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Amended claims in accordance with Rule 137(2) EPC.

(54) **BASE STATION ANTENNA FOR CELLULAR COMMUNICATIONS**

(57) The invention relates to a dual purpose base station antenna (100) for handling beamforming communications and non-beamforming communications in a communication cell, the dual purpose base station antenna comprising: an antenna mounting frame (102); a first array of antenna elements (101) arranged on the antenna mounting frame (102), the first array of antenna elements (101) being capable of generating a radio frequency transmission signal for non-beamforming communications; and a second array of antenna elements (103) attached to the antenna mounting frame (102), the second array of antenna elements (103) being capable of generating a transmission beam for beamforming communications, wherein the second array of antenna elements (103) at least partially intermeshes with the first array of antenna elements (101).

quency transmission signal for non-beamforming communications; and a second array of antenna elements (103) attached to the antenna mounting frame (102), the second array of antenna elements (103) being capable of generating a transmission beam for beamforming communications, wherein the second array of antenna elements (103) at least partially intermeshes with the first array of antenna elements (101).

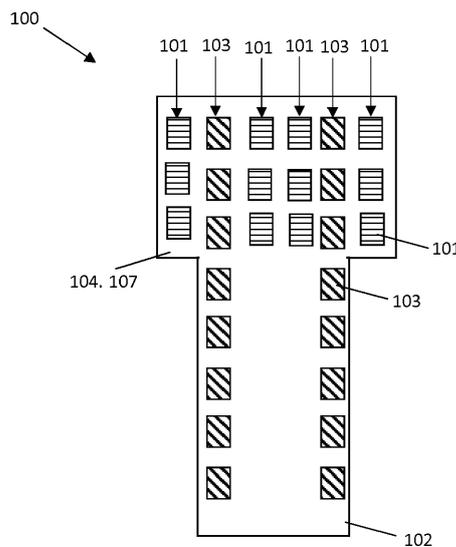


Fig. 1

DescriptionTECHNICAL FIELD

[0001] In general, the present invention relates to a base station antenna for cellular communications.

BACKGROUND

[0002] In a conventional communication scenario, e.g. according to the LTE communication technology, a sector antenna is used for radio frequency communications. In order to generate an omnidirectional, horizontal transmission pattern, usually three sector antennas are angularly arranged with the sector antennas pointing in different spatial directions.

[0003] With the upcoming 5G technologies, beamforming communications in multiple-in multiple-out (MIMO) fashion is increasingly important. Unlike a sector radiation pattern of a sector antenna, a transmission beam for beamforming communications can be steered towards different directions in order to exploit spatial diversity for more efficiently exploiting the available communication resources.

[0004] In order to support both, traditional radio frequency communications and beamforming communications, usually two separate antennas must be provided. However, the available space for mounting further antennas is limited. There is therefore a need for a more efficient antenna design concept.

SUMMARY OF THE INVENTION

[0005] It is therefore an object of the disclosure to provide an improved base station antenna, which is capable of simultaneously handling traditional radio frequency communications and beamforming communications.

[0006] The foregoing and other objects are achieved by the subject matter of the independent claims. Further implementation forms are apparent from the dependent claims, the description and the figures.

[0007] According to a first aspect, the disclosure relates to a dual purpose base station antenna for handling beamforming communications and non-beamforming, for example traditional radio frequency communications which are usually handled by one or more sector antenna, communications in a communication cell, the dual purpose base station antenna comprising: an antenna mounting frame; a first array of antenna elements arranged on the antenna mounting frame, the first array of antenna elements being capable of generating a radio frequency transmission signal for non-beamforming communications; and a second array of antenna elements attached to the antenna mounting frame, the second array of antenna elements being capable of generating a transmission beam for beamforming communications, wherein the second array of antenna elements at least partially intermeshes with the first array of antenna

elements.

[0008] The intermeshing is achieved by alternately arranging antenna elements of the first and the second array next to each other and/or above each other. Thereby, the radiating antenna aperture can efficiently be obtained. Moreover, the intermeshed antenna elements can jointly be used either for sector-like communications or for beamforming communications.

[0009] According to an embodiment, the first array of antenna elements forms a sector antenna with a sector-shaped horizontal radiation pattern for generating the radio frequency transmission signal, and the second array of antenna elements forms a multiple input multiple output (MIMO) antenna with a beam-shaped horizontal radiation pattern.

[0010] The first array can form a sector antenna for communications with a fix sector-like horizontal radiation pattern.

[0011] According to an example, the dual purpose base station antenna comprises two further first arrays of antenna elements arranged in an angular fashion for omnidirectional communications.

[0012] According to an example, the first array of antenna elements and the second array of antenna elements are independently and/or simultaneously excited.

[0013] Therefore, beamforming and non-beamforming communications such as sector-like radiation can be handled independently from each other. Thereby, the number of communicating user entities can be increased.

[0014] According to an example, the first array of antenna elements and the second array of antenna elements jointly form a composite array of antenna elements, the composite array of antenna elements being capable of generating a second transmission beam with reduced beam width compared to the transmission beam generated only by the second array of antenna elements.

[0015] The reduced width or increased beam separation can be obtained due to the increased number of antenna elements available for beamforming.

[0016] According to an example, the first array of antenna elements and the second array of antenna elements share common antenna elements, the common antenna elements being assigned to the first array for generating the radio frequency transmission signal, or being assigned to the second array of antenna elements for generating the transmission beam.

[0017] Thereby, the available antenna elements can more efficiently be used for communications.

[0018] According to an example, the second array of antenna elements is arranged on a carrier, in particular on a dielectric carrier, the carrier being attached to the antenna mounting frame such that the intermeshing antenna elements of the second array of antenna elements do not overlay the antenna elements of the first array of antenna elements.

[0019] In this way, e.g. existing sector antennas can be provided with additional beamforming functionality for beamforming communications.

[0020] According to an example, the carrier overlays the first array of antenna elements. This enables a space-efficient antenna design.

[0021] According to an example, the second array of antenna elements is arranged on the antenna mounting frame, wherein antenna elements of the second array of antenna elements and elements of the first array of antenna elements are alternately arranged on the antenna mounting frame.

[0022] Thereby, the available antenna space can more efficiently be used. Moreover, the antenna elements can be arranged within the same plane which simplifies controlling antenna elements for e.g. generating a transmission beam.

[0023] According to an example, the antenna mounting frame comprises a widened portion for accommodating the second array of antenna elements. Thereby, the second array of antenna elements can be arranged in a plane suitable for accommodating a plurality of antenna elements, e.g. 64, according to the 5G communication technology.

[0024] According to an example, the dual purpose base station antenna comprises a third array of antenna elements being capable of beamforming communications, wherein the third array of antenna elements is arranged below or above the second array of antenna elements.

[0025] Thereby, another transmission beam can be generated. Moreover, the third array of antenna elements can be tilted downwards for directing transmission beams more easily towards e.g. urban areas located below the antenna, or tilted upwards for beamforming communications with e.g. drones.

[0026] According to an example, the third array of antenna elements at least partially intermeshes with the first array of antenna elements. Thereby, the above mentioned advantages can be achieved in connection with the third array of elements as described above.

[0027] According to an example, the first array of antenna elements forms a sector antenna, and the second array of antenna elements forms a multiple input multiple output (MIMO) beamforming antenna.

[0028] According to an example, the first array of antenna elements is configured for communications in a first frequency range, in particular 800 MHz, 0.8, 0.9, 1.8 GHz and 2.1 GHz, and the second array of antenna elements is configured for communications in a second frequency range, in particular 3.4 to 3.8 GHz, or 24.25 to 29.5 GHz or 31.8 to 33.4GHz or 37 to 40 GHz or 57 to 77 GHz, wherein the first frequency range at least partly differs from the second frequency range.

[0029] According to a second aspect, the disclosure relates to a MIMO base station system, comprising: the dual purpose base station antenna according to the first aspect; and a MIMO base station for cellular communications, wherein the MIMO base station is configured to excite the first antenna array to generate the a radio frequency transmission signal for non-beamforming com-

munications, and to excite the second array of antenna elements to transmit the transmission beam or to receive a reception beam from a user equipment or a user entity.

[0030] The MIMO base station system can in this way be also deployed for handling communications without beamforming. Thereby, radio access can be provided to user entities being capable and being non-capable of beamforming.

[0031] According to an example, the dual purpose base station antenna and the MIMO base station are configured for communicating according to one of the following communication technologies: GSM, LTE, LTE-A, UMTS, HSPA, 3GPP, in particular 3GPP NR, New Radio, 5G or IEEE radio systems such as Wireless LAN, WiGig, or any of the evolutions and successors of these technologies.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Further embodiments of the invention will be described with respect to the following figures, wherein:

Figure 1 shows an example of a dual purpose base station antenna;

Figure 2 shows an example of a dual purpose base station antenna;

Figure 3 shows an example of a dual purpose base station antenna; and

Figure 4 shows an example of a base station system.

[0033] In the various figures, identical reference signs will be used for identical or at least functionally equivalent features.

DETAILED DESCRIPTION OF EMBODIMENTS

[0034] In the following description, reference is made to the accompanying drawings, which form part of the disclosure, and in which are shown, by way of illustration, specific aspects in which the present invention may be placed. It will be appreciated that other aspects may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, as the scope of the present invention is defined by the appended claims.

[0035] For instance, it will be appreciated that a disclosure in connection with a described method may also hold true for a corresponding device or system configured to perform the method and vice versa. For example, if a specific method step is described, a corresponding device may include a unit to perform the described method step, even if such unit is not explicitly described or illustrated in the figures.

[0036] Moreover, in the following detailed description

as well as in the claims, embodiments with different functional blocks or processing units are described, which are connected with each other or exchange signals. It will be appreciated that the present invention covers embodiments as well, which include additional functional blocks or processing units that are arranged between the functional blocks or processing units of the embodiments described below.

[0037] Fig. 1 shows a dual purpose base station antenna 100 for handling beamforming communications and non-beamforming communications in a communication cell, the dual purpose base station antenna comprising an antenna mounting frame 102, being e.g. formed from metal, metal mesh or plastic, a first array of antenna elements 101 arranged on the antenna mounting frame 102, the first array of antenna elements 101 being capable of generating a radio frequency transmission signal for non-beamforming communications; and a second array of antenna elements 103 attached to the antenna mounting frame 102, the second array of antenna elements 103 being capable of generating a transmission beam for beamforming communications, wherein the second array of antenna elements 103 at least partially intermeshes with the first array of antenna elements 101.

[0038] As depicted in Fig. 1, the second array of antenna elements 103 is arranged on the antenna mounting frame 102, wherein antenna elements of the second array of antenna elements 103 and elements of the first array of antenna elements 101 are alternately arranged on the antenna mounting frame 102, thereby intermeshing with each other.

[0039] The antenna mounting frame 102 comprises a widened portion 104 for accommodating the second array of antenna elements 103. However, the antenna mounting frame 102 can have a constant width.

[0040] Alternatively, the second array of antenna elements 103 is arranged on a carrier 107, in particular on a dielectric carrier, the carrier 107 being attached to the antenna mounting frame 102 such that the intermeshing antenna elements of the second array of antenna elements 103 do not overlay the antenna elements of the first array of antenna elements 101.

[0041] Both alternatives are depicted in Fig. 1.

[0042] The antenna mounting frame 102 is provided for mounting the dual purpose base station antenna 100 e.g. on a roof of a building or on a mast.

[0043] Fig. 2 shows the dual purpose base station antenna 100 according to an example, comprising a third array of antenna elements 109 being capable of beamforming communications, wherein the third array of antenna elements 109 is arranged below or above the second array of antenna elements 103. The third array of antenna elements 109 at least partially intermeshes with the first array of antenna elements 101.

[0044] The third array of antenna elements 109 can be used for beamforming towards areas located below the dual purpose base station antenna 100, whereas the first array of antenna elements 101 can be used for beam-

forming towards areas located above the dual purpose base station antenna 100, for example for drone communications.

[0045] The third array of antenna elements 109 can be deployed correspondingly to the deployment of the first array of antenna elements 101. Therefore, the description relating to the first array of antenna elements 101 also applies to the third array of antenna elements 109.

[0046] Fig. 3 shows the dual purpose base station antenna 100 according to an example, where the first array of antenna elements 101 and the second array of antenna elements 103 share common antenna elements 105, the common antenna elements 105 being assigned to the first array of antenna elements 101 for generating the radio frequency transmission signal, or being assigned to the second array of antenna elements 103 for generating the transmission beam.

[0047] Fig. 4 shows an example of a MIMO base station system 200, comprising a MIMO base station 201 and the dual purpose base station antenna 100.

[0048] The MIMO base station 201 is configured to excite the first array of antenna elements 101 to generate the a radio frequency transmission signal for non-beamforming communications, and to excite the second array of antenna elements 103 to transmit the transmission beam or to receive a reception beam from a user equipment or a user entity.

[0049] The MIMO base station 201 can be configured for communicating according to one of the following communication technologies: GSM, LTE, LTE-A, UMTS, HSPA, 3GPP, in particular 3GPP NR, New Radio, 5G or IEEE radio systems such as Wireless LAN, WiGig, or any of the evolutions and successors of these technologies.

[0050] The MIMO base station 201 can generate the respective transmission beam using a beamforming codebook according to a MIMO communication technology in order to generate a steering signal for steering the first array of antenna elements 101 and/or the third array of antenna elements 109. The codebook can for example indicate an amplitude and/or a phase of a signal driving the respective antenna element or several antenna elements to generate the spatially directed beam. For example, the codebook can have an entry $1 + j1$ defining an amplitude and a phase of a complex signal. The steering signal can indicate the phase. Thereby, a spatially directed transmission beam can be generated, or, conversely, a spatially directed reception beam can be received.

[0051] While a particular feature or aspect of the disclosure may have been disclosed with respect to only one of several implementations or embodiments, such feature or aspect may be combined with one or more other features or aspects of the other implementations or embodiments as may be desired and advantageous for any given or particular application. Furthermore, to the extent that the terms "include", "have", "with", or other variants thereof are used in either the detailed description

or the claims, such terms are intended to be inclusive in a manner similar to the term "comprise". Also, the terms "exemplary", "for example" and "e.g." are merely meant as an example, rather than the best or optimal. The terms "coupled" and "connected", along with derivatives may have been used. It should be understood that these terms may have been used to indicate that two elements cooperate or interact with each other regardless of whether they are in direct physical or electrical contact, or they are not in direct contact with each other.

[0052] Although specific aspects have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific aspects shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the specific aspects discussed herein.

[0053] Although the elements in the following claims are recited in a particular sequence with corresponding labeling, unless the claim recitations otherwise imply a particular sequence for implementing some or all of those elements, those elements are not necessarily intended to be limited to being implemented in that particular sequence.

[0054] Many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the above teachings. Of course, those skilled in the art readily recognize that there are numerous applications of the invention beyond those described herein. While the present invention has been described with reference to one or more particular embodiments, those skilled in the art recognize that many changes may be made thereto without departing from the scope of the present invention. It is therefore to be understood that within the scope of the appended claims and their equivalents, the invention may be practiced otherwise than as specifically described herein.

Claims

1. Dual purpose base station antenna (100) for handling beamforming communications and non-beamforming communications in a communication cell, the dual purpose base station antenna comprising:

an antenna mounting frame (102);
 a first array of antenna elements (101) arranged on the antenna mounting frame (102), the first array of antenna elements (101) being capable of generating a radio frequency transmission signal for non-beamforming communications; and
 a second array of antenna elements (103) attached to the antenna mounting frame (102), the second array of antenna elements (103) being capable of generating a transmission beam for

beamforming communications, wherein the second array of antenna elements (103) at least partially intermeshes with the first array of antenna elements (101).

2. The dual purpose base station antenna (100) according to claim 1, wherein the first array of antenna elements (101) forms a sector antenna with a sector-shaped horizontal radiation pattern for generating the radio frequency transmission signal, and wherein the second array of antenna elements (103) forms a multiple input multiple output (MIMO) antenna with a beam-shaped horizontal radiation pattern.
3. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) and the second array of antenna elements (103) are independently and/or simultaneously excited.
4. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) and the second array of antenna elements (103) jointly form a composite array of antenna elements (101, 103), the composite array of antenna elements (101, 103) being capable of generating a second transmission beam with reduced beam width compared to the transmission beam generated only by the second array of antenna elements.
5. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) and the second array of antenna elements (103) share common antenna elements (105), the common antenna elements (105) being assigned to the first array of antenna elements (101) for generating the radio frequency transmission signal, or being assigned to the second array of antenna elements (103) for generating the transmission beam.
6. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the second array of antenna elements (103) is arranged on a carrier (107), in particular on a dielectric carrier, the carrier (107) being attached to the antenna mounting frame (102) such that the intermeshing antenna elements of the second array of antenna elements (103) do not overlay the antenna elements of the first array of antenna elements (101).
7. The dual purpose base station antenna (100) according to claim 6, wherein the carrier (107) overlays the first array of antenna elements (101).
8. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein

the second array of antenna elements (103) is arranged on the antenna mounting frame (102), wherein antenna elements of the second array of antenna elements (103) and elements of the first array of antenna elements (101) are alternately arranged on the antenna mounting frame (102).

9. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the antenna mounting frame (102) comprises a widened portion (104) for accommodating the second array of antenna elements (103).

10. The dual purpose base station antenna (100) according to anyone of the preceding claims, comprising a third array of antenna elements (109) being capable of beamforming communications, wherein the third array of antenna elements (109) is arranged below or above the second array of antenna elements (103).

11. The dual purpose base station antenna (100) according to claim 10, wherein the third array of antenna elements (109) at least partially intermeshes with the first array of antenna elements (101).

12. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) forms a sector antenna, and wherein the second array of antenna elements (103) forms a multiple input multiple output (MIMO) beamforming antenna.

13. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) is configured for communications in a first frequency range, in particular 800 MHz, 0.8, 0.9, 1.8 GHz and 2.1 GHz, wherein the second array of antenna elements (103) is configured for communications in a second frequency range, in particular 3.4 to 3.8 GHz, or 24.25 to 29.5 GHz or 31.8 to 33.4GHz or 37 to 40 GHz or 57 to 77 GHz, and wherein the first frequency range at least partly differs from the second frequency range.

14. MIMO base station system (200), comprising:

a MIMO base station (201); and
the dual purpose base station antenna (100) according to anyone of the preceding claims;
wherein the MIMO base station (201) is configured to excite the first array of antenna elements (101) to generate the a radio frequency transmission signal for non-beamforming communications, and to excite the second array of antenna elements (103) to transmit the transmission beam or to receive a reception beam from a user

entity.

15. The MIMO base station system (200) according to claim 14, wherein the dual purpose base station antenna (100) and the a MIMO base station (201) are configured for communicating according to one of the following communication technologies: GSM, LTE, LTE-A, UMTS, HSPA, 3GPP, in particular 3GPP NR, New Radio, 5G or IEEE radio systems such as Wireless LAN, WiGig, or any of the evolutions and successors of these technologies.

Amended claims in accordance with Rule 137(2) EPC.

1. Dual purpose base station antenna (100) for handling beamforming communications and non-beamforming communications in a communication cell, the dual purpose base station antenna comprising:

an antenna mounting frame (102);
a first array of antenna elements (101) arranged on the antenna mounting frame (102), wherein the first array of antenna elements (101) is configured to generate a radio frequency transmission signal for non-beamforming communications; and

a second array of antenna elements (103) attached to the antenna mounting frame (102), wherein the second array of antenna elements (103) is configured to generate a transmission beam for beamforming communications, wherein the second array of antenna elements (103) at least partially intermeshes with the first array of antenna elements (101); and

a third array of antenna elements (109) configured to generate a transmission beam for beamforming communications, wherein the third array of antenna elements (109) is arranged below or above the second array of antenna elements (103),

wherein the third array of antenna elements (109) is configured to be used for beamforming towards areas located below the dual purpose base station antenna (100), whereas the second array of antenna elements (103) is configured to be used for beamforming towards areas located above the dual purpose base station antenna (100).

2. The dual purpose base station antenna (100) according to claim 1, wherein the first array of antenna elements (101) forms a sector antenna with a sector-shaped horizontal radiation pattern for generating the radio frequency transmission signal, and wherein the second array of antenna elements (103) forms a multiple input multiple output (MIMO) antenna with

a beam-shaped horizontal radiation pattern.

3. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) and the second array of antenna elements (103) are independently and/or simultaneously excited.
4. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) and the second array of antenna elements (103) jointly form a composite array of antenna elements (101, 103), wherein the composite array of antenna elements (101, 103) is configured to generate a second transmission beam with reduced beam width compared to the transmission beam generated only by the second array of antenna elements.
5. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) and the second array of antenna elements (103) share common antenna elements (105), the common antenna elements (105) being assigned to the first array of antenna elements (101) for generating the radio frequency transmission signal, or being assigned to the second array of antenna elements (103) for generating the transmission beam.
6. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the second array of antenna elements (103) is arranged on a carrier (107), in particular on a dielectric carrier, the carrier (107) being attached to the antenna mounting frame (102) such that the intermeshing antenna elements of the second array of antenna elements (103) do not overlay the antenna elements of the first array of antenna elements (101).
7. The dual purpose base station antenna (100) according to claim 6, wherein the carrier (107) overlays the first array of antenna elements (101).
8. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the second array of antenna elements (103) is arranged on the antenna mounting frame (102), wherein antenna elements of the second array of antenna elements (103) and elements of the first array of antenna elements (101) are alternately arranged on the antenna mounting frame (102).
9. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the antenna mounting frame (102) comprises a widened portion (104) for accommodating the second array of antenna elements (103).
10. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the third array of antenna elements (109) at least partially intermeshes with the first array of antenna elements (101).
11. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) forms a sector antenna, and wherein the second array of antenna elements (103) forms a multiple input multiple output (MIMO) beamforming antenna.
12. The dual purpose base station antenna (100) according to anyone of the preceding claims, wherein the first array of antenna elements (101) is configured for communications in a first frequency range, in particular 800 MHz, 0.9, 1.8 GHz and 2.1 GHz, wherein the second array of antenna elements (103) is configured for communications in a second frequency range, in particular 3.4 to 3.8 GHz, or 24.25 to 29.5 GHz or 31.8 to 33.4GHz or 37 to 40 GHz or 57 to 77 GHz, and wherein the first frequency range at least partly differs from the second frequency range.
13. MIMO base station system (200), comprising:
 - a MIMO base station (201); and
 - the dual purpose base station antenna (100) according to anyone of the preceding claims; wherein the MIMO base station (201) is configured to excite the first array of antenna elements (101) to generate the a radio frequency transmission signal for non-beamforming communications, and to excite the second array of antenna elements (103) to transmit the transmission beam or to receive a reception beam from a user entity.
14. The MIMO base station system (200) according to claim 13, wherein the dual purpose base station antenna (100) and the a MIMO base station (201) are configured for communicating according to one of the following communication technologies: GSM, LTE, LTE-A, UMTS, HSPA, 3GPP, in particular 3GPP NR, New Radio, 5G or IEEE radio systems such as Wireless LAN, WiGig.

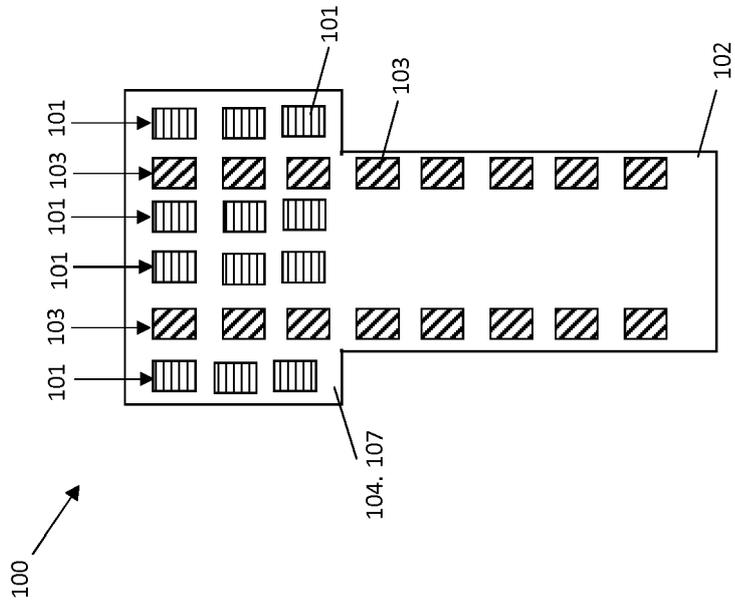


Fig. 1

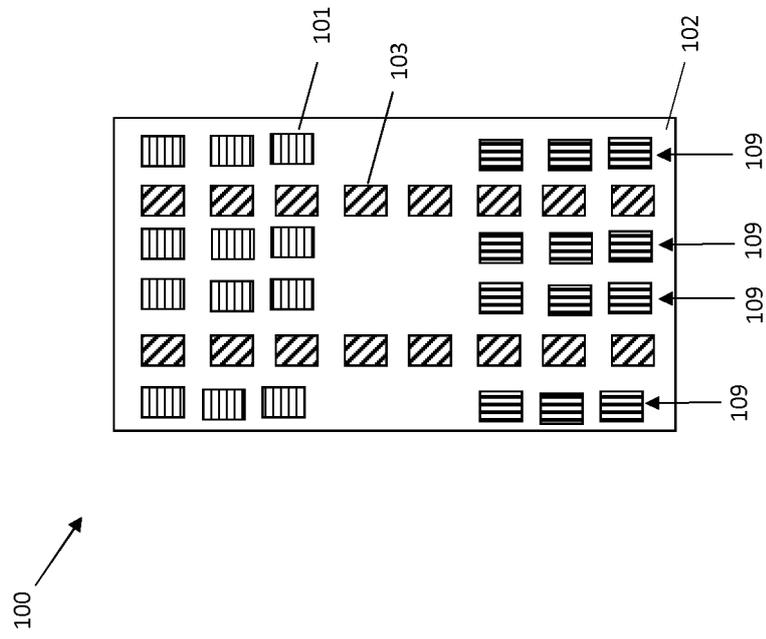


Fig. 2

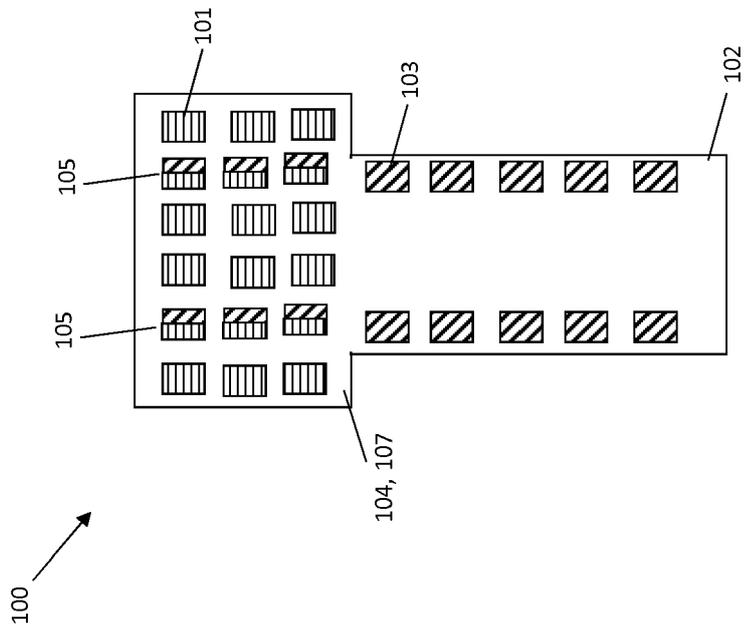


Fig. 3

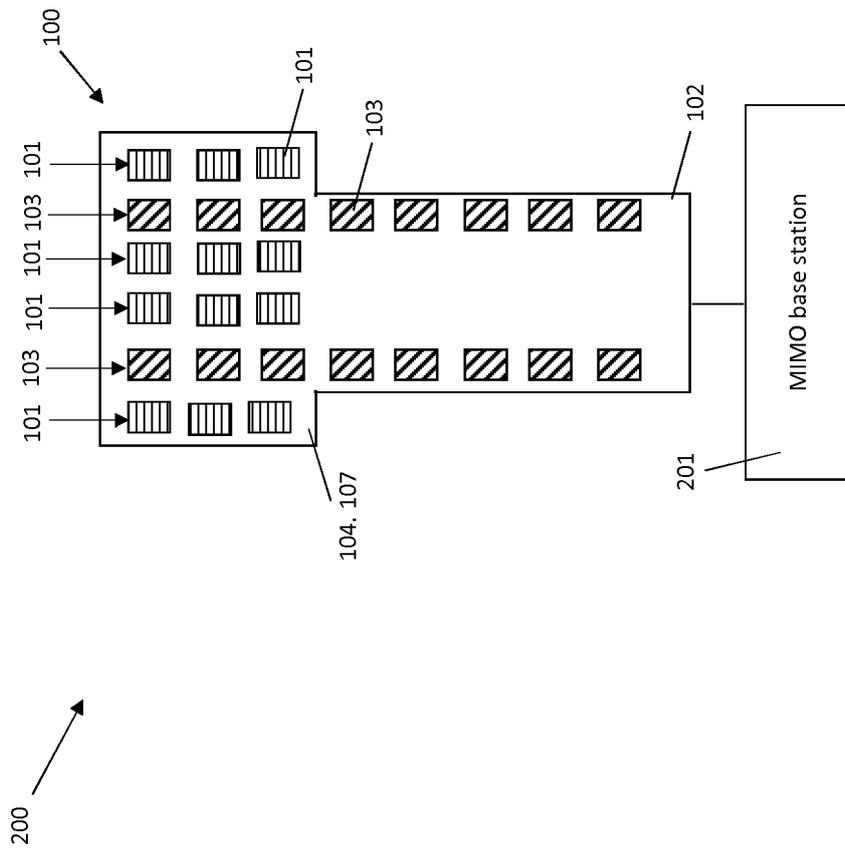


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 17 21 0467

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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 A	WO 2007/118211 A2 (ANDREW CORP [US]) 18 October 2007 (2007-10-18) * page 16, line 10 - page 16, line 26; figure 3c *	1-3,6-15 4,5	INV. H01Q5/42 H01Q1/24 H01Q21/06
X A	WO 2016/173633 A1 (HUAWEI TECH CO LTD [CN]; HÖGGERG MATS [SE]; SIHLBOM BJÖRN [SE]; IMBERG) 3 November 2016 (2016-11-03) * page 5, line 35 - page 5, line 37 * * page 11, line 17 - page 11, line 22 * * page 12, line 7 - page 12, line 16 * * page 12, line 32 - page 13, line 2 * * page 17, line 9 - page 17, line 32; figure 3A * * page 21, line 6 - page 21, line 22; figure 7D *	1-3,5-15 4	
X	US 2016/087349 A1 (LEE KYUNGHAEUNG [KR] ET AL) 24 March 2016 (2016-03-24) * page 3, paragraph 45 - page 3, paragraph 48; figures 3, 4 * * page 4, paragraph 63 - page 4, paragraph 65; figure 7 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) H01Q
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 6 June 2018	Examiner Blech, Marcel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)

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

EP 17 21 0467

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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
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