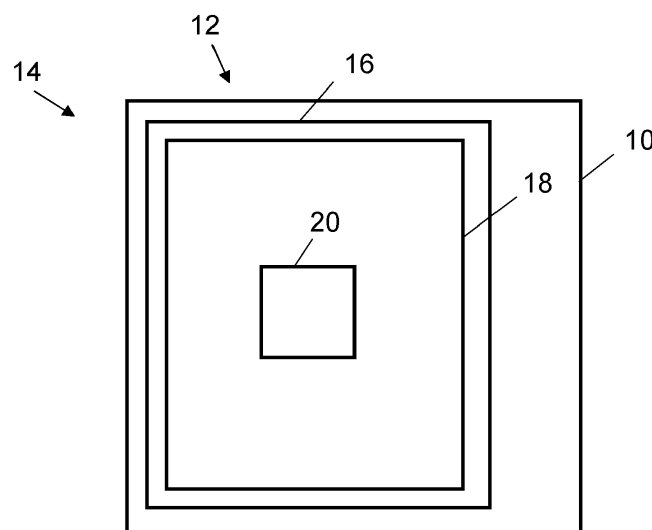
(72) Inventors:  
• **FERNANDEZ DURAN, Alfonso**  
**28050 Madrid (ES)**  
• **RAJO IGLESIAS, Eva**  
**28911 Leganés (ES)**  
• **SANJUAN FLORES, Tomas**  
**28050 Madrid (ES)**  
• **SÁNCHEZ FERNÁNDEZ, Matilde Pilar**  
**28911 Leganés (ES)**

(74) Representative: **Swindell & Pearson Limited**  
**48 Friar Gate**  
**Derby DE1 1GY (GB)**

(54) **ANTENNA ARRANGEMENT**

(57) An antenna arrangement comprising: a first antenna configured to operate a first frequency range; and a second antenna configured to operate in a second frequency range; wherein the first antenna comprises a reflector configured to provide a reflective surface at, at least, the first frequency range, and the second antenna

comprises at least one conductive element configured to receive and/or radiate in the second frequency range, wherein at least a portion of the at least one conductive element is configured to act as at least a portion of the reflective surface of the reflector.



**FIG. 1**

## Description

### TECHNOLOGICAL FIELD

**[0001]** Embodiments of the present disclosure relate to an antenna arrangement.

### BACKGROUND

**[0002]** It is desirable to have an antenna arrangement that operates in a plurality of frequency ranges.

**[0003]** However, such antenna arrangements can be complicated and/or large.

### BRIEF SUMMARY

**[0004]** According to various, but not necessarily all, embodiments there is provided an antenna arrangement comprising:

a first antenna configured to operate in a first frequency range; and  
 a second antenna configured to operate in a second frequency range;  
 wherein the first antenna comprises a reflector configured to provide a reflective surface at, at least, the first frequency range, and  
 the second antenna comprises at least one conductive element configured to receive and/or radiate in the second frequency range, wherein at least a portion of the at least one conductive element is configured to act as at least a portion of the reflective surface of the reflector.

**[0005]** In some examples, the at least one conductive element is positioned between the reflector and at least one receiving and/or radiating element of the first antenna.

**[0006]** In some examples, the at least one conductive element is supported by the reflector.

**[0007]** In some examples, at least a plurality of points of a perimeter of the at least one conductive element is substantially at a fixed distance from the reflector.

**[0008]** In some examples, the fixed distance is substantially  $n$  times  $\lambda/2$ , wherein  $n$  is a positive integer and  $\lambda$  is a wavelength that corresponds to a frequency of the first frequency range.

**[0009]** In some examples, the at least one conductive element is configured to receive and/or radiate in a plurality of frequencies within the second frequency range and/or in a plurality of polarisations.

**[0010]** In some examples, the first frequency range is located at frequencies that are substantially higher than the respective frequencies of the second frequency range.

**[0011]** In some examples, the first frequency range does not overlap with the second frequency range.

**[0012]** In some examples, at least one of the at least

one conductive element has a shape that is conforming to the reflective surface of the reflector.

**[0013]** In some examples, the at least one conductive element comprises a plurality of conductive elements, and one or more of the conductive elements of the plurality of conductive elements has or have a shape that is substantially conforming to the reflective surface of the reflector.

**[0014]** In some examples, the reflective surface is substantially parabolic in shape and the plurality of conductive elements is configured in a substantially parabolic shape.

**[0015]** In some examples, the antenna arrangement is configured to allow different pointing directions for the first and second antennas.

**[0016]** In some examples, one or more feed lines to the at least one conductive element pass through at least one opening in the reflector.

**[0017]** In some examples, one or more feed lines to the at least one conductive element run across the reflective surface of the reflector.

**[0018]** According to various, but not necessarily all, embodiments there is provided an apparatus comprising an antenna arrangement as described herein.

**[0019]** According to various, but not necessarily all, embodiments there is provided an antenna arrangement comprising:

a first antenna configured to operate in a first frequency range; and  
 a second antenna configured to operate in a second frequency range;  
 wherein the first antenna comprises a reflector configured to provide a reflective surface at, at least, the first frequency range, and  
 the second antenna comprises at least one conductive element configured to receive and/or radiate in the second frequency range, wherein the at least one conductive element is positioned between the reflector and at least one receiving and/or radiating element of the first antenna.

**[0020]** According to various, but not necessarily all, embodiments there is provided examples as claimed in the appended claims.

**[0021]** The description of a function and/or action should additionally be considered to also disclose any means suitable for performing and/or configured to perform that function and/or action.

### BRIEF DESCRIPTION

**[0022]** Some examples will now be described with reference to the accompanying drawings in which:

FIG. 1 shows an example of the subject-matter described herein;

FIG. 2 shows another example of the subject-matter

described herein;

FIG. 3A shows another example of the subject-matter described herein;

FIG. 3B shows another example of the subject-matter described herein;

FIG. 3C shows another example of the subject-matter described herein;

FIG. 4 shows another example of the subject-matter described herein;

FIG. 5 shows another example of the subject-matter described herein;

FIG. 6A shows another example of the subject-matter described herein;

FIG. 6B shows another example of the subject-matter described herein;

FIG. 6C shows another example of the subject-matter described herein;

FIG. 7 shows another example of the subject-matter described herein;

FIG. 8 shows another example of the subject-matter described herein; and

FIG. 9 shows another example of the subject-matter described herein.

#### DETAILED DESCRIPTION

**[0023]** The figures illustrate examples of an antenna arrangement 10 for operation in a first and a second frequency range.

**[0024]** In examples, the antenna arrangement 10 comprises:

a first antenna 12 configured to operate in a first frequency range; and

a second antenna 14 configured to operate in a second frequency range;

wherein the first antenna 12 comprises a reflector 16 configured to provide a reflective surface 18 at, at least, the first frequency range, and the second antenna 14 comprises at least one conductive element 20 configured to receive and/or radiate in the second frequency range, wherein at least a portion of the at least one conductive element 20 is configured to act as at least a portion of the reflective surface 18 of the reflector 16.

**[0025]** The term "conductive" is used to refer to electrical conductivity, that is, capable of transferring a direct electrical current.

**[0026]** The frequency range of an antenna is the range over which it is considered to provide a satisfactory performance, such as a useful level of signal strength or sufficiently high antenna efficiency or gain. A frequency range can in turn be divided into smaller sub-ranges, for example, into frequency bands that represent definitive intervals in the frequency domain and that are official intervals defined by standardization bodies.

**[0027]** FIG. 1 schematically illustrates an example of

an antenna arrangement 10.

**[0028]** Various features referenced in the discussion of FIG. 1 can be found in the other FIGs. Furthermore, during the discussion of FIG. 1, reference will be made to other FIGs. By way of example.

**[0029]** The antenna arrangement 10 comprises a first antenna 12 configured to operate in a first frequency range and a second antenna 14 configured to operate in a second frequency range.

**[0030]** In examples, the first frequency range can be considered higher relative to the second frequency range and, similarly, the second frequency range can be considered lower relative to the first frequency range.

**[0031]** In examples, it can be considered that the first antenna 12 is configured to operate in at least one higher frequency band and the second antenna 14 is configured to operate in at least one lower frequency band.

**[0032]** That is, in examples, the first antenna 12 is configured to operate in at least one first frequency band and the second antenna 14 is configured to operate in at least one second frequency band, the first frequency band being of higher frequencies than the second frequency band.

**[0033]** In some examples, the first frequency range and the second frequency range can at least partially overlap.

**[0034]** In some examples, the at least one higher frequency band and the at least one lower frequency band can at least partially overlap.

**[0035]** In examples, the first frequency range is located at frequencies that are substantially higher than the respective frequencies of the second frequency range. Accordingly, in examples, the upper frequency of the first frequency range is substantially higher than the upper frequency of the second frequency range and the lower frequency of the first frequency range is substantially higher than the lower frequency of the second frequency range.

**[0036]** In examples, the first frequency range does not overlap with the second frequency range. In examples, it can be considered that the first frequency range does not have and/or does not exhibit an overlap with the second frequency range.

**[0037]** In examples, the first antenna 12 can be configured to operate in any suitable higher frequency band or bands and/or the second antenna 14 can be configured to operate in any suitable lower frequency band or bands.

**[0038]** For example, the first antenna 12 can be configured to operate in at least one higher frequency band in the range 25GHz to 30GHz and/or the second antenna 14 can be configured to operate in at least one lower frequency band in the range 2.1GHz to 4GHz.

**[0039]** The first antenna 12 and/or second antenna 14 can have any suitable configuration and/or form. For example, the first antenna 12 can have any suitable configuration and/or form to operate in the range 25GHz to 30GHz and/or the second antenna 14 can have any suitable configuration and/or form to operate in the range 2.1GHz to 4GHz.

**[0040]** The first antenna 12 can, in some examples, be considered a millimeter wave antenna.

**[0041]** In examples, the first antenna 12 comprises a reflector 16 configured to provide a reflective surface 18 at, at least, the first frequency range. The reflector 16 can be considered an antenna reflector.

**[0042]** The reflector 16 can have any suitable size, and/or shape, and/or form, and/or configuration to provide a reflective surface 18 at, at least, the first frequency range.

**[0043]** The reflective surface 18 can comprise any suitable surface or surfaces of the reflector 16. The reflective surface 18 can be considered a portion of the reflector 16.

**[0044]** In examples, the reflector 16 can have any suitable size, and/or shape, and/or form, and/or configuration to provide a reflective surface 18 configured to direct and/or reflect electromagnetic waves at, at least, the first frequency range, to and/or from at least one receiving and/or radiating element 22 of the first antenna 12. The at least one receiving and/or radiating element 22 can be considered an antenna feed.

**[0045]** It can be considered that the reflector 16 is configured to direct and/or reflect electromagnetic waves at, at least, the first frequency range, to and/or from at least one receiving and/or radiating element 22 of the first antenna 12.

**[0046]** In examples, the reflector 16 can have any suitable size, and/or shape, and/or form, and/or configuration to provide a reflective surface 18 to add gain to the first frequency range.

**[0047]** In some examples, reflector 16 and/or the reflective surface 18 is substantially parabolic in shape.

**[0048]** The reflective surface 18 of the reflector 16 can be considered a surface from which electromagnetic waves are reflected to/from at least one receiving and/or radiating element 22 of the first antenna 12.

**[0049]** By way of example, reference is made to the example of FIG. 4.

**[0050]** The example of FIG. 4 schematically illustrates an antenna arrangement 10 comprising a first antenna 12 and a second antenna 14.

**[0051]** In the example of FIG. 4, the reflector 16 is substantially parabolic in shape and is configured to provide a reflective surface 18 that is substantially parabolic in shape.

**[0052]** In the illustrated example, the reflective surface 18, of the reflector 16, is configured to direct electromagnetic waves to/from the receiving and/or radiating element 22 of the first antenna 12.

**[0053]** Returning to FIG. 1, in the example of FIG. 1, the second antenna 14 comprises at least one conductive element 20 configured to receive and/or radiate in the second frequency range, wherein at least a portion of the at least one conductive element 20 is configured to act as at least a portion of the reflective surface 18 of the reflector 16.

**[0054]** Consequently, FIG. 1 illustrates an antenna arrangement 10 comprising,

a first antenna 12 configured to operate in a first frequency range; and

a second antenna 14 configured to operate in a second frequency range;

wherein the first antenna 12 comprises a reflector 16 configured to provide a reflective surface 18 at, at least, the first frequency range and,

the second antenna 14 comprises at least one conductive element 20 configured to receive and/or radiate in the second frequency range, wherein at least a portion of the at least one conductive element 20 is configured to act as at least a portion of the reflective surface 18 of the reflector 16.

**[0055]** The at least one conductive element 20 can have any suitable shape, and/or size, and/or form and/or configuration to receive and/or radiate in the second frequency range and to act as at least a portion of the reflective surface 18 of the reflector 16.

**[0056]** For example, the at least one conductive element can comprise one or more patch antennas and/or, in some examples, can comprise one or more slots and so on.

**[0057]** For example, the at least one conductive element can be rectangular, square, circular, cross shaped and so on. In examples, different ones of the at least one conductive element 20 can have different shapes, and/or sizes, and/or forms, and/or configurations and so on.

**[0058]** In examples, the at least one conductive element 20 is configured to resonate in the second frequency range. The reflector 16 can act as a ground plane for the at least one conductive element 20.

**[0059]** In examples, the at least one conductive element 20 is configured to receive and/or radiate in the second frequency range and also to function as at least a portion of the reflective surface 18 of the reflector 16.

**[0060]** In examples, it can be considered that the at least one conductive element 20 is configured to substantially replace at least a portion of the reflective surface 18 of the reflector 16.

**[0061]** In examples, it can be considered that at least a portion of the at least one conductive element 20 is configured to reflect electromagnetic waves to and/or from at least one receiving and/or radiating element 22 of the first antenna 12.

**[0062]** In examples, it can be considered that at least one conductive element 20 is configured to reflect electromagnetic waves to a point substantially corresponding to a focus of the reflector 16.

**[0063]** In examples, it can be considered that the at least one conductive element 20 is configured to not substantially affect the performance of the first antenna 12 in the first frequency range.

**[0064]** In examples, it can be considered that the at least one conductive element 20 is configured to allow electromagnetic waves reflected from the conductive element 20 and from the reflective surface 18 of the reflector 16 to be in phase.

**[0065]** The at least one conductive element 20 can be configured and/or arranged in any suitable way. In examples, the at least one conductive element 20 is positioned between the reflector 16 and at least one receiving and/or radiating element 22 of the first antenna 12.

**[0066]** Referring to the example of FIG. 4, in the illustrated example the antenna arrangement 10 comprises a conductive element 20 positioned between the reflector 16 and receiving and/or radiating element 22 of the first antenna 12.

**[0067]** Referring again to the example of FIG. 1, the at least one conductive element 20 can be supported and/or held in any suitable way.

**[0068]** In some examples, the at least one conductive element 20 is supported by the reflector 16. For example, the at least one conductive element 20 can be supported using dielectric material(s) between the at least one conductive element 20 and the reflector 16. See, for example, FIG. 6A.

**[0069]** Air can be used as a dielectric between the at least one conductive element 20 and the reflector 16. In such examples, the at least one conductive element 20 can, for example, be supported by one or more columns of dielectric material.

**[0070]** In some examples, one or more feed lines of the at least one conductive element 20 can be used to support the at least one conductive element 20. For example, the at least one conductive element 20 can be fed from behind the reflector 16 and the feed line(s) used to support the at least one conductive element 20.

**[0071]** The size of the at least one conductive element 20 can be configured based, at least in part, on the permittivity of the dielectric(s) used, to allow the at least one conductive element to receive and/or radiate in the second frequency range.

**[0072]** In some examples, at least a plurality of points of a perimeter of the at least one conductive element 20 is at a fixed distance 24 from the reflector 16.

**[0073]** It can be considered that at least a plurality of points of a perimeter of the at least one conductive element 20 is at a fixed distance 24 from the reflector 16 to allow the at least one conductive element 20 to act as at least a portion of the reflective surface 18 of the reflector 16.

**[0074]** In examples, at least a plurality of points of a perimeter of the at least one conductive element 20 is substantially at a fixed distance 24 from the reflector 16 in a direction towards at least one receiving and/or radiating element 22 of the first antenna 12.

**[0075]** By way of example, reference is made to the example of FIG. 3A.

**[0076]** FIG. 3A schematically illustrates an example of a cross section through a conductive element 20 and a reflector 16 configured to provide a reflective surface 18.

**[0077]** It can be seen from the example of FIG. 3A that the conductive element 20 is at a fixed distance 24 from the reflector 16. In the example of FIG. 3A, the support(s) for the conductive element 20 are not shown.

**[0078]** In the illustrated example, a receiving and/or radiating element 22 of the first antenna 12 is generally to the left of the figure and therefore the conductive element 20 is at a fixed distance 24 from the reflector 16 in a direction generally towards the receiving and/or radiating element 22 of the first antenna 12.

**[0079]** In the example of FIG. 3A, the conductive element 20 has a shape that is conforming to the shape of the reflective surface 18 of the reflector 16. Accordingly, in the example of FIG. 3A, the perimeter of the conductive element 20 is at a fixed distance 24 from the reflector 16 as the shape of the conductive element 20 is conforming to the shape of the reflective surface 18 of the reflector 16.

**[0080]** Returning to FIG. 1, in examples any suitable selected points of the perimeter of the at least one conductive element 20 can be at a fixed distance 24 from the reflector 16. For example, the centers of the at least one conductive element's edges can be at a fixed distance 24 from the reflector 16.

**[0081]** In examples, the fixed distance 24 is substantially  $n$  times  $\lambda/2$ , wherein  $n$  is a positive integer and  $A$  is a wavelength that corresponds to a frequency of the first frequency range.

**[0082]** In examples,  $A$  is a wavelength that corresponds to a resonant frequency of the first frequency range.

**[0083]** In examples,  $A$  is a wavelength that corresponds to a center frequency of the first frequency range.

**[0084]** Reference is again made to the example of FIG. 4.

**[0085]** In the example of FIG. 4, the conductive element 20 is at a fixed distance 24 from the reflector 16 and is configured to act as a portion of the reflective surface 18 of the reflector 16.

**[0086]** In the illustrated example, the conductive element 20 has a shape that is conforming to reflective surface 18 of the reflector 16 and is therefore also parabolic in shape.

**[0087]** Accordingly, in the example of FIG. 4, the perimeter of the conductive element 20 is substantially at a fixed distance 24 from the reflector 16.

**[0088]** In the example of FIG. 4, the conductive element 20 is located at 5mm ( $\lambda/2$  of a frequency of the first frequency range) distance from the reflector 16. This allows for an integer number of  $A$  round trips so that the waves reflected by the reflector 16 and the waves reflected by the conductive element 20 are in phase.

**[0089]** Referring again to FIG. 1, in examples, the at least one conductive element 20 is configured to receive and/or radiate in a plurality of frequencies within the second frequency range and/or in a plurality of polarisations.

**[0090]** In some examples, the at least one conductive element 20 is configured to resonate in a plurality of frequencies within the second frequency range.

**[0091]** The at least one conductive element 20 can have any suitable form and/or shape and/or size and/or configuration to receive and/or radiate in a plurality of frequencies within the second frequency range and/or in

a plurality of polarisations.

**[0092]** For example, the at least one conductive element 20 can comprise one or more slots. See, for example, FIG. 7.

**[0093]** In some examples, at least one of the at least one conductive element 20 has a shape that is conforming to the reflective surface 18 of the reflector 16.

**[0094]** In examples, it can be considered that a conductive element 20 has a shape that is conforming to the reflective surface 18 of the reflector 16 if the shape of the conductive element 20 matches, and/or follows, and/or is in line with, and/or mirrors the shape of the reflective surface 18 of the reflector 16.

**[0095]** In examples, it can be considered that a conductive element 20 has a shape that is conforming to the reflective surface 18 of the reflector 16 if the perimeter of the conductive element 20 is at a substantially fixed distance 24 from the reflective surface 18 of the reflector 16.

**[0096]** See, for example, FIG. 4 in which the conductive element 20 has a substantially parabolic shape and the reflector 16, and reflective surface 18, also has a substantially parabolic shape such that the conductive element 20 has a shape that is conforming to the reflective surface 18 of the reflector 16 and the perimeter of the conductive element 20 is at a fixed distance 24 from the reflector 16.

**[0097]** An element or elements that has/have a shape that is conforming to the shape of another element can be considered to have a shape that conforms to the shape of the other element. For example, the conductive element 20 in the example of FIG. 4 can be considered to have a shape that conforms to the reflective surface 18 of the reflector 16.

**[0098]** In examples, the at least one conductive element 20 comprises a plurality of conductive elements 20, and the plurality of conductive elements 20 is configured in a shape that is substantially conforming to the reflective surface 18 of the reflector 16.

**[0099]** In examples, the plurality of conductive elements 20 can be considered a group of conductive elements 20.

**[0100]** Accordingly, in examples, a group of conductive elements 20 is configured/arranged in a shape that is substantially conforming to the reflective surface 18 of the reflector 16. For example, the group of conductive elements 20 can be configured/arranged in a mosaic having a shape that is substantially conforming to the reflective surface 18 of the reflector 16.

**[0101]** One or more of the conductive elements 20 of the plurality of conductive elements 20 can have a shape that is substantially conforming to the reflective surface 18 of the reflector 16 and/or one or more of the conductive elements 20 of the plurality of conductive elements 20 can have a shape that is substantially non-conforming to the reflective surface 18 of the reflector 16.

**[0102]** Accordingly, in examples, one or more of the conductive elements 20 of the plurality of conductive el-

ements 20 has a shape that is substantially non-conforming to the reflective surface 18 of the reflector 16.

**[0103]** For example, the reflective surface 18 of the reflector 16 can have a curved shape but one or more of the conductive elements 20 of the plurality of conductive elements can be substantially flat and arranged in a shape that is substantially conforming to the curved shape of the reflective surface 27 of the reflector 16.

**[0104]** By way of example, reference is made to FIG. 3B.

**[0105]** The example of FIG. 3B is similar to the example of FIG. 3A, and similarly schematically illustrates a cross-section of a reflector 16 having a reflective surface 18 and associated conductive elements 20.

**[0106]** In the example of FIG. 3B, a dashed line 28 is present indicating a curve that is conforming to the shape of the reflective surface 18 of the reflector 16.

**[0107]** In the example of FIG. 3B, the plurality of conductive elements 20 are substantially flat and are therefore non-conforming to the shape of the reflective surface 18. However, the conductive elements 20 are arranged in a shape that is substantially conforming to the shape of the reflective surface 18.

**[0108]** This can be seen in the example of FIG. 3B as the configuration of the plurality of conductive elements 20 are arranged to substantially follow the dashed line 28, although the individual conductive elements 20 are substantially flat.

**[0109]** In examples, it can be considered that a plurality of conductive elements 20, that are substantially non-conforming to the reflective surface 18 of the reflector 16, are arranged in a shape that is substantially conforming to the reflective surface 18 of the reflector 16 if a plurality of points of the individual conductive elements 20 lie on a surface that has a shape that is conforming to the shape of the reflective surface 18 of the reflector 16.

**[0110]** For example, it can be considered that a plurality of conductive elements 20, that are substantially non-conforming to the reflective surface 18 of the reflector 16, are arranged in a shape that is substantially conforming to the reflective surface 18 of the reflector 16 if at least a plurality of points of a perimeter of the conductive elements 20 lie on a surface having a shape that is conforming to the shape of the reflective surface 18 of the reflector 16.

**[0111]** Accordingly, in some examples, a plurality of points of the perimeter of the individual conductive elements 20, but not all of the perimeter, are substantially at a fixed distance from the reflector 16.

**[0112]** In some examples, the plurality of conductive elements 20 is configured in a shape that is substantially conforming to the reflective surface 18 of the reflector 16 and one or more of the conductive elements 20 of the plurality of conductive elements 20 has a shape that is substantially conforming to the reflective surface 18 of the reflector 16.

**[0113]** By way of example, reference is made to FIG. 3C.

**[0114]** The example of FIG. 3C is similar to the example of FIG. 3B. However, in the example of FIG. 3C, the group of conductive elements 20 is configured in a shape that is substantially conforming to the reflective surface 18 of the reflector 16 and the individual conductive elements 20 are also substantially conforming to the reflective surface 18 of the reflector 16.

**[0115]** This can be seen in the example of FIG. 3C as the individual conductive elements 20 follow the dashed line 28 representing a line that is conforming to the shape of the reflective surface 18 of the reflector 16.

**[0116]** Accordingly, in the example of FIG. 3C, the perimeter of the individual conductive elements 20 is substantially at a fixed distance from the reflector 16.

**[0117]** Returning to the discussion of FIG. 1, in examples, the reflective surface 18 is substantially parabolic in shape and the plurality of conductive elements is configured in a substantially parabolic shape.

**[0118]** In examples, the antenna arrangement 10 is configured to allow different pointing directions for the first and second antennas 12, 14.

**[0119]** In examples, it can be considered that the antenna arrangement 10 is configured to allow different boresights for the first and second antennas 12, 14.

**[0120]** The antenna arrangement 10 can be configured in any suitable way to allow different pointing directions for the first and second antennas 12, 14.

**[0121]** For example, the antenna arrangement 10 can be configured to allow different combinations of phases to be applied to feeds of at least one conductive element 20 to point the beam at the second frequency range to an arbitrary direction independently to the pointing of the first antenna 12 at the first frequency range.

**[0122]** In examples, the at least one receiving and/or radiating element 22 of the first antenna 12, in combination with a shape in the reflector 16/reflecting surface 18, can point to an arbitrary direction independently of the second antenna 14.

**[0123]** For example, the pointing direction of the first antenna 12 in the first frequency range can be kept fixed at zero degrees and simultaneously the beam of the second antenna 14 in the second frequency range can point to other directions.

**[0124]** In examples, the at least one conductive element 20 can be fed in any suitable way using any suitable method. For example, one or more feed lines can be provided to the conductive element 20.

**[0125]** In some examples, one or more feed lines to the at least one conductive element 20 pass through at least one opening in the reflector 16.

**[0126]** In some examples, one or more feed lines to the at least one conductive element 20 run across the reflective surface 27 of the reflector 16.

**[0127]** In examples, feed lines to at least once conductive element 20 that run across the reflective surface 18 of the reflector 16 can be configured to act as at least a portion of the reflective surface 18 of the reflector 16 as described in relation to the one or more conductive ele-

ments 20.

**[0128]** FIG. 2 schematically illustrates an example of an apparatus 26. In examples, the apparatus 26 can be considered an electronic device.

**[0129]** In the example of FIG. 2, the apparatus 26 comprises an antenna arrangement 10 as described herein.

**[0130]** Accordingly, FIG. 2 illustrates in the example of an apparatus comprising an antenna arrangement 10 as described herein.

**[0131]** In examples, the apparatus 26 can comprise a customer premises equipment (CPE).

**[0132]** FIG. 5 illustrates an example of an antenna arrangement 10.

**[0133]** The example of FIG. 5 is similar to the example of FIG. 4. However, in the example of FIG. 5 the second antenna 14 comprises a plurality of conductive elements 20 configured to receive and/or radiate in the second frequency range.

**[0134]** In the example of FIG. 5, the plurality of conductive elements has a shape that is substantially conforming to the reflective surface 18 of the reflector 10 and the individual conductive elements 20 also have shapes that are conforming to the reflective surface 18 of the reflector 16.

**[0135]** FIG. 6A illustrates an example of an antenna arrangement 10.

**[0136]** The antenna arrangement 10 comprises a first antenna 12 comprising a reflector 16 configured to provide a reflective surface 18, and a plurality of receiving and/or radiating elements 22.

**[0137]** The reflector 16, in the example of FIG. 6A, has a parabolic shape and focal shift.

**[0138]** The first antenna 12 is configured to operate in frequency bands n257, n261 (28 GHz), and n258 (26 GHz). The reflector 16 is configured to provide a reflective surface 18 at, at least, these bands.

**[0139]** The first antenna 12 is configured to provide a gain of 19 dBi and vertical steerability of  $\pm 15^\circ$ .

**[0140]** The antenna arrangement 10 of FIG. 6A also comprises a second antenna 14 comprising a plurality of conductive elements 20 configured to act as a portion of the reflective surface 18 of the reflector 16. In the example of FIG. 6A, the conductive elements 20 are patches, comprising slots 34 to resonate in several frequency bands.

**[0141]** In the illustrated example, the conductive elements 20 are conforming to the reflective surface 18 of the reflector 16 and at a fixed distance 24 from the reflector supported on a dielectric substrate 32 with  $\epsilon_r = 1.8$ . The size of the conductive elements 20 has been reduced to resonate appropriately.

**[0142]** In FIG. 6A, the thickness of the dielectric material is 4.5 mm to keep the A roundtrip at 28 GHz. In the illustrated example, the  $\epsilon_r = 1.8$  has been achieved by means of vertical additive manufacturing with PLA (Polylactic Acid) material using a rectilinear infill of 25% in mass.

**[0143]** The second antenna 14 is configured to operate in frequency bands B40 (2.3 GHz) and B42 (3.5 GHz).

[0144] The second antenna 14 is configured to provide a gain of 5 dBi in both bands and polarization rejection of at least 19 dBi.

[0145] Dimensions of this example are detailed in relation to FIGs 6B, 6C and 7. The size of the reflector 16 is approximately  $11 \lambda$  at 28 GHz in both planes which is a size big enough to provide a good directivity and still fit in typical CPE modules.

[0146] In the illustrated example, the two sub-6 GHz conforming patches are fed at the center by an SMA connector and the U-type slot makes them dual band and reduces their size below the classical  $0.5 \lambda_{gr}$ .

[0147] The dimensions and position of the U-slot (described in relation to FIG. 7) are used together with the size of the patch to obtain a good matching in the two considered sub-6 GHz bands.

[0148] The U-shape slot patch is a dual-band antenna where the two resonances correspond respectively to the one of the U-slot (upper band) and the one of the patch (lower band) that is also including the presence of the slot.

[0149] The two conforming patches are rotated  $90^\circ$  with respect to each other to provide polarization diversity. The distance between the two patches is  $D_U = 8.2$  mm (FIG. 7) in this example which avoids strong coupling effects.

[0150] In the illustrated example, the reflector 16 is fed by a linear array of 4 patches operating at 28 GHz. The position of this array at the focus of the reflector 16 is implemented by an arm that is manufactured by conventional additive manufacturing with PLA material.

[0151] The details of the feed system and dimensions are described in relation to FIG. 8.

[0152] FIG. 6B and FIG. 6C illustrate side view and top views respectively of the antenna system 10 of FIG. 6A.

[0153] Table 1 indicates dimensions of the various aspects of the example illustrated in FIGs 6B and 6C.

Table 1

| Parameter  | Value [mm] |
|------------|------------|
| $W_{ref}$  | 120        |
| $L_{ref}$  | 117.4      |
| $H_{ref}$  | 31.5       |
| $T_{ref}$  | 4          |
| $H_{feed}$ | 60         |
| $X_{arm}$  | 54.7       |
| $Y_{arm}$  | 46.5       |

[0154] FIG. 7 illustrates the conductive elements 20 of the example of FIG. 6A.

[0155] Table 2 indicates dimensions of the various aspects of the example illustrated in FIG. 7.

Table 2

| Parameter | Value [mm] |
|-----------|------------|
| $W_{pat}$ | 33         |
| $L_{pat}$ | 71.7       |
| $T_{pat}$ | 5          |
| $U_1$     | 21.3       |
| $U_2$     | 14.1       |
| $U_3$     | 16.6       |
| $U_4$     | 14.1       |
| $D_1$     | 4.6        |
| $U_5$     | 21.9       |
| $U_6$     | 13.6       |
| $U_7$     | 17.3       |
| $U_8$     | 13.4       |
| $D_2$     | 4          |
| $D_U$     | 8.2        |

[0156] FIG. 8 illustrates the receiving and/or radiating elements of the first antenna 12 of the example of FIG. 6A.

[0157] FIG. 8 can be considered to illustrate the feed system of the first antenna 12.

[0158] Table 3 indicates dimensions of the various aspects of the example illustrated in FIG. 8.

Table 2

| Parameter | Value [mm] |
|-----------|------------|
| $W_p$     | 23.2       |
| $l_p$     | 19.8       |
| $p_1$     | 2.7        |
| $p_2$     | 2.7        |
| $p_3$     | 2.66       |

[0159] FIG. 9 illustrates an example of a method 900.

[0160] Method 900 can be performed in any suitable way using any suitable method or methods.

[0161] At block 902, method 900 comprises providing a first antenna 12 configured to operate in a first frequency range.

[0162] At block 904, method 900 comprises providing a second antenna 14 configured to operate in a second frequency range.

[0163] The first antenna 12 comprises a reflector 16 configured to provide a reflective surface 18 at, at least, the first frequency range, and the second antenna 14 comprises at least one conductive element 20 configured to receive and/or radiate in the second frequency range,



wherein at least a portion of the at least one conductive element 20 is configured to act as at least a portion of the reflective surface 18 of the reflector 16.

**[0164]** Method 900 can be considered a method of manufacturing an antenna arrangement 10 as described herein.

**[0165]** Examples of the disclosure are advantageous and/or provide technical benefits.

**[0166]** For example, examples of the disclosure provide for a saving in space for an antenna arrangement having different frequency bands sharing the same space and the same antenna assembly.

**[0167]** For example, examples of the disclosure provide for an integrated antenna assembly in which the first and second antennas can operate independently of each other.

**[0168]** For example, examples of the disclosure provide for an integrated antenna assembly in which it is possible to achieve different pointing directions for higher and lower frequency bands.

**[0169]** For example, examples of the disclosure provide for adding other frequency bands to an existing reflector antenna by adding one or more conductive elements as described herein.

**[0170]** For example, in examples involving a rotating antenna, examples of the disclosure provide for a reduction in the total size which reduces the torque.

**[0171]** For example, in examples involving an outdoor antenna, examples of the disclosure provide for a reduction in the total size which reduces the wind load.

**[0172]** Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

**[0173]** Where the term band or bandwidth is used for the first antenna 12, the second antenna 14 and/or the antenna arrangement 10, it refers to an 'operational bandwidth'.

**[0174]** An operational resonant mode (operational bandwidth) is a frequency range over which an antenna can efficiently operate. An operational resonant mode (operational bandwidth) may be defined as where the return loss S11 of the antenna is greater than (more negative than) an operational threshold T and where the radiated efficiency (er) is greater than an operational threshold in an efficiency plot.

**[0175]** The first antenna 12 and/or second antenna 14 and/or antenna arrangement 10 can be configured to operate in a plurality of operational resonant frequency bands. For example, the operational frequency bands may include (but are not limited to) Long Term Evolution (LTE) (US) (734 to 746 MHz and 869 to 894 MHz), Long Term Evolution (LTE) (rest of the world) (791 to 821 MHz and 925 to 960 MHz), amplitude modulation (AM) radio (0.535-1.705 MHz); frequency modulation (FM) radio (76-108 MHz); Bluetooth (2400-2483.5 MHz); wireless local area network (WLAN) (2400-2483.5 MHz); hiper

local area network (HiperLAN) (5150-5850 MHz); global positioning system (GPS) (1570.42-1580.42 MHz); US - Global system for mobile communications (US-GSM) 850 (824-894 MHz) and 1900 (1850 - 1990 MHz); global system for mobile communications (GSM) 900 (880-960 MHz) and 1800 (1710 - 1880 MHz); European wideband code division multiple access (EU-WCDMA) 900 (880-960 MHz); personal communications network (PCN/DCS) 1800 (1710-1880 MHz); US wideband code division multiple access (US-WCDMA) 1700 (transmit: 1710 to 1755 MHz, receive: 2110 to 2155 MHz) and 1900 (1850-1990 MHz); wideband code division multiple access (WCDMA) 2100 (transmit: 1920-1980 MHz, receive: 2110-2180 MHz); personal communications service (PCS) 1900 (1850-1990 MHz); time division synchronous code division multiple access (TD-SCDMA) (1900 MHz to 1920 MHz, 2010 MHz to 2025 MHz), ultra wideband (UWB) Lower (3100-4900 MHz); UWB Upper (6000-10600 MHz); digital video broadcasting - handheld (DVB-H) (470-702 MHz); DVB-H US (1670-1675 MHz); digital radio mondiale (DRM) (0.15-30 MHz); worldwide interoperability for microwave access (WiMax) (2300-2400 MHz, 2305-2360 MHz, 2496-2690 MHz, 3300-3400 MHz, 3400-3800 MHz, 5250-5875 MHz); digital audio broadcasting (DAB) (174.928-239.2 MHz, 1452.96- 1490.62 MHz); radio frequency identification low frequency (RFID LF) (0.125-0.134 MHz); radio frequency identification high frequency (RFID HF) (13.56-13.56 MHz); radio frequency identification ultra high frequency (RFID UHF) (433 MHz, 865-956 MHz, 2450 MHz), frequency allocations for 5G may include e.g. 700MHz, 410 MHz - 7125 MHz (FR1), 24250 MHz - 52600 MHz (FR2), 3.6-3.8GHz, 24.25-27.5GHz, 31.8-33.4GHz, 37.45-43.5, 66-71GHz, mmWave, and > 24GHz).

**[0176]** The first antenna 12 and/or second antenna 14 and/or antenna arrangement 10 can be configured to operate in a plurality of operational resonant frequency bands. For example, the operational frequency bands may include (but are not limited to)

|   | FDD       |  | TDD |           |
|---|-----------|--|-----|-----------|
| A | 555-806   |  | A   | 2010-2025 |
| B | 694-960   |  | B   | 1930-1990 |
| C | 806-894   |  | C   | 1910-1930 |
| D | 694-862   |  | D   | 2570-2620 |
| E | 790-960   |  | E   | 2300-2400 |
| F | 694-894   |  | F   | 1880-1920 |
| G | 870-960   |  | G   | 2545-2650 |
| H | 694-906   |  | H   | 2500-2690 |
| I | 824-960   |  | L   | 1880-2025 |
| J | 1400-2200 |  | M   | 1880-2690 |

(continued)

|   | FDD       |  | TDD |           |
|---|-----------|--|-----|-----------|
| K | 824-894   |  | Y   | 3300-3800 |
| L | 1695-2690 |  | U   | 3400-3600 |
| M | 2300-2690 |  | Z   | 3400-4200 |
| N | 790-862   |  |     |           |
| P | 1850-1995 |  |     |           |
| Q | 1710-1880 |  |     |           |
| R | 1695-2200 |  |     |           |
| S | 806-870   |  |     |           |
| U | 1920-2170 |  |     |           |
| W | 1695-2400 |  |     |           |
| Y | 1400-1520 |  |     |           |
| Z | 23002400  |  |     |           |

**[0177]** The radio frequency circuitry and the antenna may be configured to operate in a plurality of operational resonant frequency bands. For example, the operational frequency bands may include (but are not limited to) the bands specified in the current release of 3GPP TS 36.101.

**[0178]** As used here 'module' refers to a unit or apparatus that excludes certain parts/components that would be added by an end manufacturer or a user. The antenna arrangement 10 can be a module.

**[0179]** The above described examples find application as enabling components of: automotive systems; telecommunication systems; electronic systems including consumer electronic products; distributed computing systems; media systems for generating or rendering media content including audio, visual and audio visual content and mixed, mediated, virtual and/or augmented reality; personal systems including personal health systems or personal fitness systems; navigation systems; user interfaces also known as human machine interfaces; networks including cellular, non-cellular, and optical networks; ad-hoc networks; the internet; the internet of things; virtualized networks; and related software and services.

**[0180]** The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use 'comprise' with an exclusive meaning then it will be made clear in the context by referring to "comprising only one.." or by using "consisting".

**[0181]** In this description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term 'example' or 'for example' or 'can' or 'may' in

the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some of or all other examples. Thus 'example', 'for example', 'can' or 'may' refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class. It is therefore implicitly disclosed that a feature described with reference to one example but not with reference to another example, can where possible be used in that other example as part of a working combination but does not necessarily have to be used in that other example.

**[0182]** Although examples have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the claims.

**[0183]** Features described in the preceding description may be used in combinations other than the combinations explicitly described above.

**[0184]** Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

**[0185]** Although features have been described with reference to certain examples, those features may also be present in other examples whether described or not.

**[0186]** The term 'a' or 'the' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising a/the Y indicates that X may comprise only one Y or may comprise more than one Y unless the context clearly indicates the contrary. If it is intended to use 'a' or 'the' with an exclusive meaning then it will be made clear in the context. In some circumstances the use of 'at least one' or 'one or more' may be used to emphasize an inclusive meaning but the absence of these terms should not be taken to infer any exclusive meaning.

**[0187]** The presence of a feature (or combination of features) in a claim is a reference to that feature or (combination of features) itself and also to features that achieve substantially the same technical effect (equivalent features). The equivalent features include, for example, features that are variants and achieve substantially the same result in substantially the same way. The equivalent features include, for example, features that perform substantially the same function, in substantially the same way to achieve substantially the same result.

**[0188]** In this description, reference has been made to various examples using adjectives or adjectival phrases to describe characteristics of the examples. Such a description of a characteristic in relation to an example indicates that the characteristic is present in some examples exactly as described and is present in other examples substantially as described.

**[0189]** Whilst endeavoring in the foregoing specifica-

tion to draw attention to those features believed to be of importance it should be understood that the Applicant may seek protection via the claims in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not emphasis has been placed thereon.

## Claims

1. An antenna arrangement comprising:
  - a first antenna configured to operate in a first frequency range; and
  - a second antenna configured to operate in a second frequency range;
  - wherein the first antenna comprises a reflector configured to provide a reflective surface at, at least, the first frequency range, and
  - the second antenna comprises at least one conductive element configured to receive and/or radiate in the second frequency range, wherein at least a portion of the at least one conductive element is configured to act as at least a portion of the reflective surface of the reflector.
2. The antenna arrangement as claimed in claim 1, wherein the at least one conductive element is positioned between the reflector and at least one receiving and/or radiating element of the first antenna.
3. The antenna arrangement as claimed in claim 1 or 2, wherein the at least one conductive element is supported by the reflector.
4. The antenna arrangement as claimed in any preceding claim, wherein at least a plurality of points of a perimeter of the at least one conductive element is substantially at a fixed distance from the reflector.
5. The antenna arrangement as claimed in claim 4, wherein the fixed distance is substantially  $n$  times  $\lambda/2$ , wherein  $n$  is a positive integer and  $\lambda$  is a wavelength that corresponds to a frequency of the first frequency range.
6. The antenna arrangement as claimed in any preceding claim, wherein the at least one conductive element is configured to receive and/or radiate in a plurality of frequencies within the second frequency range and/or in a plurality of polarisations.
7. The antenna arrangement as claimed in any preceding claim, wherein the first frequency range is located at frequencies that are substantially higher than the respective frequencies of the second frequency range.
8. The antenna arrangement as claimed in any preceding claim, wherein the first frequency range does not overlap with the second frequency range.
9. The antenna arrangement as claimed in any preceding claim, wherein at least one of the at least one conductive element has a shape that is conforming to the reflective surface of the reflector.
10. The antenna arrangement as claimed in any preceding claim, wherein the at least one conductive element comprises a plurality of conductive elements, and one or more of the conductive elements of the plurality of conductive elements has or have a shape that is substantially conforming to the reflective surface of the reflector.
11. The antenna arrangement as claimed in claim 10, wherein the reflective surface is substantially parabolic in shape and the plurality of conductive elements is configured in a substantially parabolic shape.
12. The antenna arrangement as claimed in any preceding claim, wherein the antenna arrangement is configured to allow different pointing directions for the first and second antennas.
13. The antenna arrangement as claimed in any preceding claim, wherein one or more feed lines to the at least one conductive element pass through at least one opening in the reflector.
14. The antenna arrangement as claimed in any preceding claim, wherein one or more feed lines to the at least one conductive element run across the reflective surface of the reflector.
15. An apparatus comprising an antenna arrangement as claimed in at least one of claims 1 to 14.

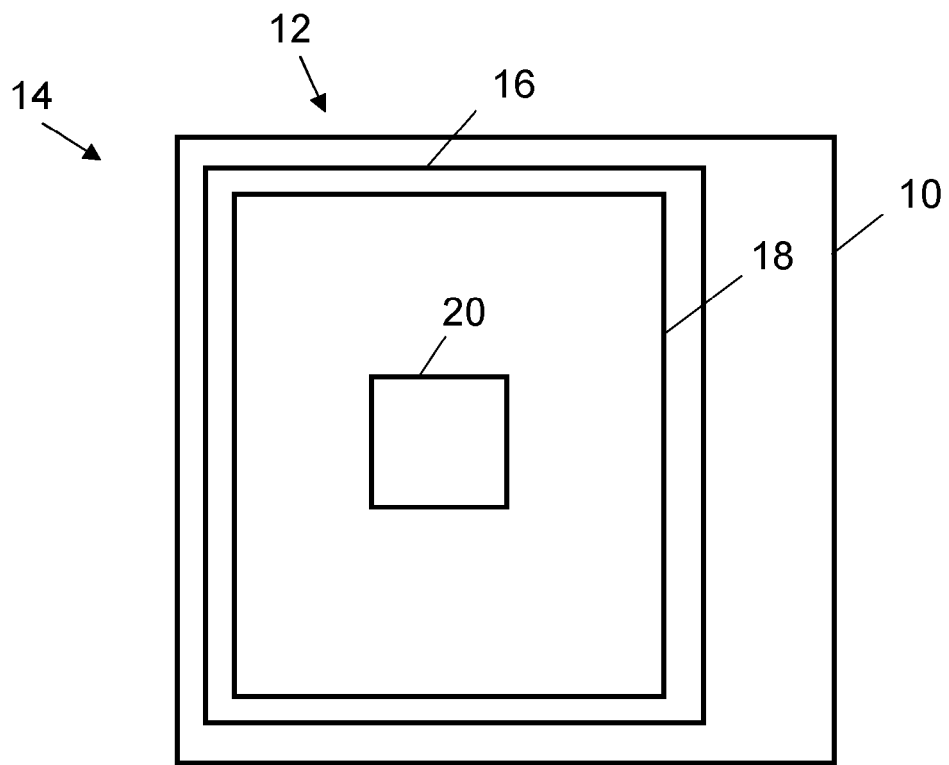


FIG. 1

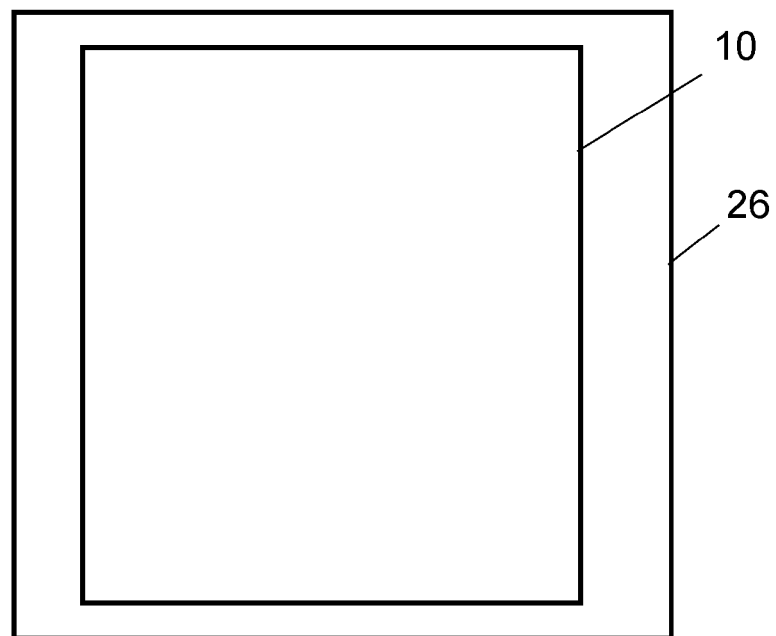


FIG. 2

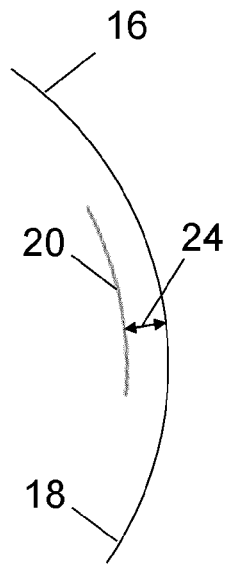


FIG. 3A

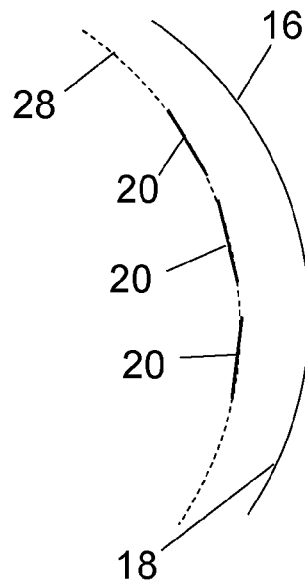


FIG. 3B

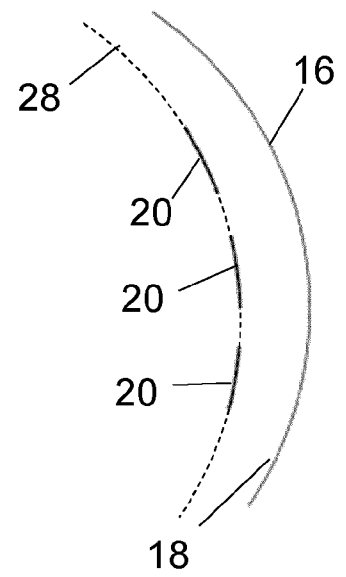


FIG. 3C

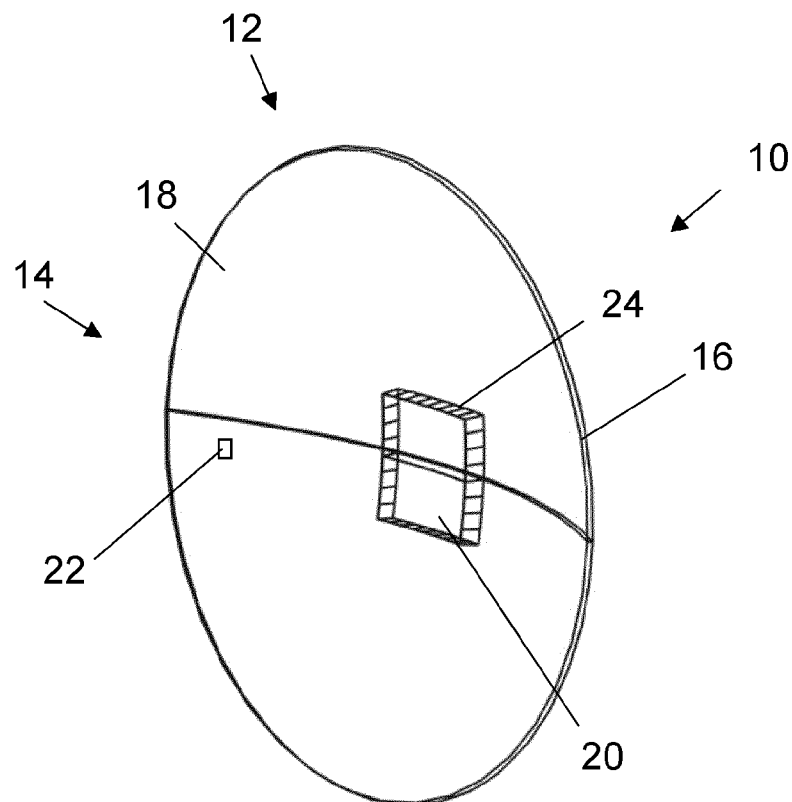


FIG. 4

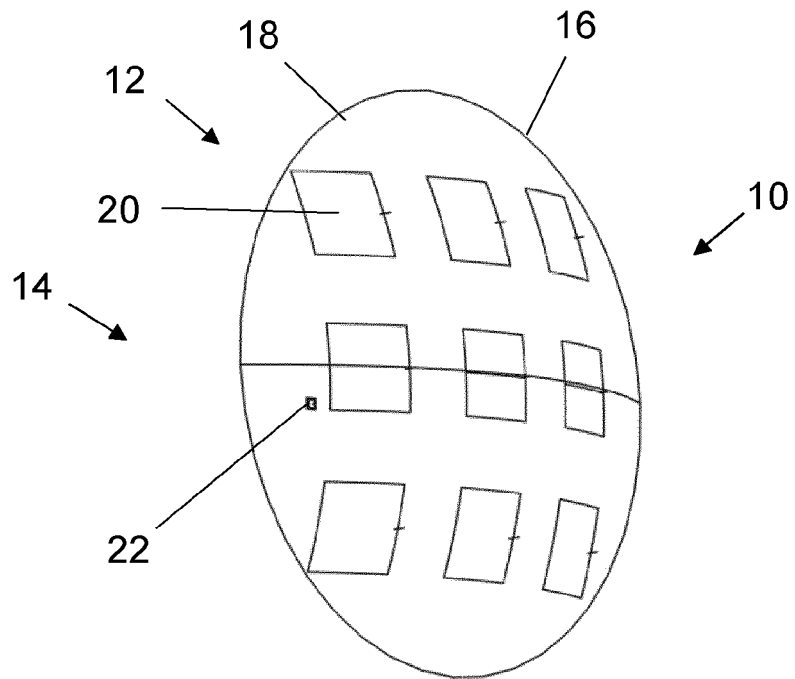


FIG. 5

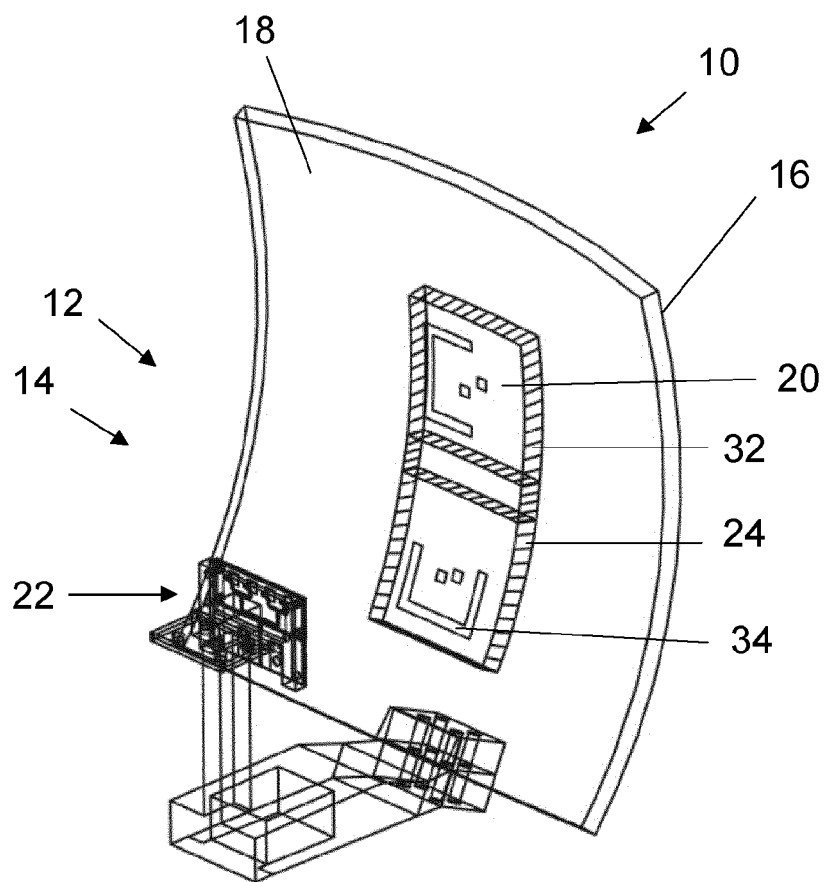


FIG. 6A

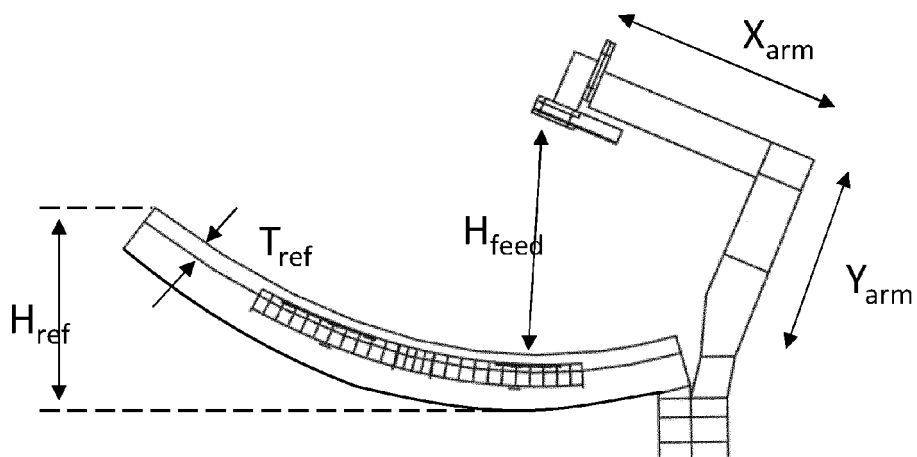


FIG. 6B

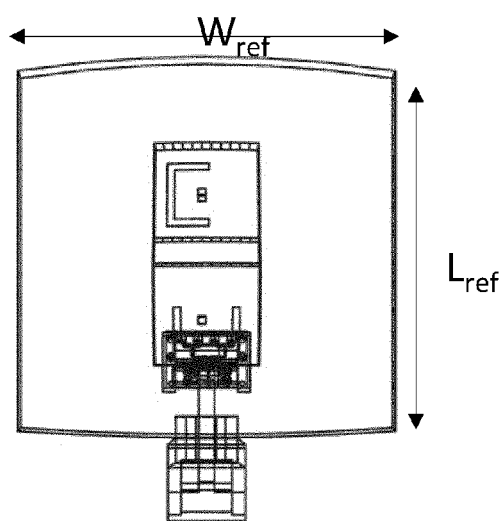


FIG. 6C

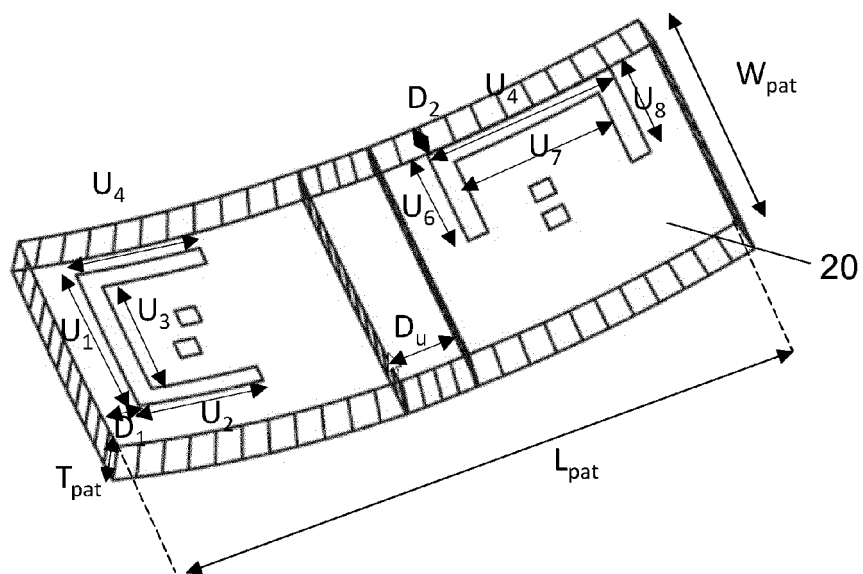


FIG. 7

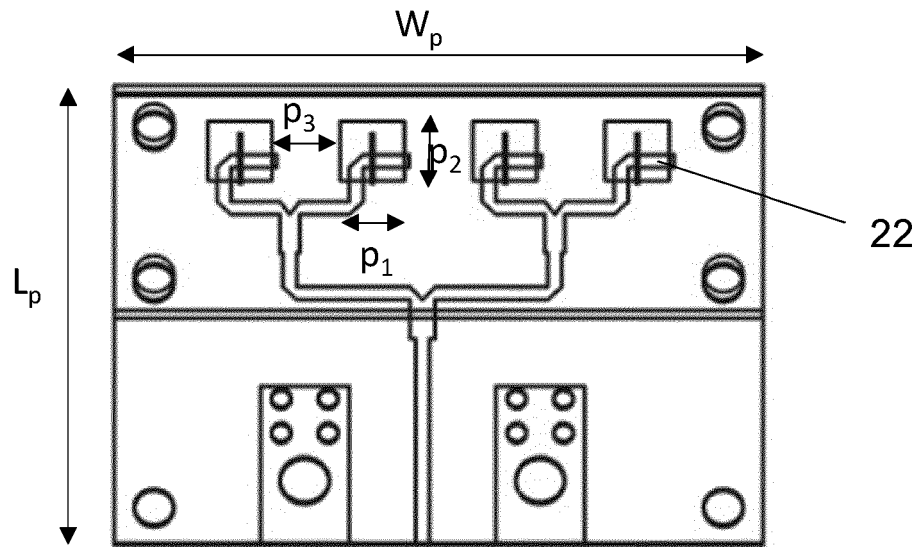


FIG. 8

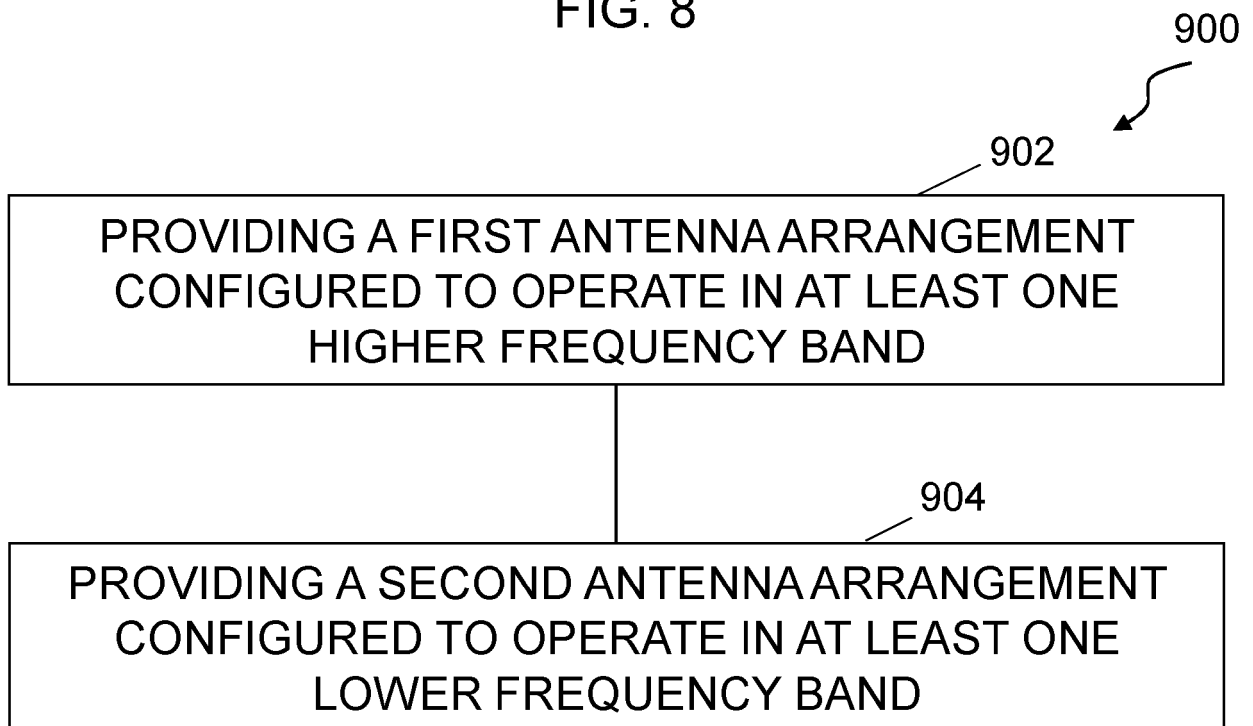


FIG. 9





## EUROPEAN SEARCH REPORT

Application Number

EP 22 38 2543

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category                                                   | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------|-----------------------------------------|
| X                                                          | JP S61 26309 A (MITSUBISHI ELECTRIC CORP)<br>5 February 1986 (1986-02-05)     | 1-4, 6-15         | INV.                                    |
| A                                                          | * page 33 - page 35; figure 4 *                                               | 5                 | H01Q5/40                                |
|                                                            | -----                                                                         |                   | H01Q9/04                                |
| A                                                          | JP H10 229308 A (MITSUBISHI ELECTRIC CORP)<br>25 August 1998 (1998-08-25)     | 1-15              | H01Q19/17                               |
|                                                            | * paragraph [0023]; figure 1 *                                                |                   | H01Q21/08                               |
|                                                            | -----                                                                         |                   | H01Q21/20                               |
|                                                            |                                                                               |                   | H01Q21/24                               |
|                                                            |                                                                               |                   | H01Q21/28                               |
|                                                            |                                                                               |                   | H01Q25/00                               |
|                                                            |                                                                               |                   | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                            |                                                                               |                   | H01Q                                    |
| The present search report has been drawn up for all claims |                                                                               |                   |                                         |

1

EPO FORM 1503 03.82 (P04C01)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------|
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Date of completion of the search | Examiner             |
| The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 21 November 2022                 | Collado Garrido, Ana |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                  |                      |

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

EP 22 38 2543

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-11-2022

| 10 | Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|----|-------------------------------------------|---------------------|----------------------------|---------------------|
|    | JP S6126309 A                             | 05-02-1986          | NONE                       |                     |
| 15 | JP H10229308 A                            | 25-08-1998          | NONE                       |                     |
| 20 |                                           |                     |                            |                     |
| 25 |                                           |                     |                            |                     |
| 30 |                                           |                     |                            |                     |
| 35 |                                           |                     |                            |                     |
| 40 |                                           |                     |                            |                     |
| 45 |                                           |                     |                            |                     |
| 50 |                                           |                     |                            |                     |
| 55 |                                           |                     |                            |                     |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82