(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 522 295 A1

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.08.2019 Bulletin 2019/32

(51) Int Cl.:
H01Q 1/22 *(2006.01)* ***H01Q 19/30*** *(2006.01)*
H01Q 5/49 *(2015.01)*

(21) Application number: **18154888.4**

(22) Date of filing: **02.02.2018**

(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:
MA MD TN

(71) Applicant: **Ingenieurbüro Kienhöfer GmbH**
76137 Karlsruhe (DE)

(72) Inventor: **Kienhöfer, Carsten**
76137 Karlsruhe (DE)

(74) Representative: **Durm Patentanwälte PartG mbB**
Patentanwälte
Moltkestrasse 45
76133 Karlsruhe (DE)

(54) **RANGE EXTENSION**

(57) The present invention relates to an apparatus (10, 10', 10") for increasing a communication range of a wireless device (18) having an internal antenna (16), comprising: a non-conductive, flat carrier (12) for coupling to the wireless device in an area of the internal antenna; and a plurality of conductive elements (14) arranged on the carrier in parallel to one another and to the carrier, and spaced apart from one another, wherein the lengths (l) of the conductive elements and the distances (d) between the conductive elements are chosen based on a radio frequency of the wireless device so that the conductive elements work together as at least one reflector element (14b) and at least one director element (14a) of a Yagi antenna; and the carrier is configured to be coupled to the wireless device in a position at which the internal antenna is parallel and centered with the conductive elements for driving the conductive elements. The present invention further relates to a method for increasing a communication range of a wireless device (18) having an internal antenna (16) and to a wireless device having an internal antenna (16).

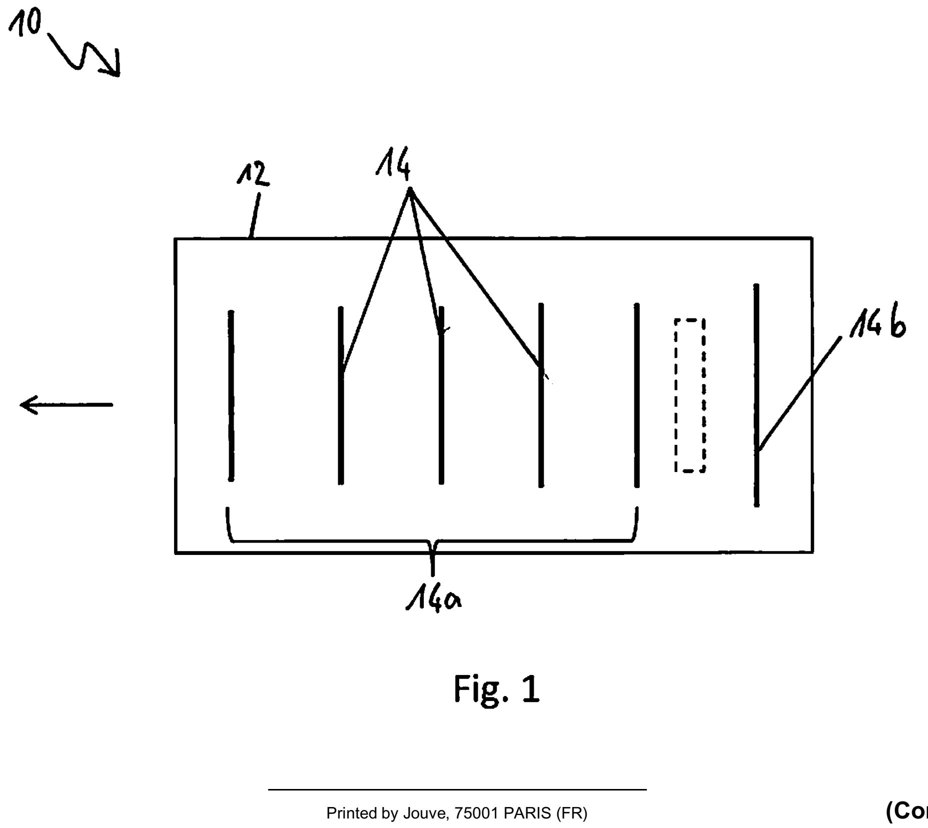

Fig. 1

Printed by Jouve, 75001 PARIS (FR)

(Cont. next page)

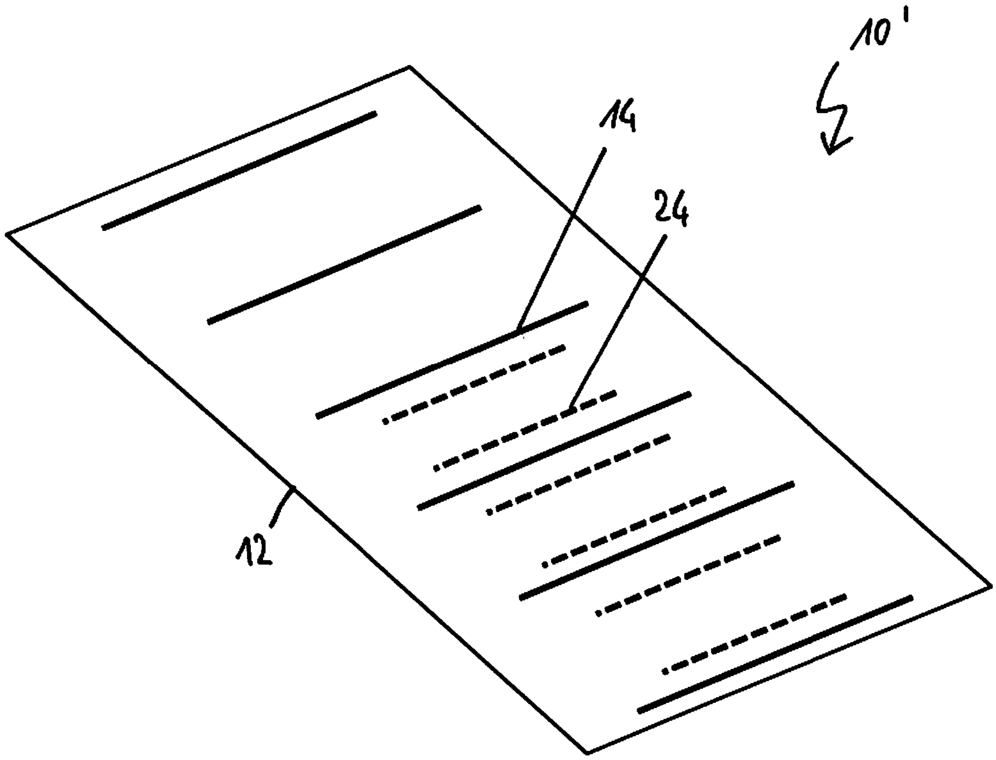

Fig. 5

Description

[0001] The present invention relates to an apparatus for increasing a communication range of a wireless device having an internal antenna as well as to a corresponding method and a wireless device.

[0002] Wireless devices (also referred to as mobile devices) such as laptop computers, mobile phones, tablets etc. have a wireless communication module for communicating with other devices and/or access points. Usually, such devices at least make use of an IEEE 802.11 standard-conform communication interface for connecting to and communicating through a wireless local area network (WLAN). As used herein, a wireless device refers to a device including a wireless communication interface, in particular a WLAN interface.

[0003] For connecting to a network, most wireless devices make use of an internal antenna that is integrated into the housing of the device. Usually, microstrip- or patch antennas are used that are arranged within the housing of the wireless device in a position where the wireless signal is disturbed by other parts or by the housing itself as little as possible. Alternatively, in some cases an interface for connecting an external antenna is foreseen. Such an interface allows that different antennas can be connected wherein it is usually possible to connect different antennas with different characteristics as long as all official regulations are complied with.

[0004] In most areas worldwide, the use of wireless communication systems is strictly regulated. Usually, open frequency ranges are assigned and the transmission power (radiated power) that a wireless system may provide is limited. For instance, for WLAN devices in Germany the maximum transmission power must not exceed 100 mW or 20 dBm EIRP (equivalent isotropically radiated power) in the 2.4 GHz range (2.400 GHz - 2.4835 GHz), 200 mW in the 5.2 GHz range (5.150 GHz - 5.350 GHz) and 1000 mW EIRP at 5.6 GHz (5.470 GHz - 5.725 GHz), respectively. Thereby, the total transmission power of a WLAN device has to be calculated by taking into account the losses in the connecting cables and the gain of the antenna in addition to the originally generated power.

[0005] Prior to using a wireless device, it is required to obtain an approval of the responsible regulation authority confirming that the device meets the regulations, in particular with respect to the radiated power. Once the device is certified, it is usually not allowed to change its setup or modify its antenna without reiterating the certification procedure. Such a certification can be obtained for the entire device or only for the wireless module alone. Since mobile devices usually have an integrated internal antenna, these devices are usually certified as a whole product without separately considering the wireless communication module.

[0006] Oftentimes, however, users of wireless devices experience situations in which the communication range of their device is not sufficient, e.g. due to inadequate positioning of the access point or simply because of a large distance. Communicating near the maximum communication range can lead to a decreasing data transfer rate and, ultimately, to a loss of connection. One approach to cope with this is to modify an external antenna of the access point to obtain a higher gain. If an existing antenna configuration is modified, however, this may result in that it is also required to reduce the generated power in order to stay under the regulated limit for the total radiated power. Also, it is often not possible to access and modify the access point, e.g. in the case of a public access point. On the other side, modifications of the antenna of the mobile device are usually not feasible due to the internal antenna being integrated in the housing of the device.

[0007] In view of this, the present invention aims at increasing a communication range of a wireless device. In particular, the transmission and reception of a wireless communication device shall be improved without violating the regulations relating to the maximum radiated power.

[0008] In a first aspect of the present invention, an apparatus for improving a transmission and reception power of a wireless device having an internal antenna is presented. The apparatus comprises a non-conductive, flat carrier for coupling to the wireless device in an area of the internal antenna; and a plurality of conductive elements arranged on the carrier in parallel to one another and to the carrier, and spaced apart from one another, wherein the lengths of the conductive elements and the distances between the conductive elements are chosen based on a radio frequency of the wireless device so that the conductive elements work together as at least one reflector element and at least one director element of a Yagi antenna; and the carrier is configured to be coupled to the wireless device in a position at which the internal antenna is parallel and centered with the conductive elements for driving the conductive elements.

[0009] In another aspect, a method for improving a transmission and reception power of a wireless device having an internal antenna is presented. The method comprises the steps of coupling an apparatus as defined above to the wireless device in the area of the internal antenna; and aligning the apparatus in the direction of a wireless network access point for increasing the communication range of the wireless device.

[0010] In yet another aspect, the present invention relates to a wireless device, in particular a laptop, having an internal antenna and including an apparatus as defined above being attached to the wireless device in the area of the internal antenna.

[0011] Preferred embodiments of the invention are defined in the dependent claims. It shall be understood that the claimed method and wireless device have similar and/or identical preferred embodiments as the claimed apparatus, in particular as defined in the dependent claims and as disclosed herein.

[0012] The present invention is based on the idea of improving the transmission and reception power of an existing wireless device, in particular a WLAN device, by means of a passive, non-powered apparatus functioning together with the internal antenna as a Yagi antenna.

[0013] On a flat carrier, i.e. a carrier having a thickness that is small in comparison to its length and width, multiple (electrically) conductive elements are arranged. The conductive elements are spaced apart and electrically isolated from one another, i.e. not connected. The lengths of and the distances between the conductive elements are chosen based on the radio frequency of the wireless device. Usually, the distances between the conductive elements need to be on the order of a quarter of the wavelength.

[0014] If the carrier and the conductive elements are situated in the vicinity of the internal antenna, it becomes possible that the conductive elements on the carrier are excited by the internal antenna, which is preferably a dipole antenna.

[0015] Thereby, the positioning of the carrier and the conductive elements with respect to the internal antenna is important. One the one hand, the internal antenna should be parallel and centered with the conductive elements. The internal antenna is aligned with the conductive elements on the carrier. On the other hand, the distance between the internal antenna and the conductive elements should be small.

[0016] In this position, the internal antenna represents the driven element of a Yagi antenna. The conductive elements on the flat carrier are the parasitic elements of the Yagi antenna. In particular, at least one of the conductive elements is arranged on one side of the internal antenna, when the flat carrier is coupled to the wireless device and functions as a reflector. On the other side of the internal antenna, preferably multiple conductive elements function as directors of the Yagi antenna.

[0017] Thus, by attaching the apparatus of the present invention to the wireless device in the area of the internal antenna a Yagi antenna setup is generated. By means of this setup, a high antenna gain can be obtained to improve a transmission and reception power of the wireless device and thereby increase the communication range. Depending on the setup, it becomes possible to obtain a gain of up to 10 dBm. By directing the carrier and the thereon arranged conductive elements in the direction of the access point, the possible communication range of the wireless device can be increased significantly.

[0018] One advantage of the apparatus of the present invention is that the certified and regulation-conform wireless device with its internal antenna is not modified. A completely passive apparatus is positioned next to an existing antenna. The antenna and the certified wireless device are not reconfigured. Therefore, it is not required to reiterate the certification procedure. Also, the access point does not need to be modified.

[0019] In a preferred embodiment, the lengths of the conductive elements and the distances between the conductive elements are chosen so that the conductive elements work together as at least one reflector element and at least one director element of a Yagi antenna being adapted for a radio frequency of 2.4 GHz, 5.2 GHz or 5.6 GHz. In particular, the setup of the present invention is suitable for improving IEEE 802.11 standard-conform communication in a wireless LAN network. Frequencies of 2.4, 5.2 and 5.6 GHz allow constructing an apparatus as defined above having a size of a couple of centimeters. For instance, for a frequency of 2.4 GHz it is possible to construct a suitable apparatus with a carrier having a length of about 15 cm and a width of about 8 cm. Such a size results in an apparatus providing a comfortable handling. In addition, most wireless devices communicate in the above-mentioned frequency ranges and it is particularly useful to improve the communication range of a standard-conform device.

[0020] In a further preferred embodiment, the carrier includes a plastic and/or a cardboard material and preferably has a rectangular shape. Preferably, the carrier is made from a plastic and/or cardboard material and accommodates the multiple conductive elements on a minimum-possible sized rectangular area. These materials and this arrangement allow a cost-efficient manufacturing and provide a sufficiently robust basis for attaching thereto the conductive elements.

[0021] Preferably, the conductive elements are printed on the carrier in a metal printing process; and/or attached to the carrier with a hydrophobic glue. It is possible to make use of a metal printing process in which metal paths are deposited on a suitable carrier substance. Thereby, a cost-efficient manufacturing can be realized. Alternatively, or in combination, it is also possible to attach separate conductive elements, for instance copper elements, by means of glue. In this respect, it is useful to make use of a hydrophobic glue to avoid a damping of the radio waves.

[0022] In a further preferred embodiment, the carrier includes a coupling portion for coupling the carrier to an upper outer area of a laptop display, preferably by clamping, sticking or pinning. The coupling portion is an area on the carrier which is designed for coupling to the wireless device. For instance, the coupling portion may be implemented by depositing an adhesion layer with an adhesive substance to a part of the carrier. The coupling portion thereby has the advantage that no further means for coupling the apparatus to the wireless device, represented by the laptop, is required. A laptop usually has multiple WLAN antennas in an upper and outer area of its display. Thus, the apparatus needs to be coupled to this area so that a Yagi antenna is formed.

[0023] Preferably, the carrier includes a pivot element for varying the orientation of the Yagi antenna formed by the conductive elements with respect to the wireless device. Thereby, the pivot element can, e.g., be implemented in the form of an articulated joint or hinge or also in the form of a flexible area in the carrier. By means of the pivot element, it is possible to direct the Yagi antenna into a desired direction without moving the wireless device. The orientation of the conductive elements with respect to the wireless device is changed without changing the orientation of the wireless device itself. By directing the Yagi antenna into the direction of the access point, the maximum gain of the antenna can be exploited to obtain an optimal connection. The comfortability for the user of the apparatus is increased.

[0024] In a preferred embodiment, the conductive elements predominantly have lengths that are different from one another, preferably between 48 mm and 60 mm; and/or are arranged on the carrier centered with respect to one another. The indicated lengths are suitable for a 2.4 GHz Yagi antenna. By arranging the conductive elements centered with respect to one another the gain is maximized. In addition, the indicated lengths and distances allow using a carrier with a size that is suitable for a mobile use.

[0025] In another preferred embodiment, the apparatus comprises a plurality of conductive elements having six conductive elements, wherein one conductive element functions as a reflector element and five conductive elements function as director elements, and/or the distances of the conductive elements from one another are 34 mm, 31 mm, 26 mm, 22 mm and 34 mm. The use of one reflector and five directors in combination with the indicated distances is suitable for a 2.4 GHz Yagi antenna. The size of the apparatus is suitable (small enough) for mobile application with a mobile wireless device. In this embodiment, the one reflector element is arranged on one side of the internal antenna and the five director elements are arranged on the other side of the internal antenna when the apparatus is coupled to the wireless device. The obtained Yagi antenna is directed in a direction orthogonally to the director elements.

[0026] In another preferred embodiment, the apparatus comprises a second plurality of conductive elements arranged on the carrier in parallel to one another and spaced apart from one another, wherein the lengths of the conductive elements of the second plurality of conductive elements and the distances between the conductive elements of the second plurality of conductive elements are chosen based on an alternative radio frequency of the wireless device so that the conductive elements of the second plurality of conductive elements work together as at least one second reflector element and at least one second director element of a second Yagi antenna. It is possible to make use of two Yagi antennas for two different frequency bands on the same carrier. One set of conductive elements forms a Yagi antenna being suitable for communication in a first band and the other set of conductive elements forms a second Yagi antenna being suitable for communication in another frequency band. Since the distances between the conductive elements and the lengths of the conductive elements are different between the first plurality and the second plurality, the two Yagi antennas do not interfere with one another and do not disturb one another. Usually, wireless devices make use of a combined antenna for both frequency bands. By making use of two different pluralities of conductive elements, it becomes possible to construct an apparatus that is suitable for wireless communication in two different frequency bands.

[0027] Preferably, the conductive elements of the second plurality of conductive elements are arranged on the carrier centered with respect to one another. In other words, the conductive elements are aligned so that the maximum possible improvement of the reception and transmission power is obtained.

[0028] In an embodiment, the plurality of conductive elements is arranged on a first side of the carrier and the second plurality of conductive elements is arranged on a second side of the carrier. By arranging the two pluralities of conductive elements on the two sides of the flat carrier a cost-efficient manufacturing becomes possible since only one carrier is required. The first plurality is arranged on an upper side and the second plurality is arranged on a lower side of the carrier. Since the carrier is thin, it is usually not required to turn the carrier from one side to another in order to use the other frequency range.

[0029] In yet another preferred embodiment, the conductive elements of the first plurality of conductive elements and/or the conductive elements of the second plurality of conductive elements are straight. Generally, the conductive elements may be straight or curved to a certain degree. Straight conductive elements can be produced more easily and at lower costs. With respect to the effect and the obtained gain it is usually not a big difference whether the elements are straight or curved.

[0030] In an embodiment of the wireless device, the wireless device has an internal dipole antenna for communicating according to the IEEE 802.11 standard. An internal dipole antenna is an optimal driving element for driving the conductive elements of the apparatus of the present invention in order to form a Yagi antenna with the internal antenna functioning as a drive element.

[0031] As used herein, the communication range of a wireless device refers to the distance over which the wireless device can communicate with other wireless devices or with an access point. An internal antenna is an antenna inside a housing of a wireless device. In particular, the apparatus of the present invention can be used with a dipole antenna. A non-conductive material refers to a material that electrically isolates one conductor from another. A plurality can refer to any number greater than one. A Yagi antenna can also be referred to as a Yagi-Una antenna. A radio frequency of a wireless device may refer to a frequency band for which the wireless device is optimized.

[0032] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter. In the following drawings

Figure 1 schematically illustrates an apparatus for increasing a communication range of a wireless device according to an aspect of the present invention;

Figure 2 schematically illustrates a wireless device having attached thereto an apparatus for increasing a communication range;

Figure 3 schematically illustrates the dimensions of an embodiment of the present invention;

Figure 4 shows a perspective illustration of an apparatus of the present invention;

Figure 5 shows a perspective illustration of another embodiment; and

Figure 6 shows an illustration of an apparatus including a pivot element.

[0033] In Figure 1, an apparatus 10 for increasing a communication range of a wireless device is schematically illustrated in a top view. The apparatus 10 comprises a non-conductive flat carrier 12 upon which a plurality of conductive elements 14 is arranged. The carrier 12 is suitable for being coupled to a wireless device in a position at which an internal antenna of the wireless device is in a specific orientation versus the conductive elements 14. In Figure 1, the respective position of the internal antenna 16 when the apparatus is coupled to a wireless device (not illustrated) is indicated by a dashed line. The internal antenna is not part of the apparatus 10 but belongs to the wireless device to which the apparatus 10 is attached.

[0034] The apparatus 10 of the present invention is based on the idea of amplifying the transmission and reception power of a wireless device by directing the signal generated by the internal antenna of the wireless device into a specific direction. To obtain this effect, the internal antenna 16 is parasitically used as a driving element to drive the conductive elements 14. The conductive elements 14 and the internal antenna 16 function together as a Yagi antenna. In the illustrated example, a subset of five conductive elements 14 is arranged on the carrier 12 so that they function as director elements 14a of the Yagi antenna. Another one of the conductive elements 14 functions as a reflector element 14b of the Yagi antenna.

[0035] In order to function as a Yagi antenna, the lengths of the conductive elements and the distances between the conductive elements 14 have to be chosen in accordance with the radio frequency of the wireless device. A higher frequency corresponding to a smaller wavelength results in shorter conductive elements with smaller distances in between one another.

[0036] The main radiation direction of the Yagi antenna is a direction parallel to the carrier and orthogonal to the direction of the conductive elements. In Figure 1, the main radiation direction is indicated by an arrow. This main radiation direction is sometimes also referred to as boom. On the other side, the electromagnetic field in the direction of the reflector 14b is damped. In order to obtain a maximum possible gain, which is usually on the order of 10 dBm, a very accurate positioning of the carrier 10 with respect to the internal antenna 16 is required. In particular, the internal antenna 16 is to be arranged in parallel to the conductive elements 14 and between the director elements 14a and the reflector element 14b.

[0037] The carrier 12 is usually manufactured from cardboard or plastic and has a thickness that provides a sufficient stability depending on the size of the carrier. For instance, the thickness of the carrier may be 1 mm or less for an apparatus 10 being suitable for a frequency range of 2.4, 5.2 or 5.6 GHz. The carrier 12 can particularly correspond to a plastic or cardboard card.

[0038] The conductive elements 14 are usually metallic. Preferably, copper is used. It is possible to fix separate single elements to the carrier or to make use of a metal printing process to deploy metal paths on the carrier 12. Also, other approaches can be used.

[0039] Preferably, the apparatus of the present invention can be used for laptops (representing wireless devices) communicating according to the WLAN standard (IEEE 802.11). However, it is also possible to construct an apparatus 10 of the present invention for being used for LTE communication or also for other standards making use of different frequencies. It is to be understood that the apparatus of the present invention can also be used with other devices such as tablets or mobile phones etc. having an internal antenna.

[0040] These devices usually have an internal dipole antenna. The apparatus 10 can particularly be used in conjunction with a dipole antenna. However, it is also possible that other antennas are accommodated.

[0041] In Figure 2, a laptop representing a wireless device 18 is schematically illustrated. Attached to the wireless device 18 is an apparatus 10. For coupling or attaching the apparatus 10 to the wireless device 18, usually a coupling method that allows fast and easy coupling and decoupling, i.e. a reversible approach, is issued.

[0042] In the illustrated example, the apparatus 10 is attached to an upper and outer area of the display of the laptop. In this area, usually the internal antenna of the laptop is integrated into the housing of the laptop. Oftentimes, a laptop has two different antennas on both sides of the display 20. In order to obtain the desired improvement of the communication range, it may be required to move the apparatus 10 from one position at the display 20 to another and to manually identify the optimal position of the apparatus 10 since the position of the internal antenna 16 differs from one wireless device to another one.

[0043] Figure 3 schematically illustrates an example for the lengths l of the different conductive elements as well as the distances d between the different conductive elements 14. The lengths l and the distances d are chosen depending on the radio frequency of the wireless device. Usually, the individual lengths l of the conductive elements 14 are slightly different from one another. The same holds for the distances d. The indicated figures are suitable for a 2.4 GHz device.

[0044] Usually, the lengths l are on the order of $\lambda/4$ with λ representing the wavelength of the respective frequency via which the wireless device communicates. For instance, a frequency of 2.4 GHz results in a $\lambda/4$ of about 3 cm. As illustrated, the distances d are on the order of 3 cm. Suitable distances d and lengths could be determined by means of a simulation. Different distances and lengths result in different characteristics with respect to the obtained gain.

[0045] Figure 4 shows a perspective illustration of the apparatus 10 of the present invention. In order to attach or couple the apparatus 10 to the wireless device, the carrier usually has a coupling portion 22 which is suitable for fixing the apparatus in a specific position at the wireless device.

[0046] In the illustrated embodiment, the coupling portion 22 is a portion of the carrier 12 having an adhesive layer for sticking to a laptop display. Since the apparatus 10 can be designed lightweight, it is possible to make use of a layer of adhesive material to stick the apparatus 10 to the wireless device 18 whenever the user requires a range extension. This adhesive layer allows positioning and repositioning the apparatus 10 in order to find the optimal position with respect to the internal antenna of the laptop.

[0047] In Figure 5, another embodiment of an apparatus 10' is illustrated. The apparatus 10' has a first plurality of conductive elements 14. In addition, another plurality of conductive elements 24 is arranged on the carrier. Thereby, it is possible that the two pluralities are arranged on the two sides of the carrier 12 as illustrated in the example of Figure 5 by the dashed lines indicating that the respective conductive elements 24 are on the lower side of the flat carrier 12.

[0048] In the illustrated example the first plurality of conductive elements 14 consists of longer conductive elements with bigger distances in between one another in comparison to the second plurality of conductive elements 24. In terms of frequency, the frequency accommodated by the first plurality of conductive elements 14 is thus smaller (i.e. has a larger wavelength) than the frequency of the second plurality of conductive elements 24. By arranging the two different sets of conductive elements 14, 24 on the same carrier, it thereby becomes possible that the same apparatus 10' accommodates two different frequency ranges. Since the wavelengths are different from one another, no disturbances occur.

[0049] Thereby, it is, e.g., possible to design an apparatus that is suitable for a 2.4 GHz WLAN and a 5.2 GHz WLAN at the same time. Since usually the same antenna is used for both frequency ranges, it becomes possible to use a single apparatus for increasing the communication range in two different WLAN standards.

[0050] It is also possible that further pluralities of conductive elements are placed on the same carrier to accommodate further frequency ranges.

[0051] In Figure 6, yet another embodiment of an apparatus 10" is schematically illustrated. The apparatus 10" has a pivot element 26 for pivoting the apparatus 10" with respect to the wireless device when being attached to the wireless device. By making use of such a pivoting function, it is possible to direct the apparatus 10" in the direction of another wireless device or an access point with which it is desired to communicate. The apparatus 10" can be directed in a specific direction without moving the wireless device by simply reorienting the apparatus 10" at the pivot element 26.

[0052] In the illustrated example, the pivot element 26 is implemented in the form of a movable bar being attached to an outer portion of the carrier 12. By moving the bar along a length axis of the carrier 12 it is possible to adjust the angle between the apparatus 10" and the wireless device. However, it is to be understood that also other implementations of the pivot element can be used. For instance, a flexible area in the carrier 12 or a hinge may be used.

[0053] The foregoing discussion discloses and describes merely exemplary embodiments of the present disclosure. As will be understood by those skilled in the art, the present disclosure may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Accordingly, the above description is intended to be illustrative, but not limiting the scope of the disclosure, as well as other claims. The disclosure, including any readily discernible variants of the teachings herein, defines, in part, the scope of the foregoing claim terminology such that no inventive subject-matter is dedicated to the public.

[0054] In the claims, the words "comprising" and "including" do not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single element or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. Apparatus (10, 10', 10") for increasing a communication range of a wireless device (18) having an internal antenna (16), comprising:

a non-conductive, flat carrier (12) for coupling to the wireless device in an area of the internal antenna; and

a plurality of conductive elements (14) arranged on the carrier in parallel to one another and to the carrier, and spaced apart from one another, wherein

the lengths (l) of the conductive elements and

the distances (d) between the conductive elements are chosen based on a radio frequency of the wireless device so that the conductive elements work together as at least one reflector element (14b) and at least one director element (14a) of a Yagi antenna; and
the carrier is configured to be coupled to the wireless device in a position at which the internal antenna is parallel and centered with the conductive elements for driving the conductive elements.

2. Apparatus (10, 10', 10") according to claim 1, wherein the lengths (I) of the conductive elements (14) and the distances (d) between the conductive elements are chosen so that the conductive elements work together as at least one reflector element and at least one director element of a Yagi antenna being adapted for a radio frequency of 2.4 GHz, 5.2 GHz or 5.6 GHz.

3. Apparatus (10, 10', 10") according to any one of the preceding claims, wherein the carrier (12) includes a plastic and/or a cardboard material and preferably has a rectangular shape.

4. Apparatus (10, 10', 10") according to any one of the preceding claims wherein the conductive elements (14) are
printed on the carrier (12) in a metal printing process; and/or.
attached to the carrier with a hydrophobic glue.

5. Apparatus (10, 10', 10") according to any one of the preceding claims, wherein the carrier (12) includes a coupling portion (22) for coupling the carrier to an upper outer area of a laptop display, preferably by clamping, sticking or pinning.

6. Apparatus (10, 10', 10") according to any one of the preceding claims, wherein the carrier (12) includes a pivot element (26) for varying the orientation of the Yagi antenna formed by the conductive elements (14) with respect to the wireless device (18).

7. Apparatus (10, 10', 10") according to any one of the preceding claims, wherein die conductive elements (14)
predominantly have lengths (I) that are different from one another, preferably between 48 mm and 60 mm; and/or
are arranged on the carrier (12) centered with respect to one another.

8. Apparatus (10, 10', 10") according to any one of the preceding claims, comprising a plurality of conductive elements (14) having six conductive elements, wherein
one conductive element functions as a reflector element (14b) and five conductive elements function as director elements (14a), and/or
the distances (d) of the conductive elements from one another are 34 mm, 31 mm, 26 mm, 22 mm und 34 mm.

9. Apparatus (10, 10', 10") according to any one of the preceding claims, comprising a second plurality of conductive elements (24) arranged on the carrier (12) in parallel to one another and spaced apart from one another, wherein
the lengths of the conductive elements of the second plurality of conductive elements and the distances between the conductive elements of the second plurality of conductive elements are chosen based on an alternative radio frequency of the wireless device (18) so that the conductive elements of the second plurality of conductive elements work together as at least one second reflector element and at least one second director element of a second Yagi antenna.

10. Apparatus (10, 10', 10") according to claim 9, wherein the conductive elements of the second plurality of conductive elements (24) are arranged on the carrier (12) centered with respect to one another.

11. Apparatus (10, 10', 10") according to any one of claims 9 or 10, wherein the plurality of conductive elements (14) is arranged on a first side of the carrier (12) and the second plurality of conductive elements (24) is arranged on a second side of the carrier.

12. Apparatus (10, 10', 10") according to any one of the preceding claims, wherein the conductive elements of the first plurality of conductive elements (14) and/or the conductive elements of the second plurality of conductive elements (24) are straight.

13. Method for increasing a communication range of a wireless device (18) having an internal antenna (16), comprising the steps:

coupling an apparatus (10, 10', 10") according to any one of the preceding claims to the wireless device in the area of the internal antenna; and
aligning the apparatus in the direction of a wireless network access point for increasing the communication range of the wireless device.

14. Wireless device (18), in particular laptop, having an internal antenna (16) and including an apparatus according to any one of claims 1 to 12 being attached to the wireless device in the area of the internal antenna.

15. Wireless device (18) as claimed in claim 14 having an internal dipole antenna for communicating ac-

cording to the IEEE 802.11 standard.

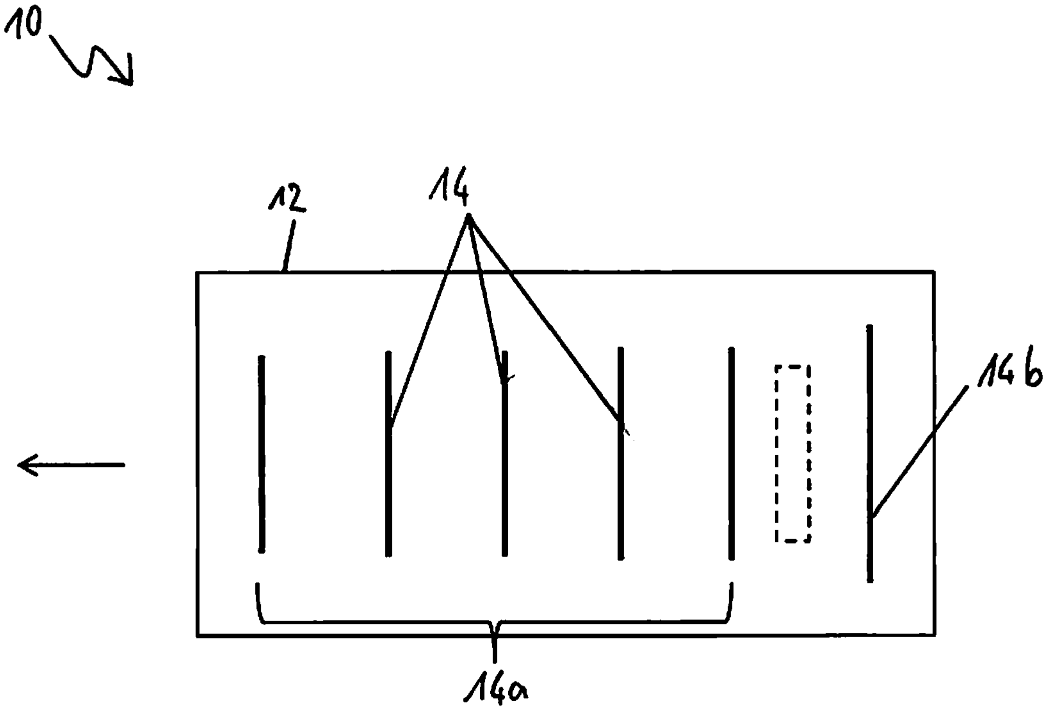

Fig. 1

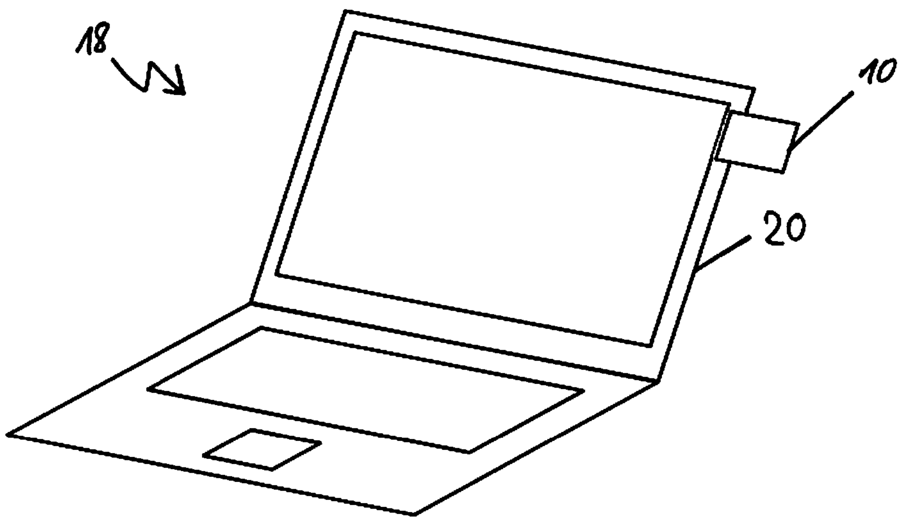

Fig. 2

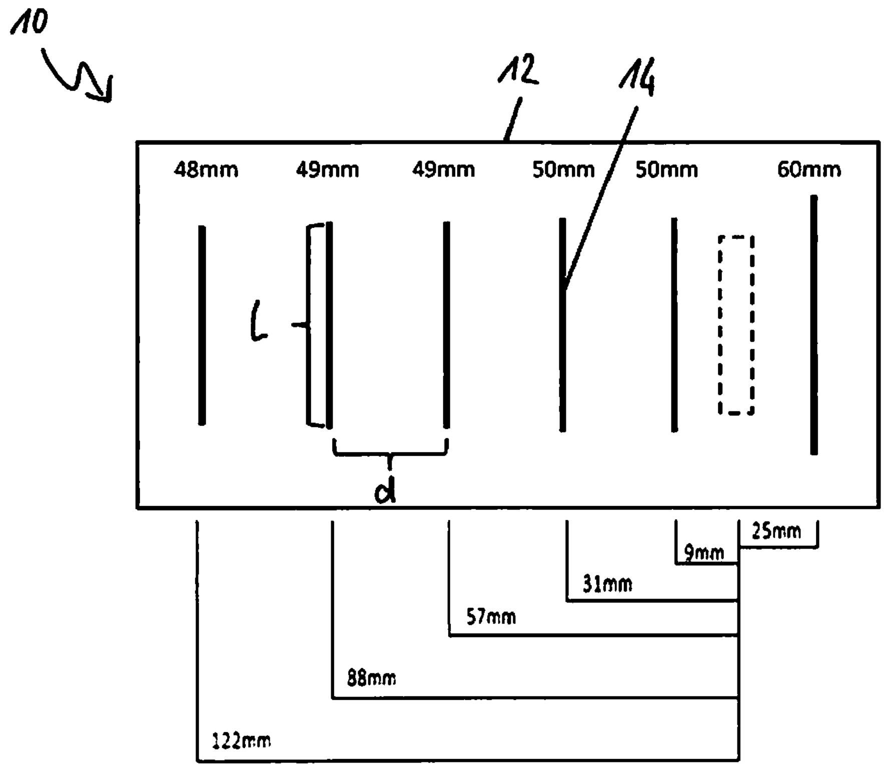
10
12
14
48mm
49mm
49mm
50mm
50mm
60mm
L
d
25mm
9mm
31mm
57mm
88mm
122mm

Fig. 3

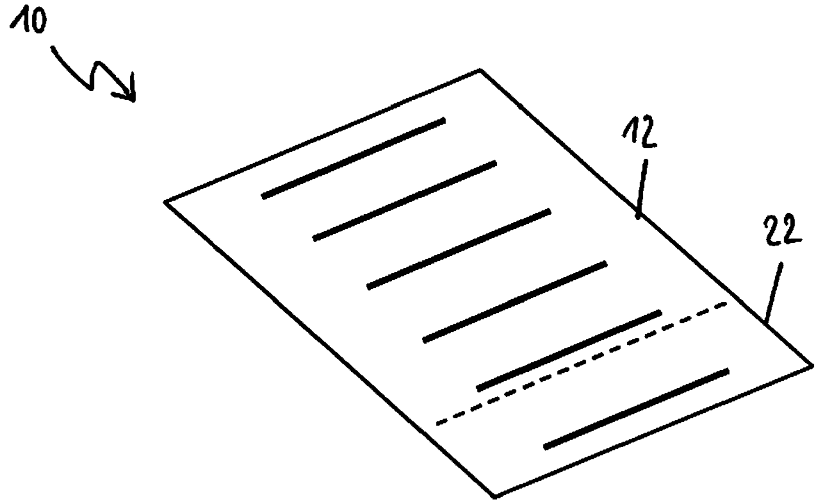
10
12
22

Fig. 4

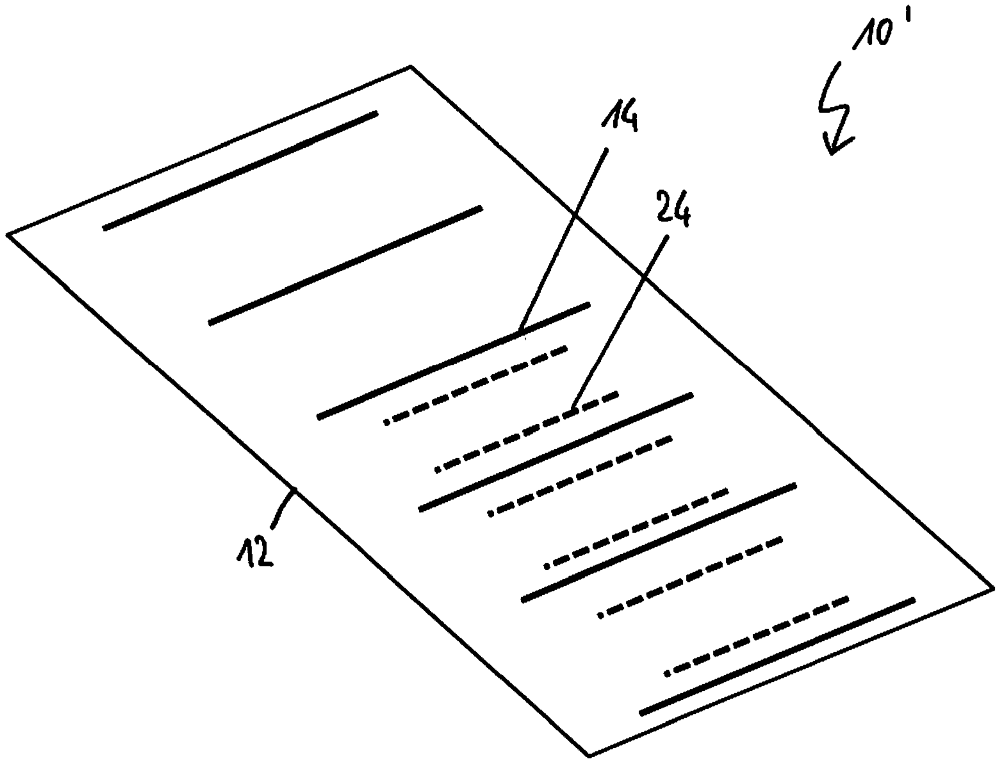

Fig. 5

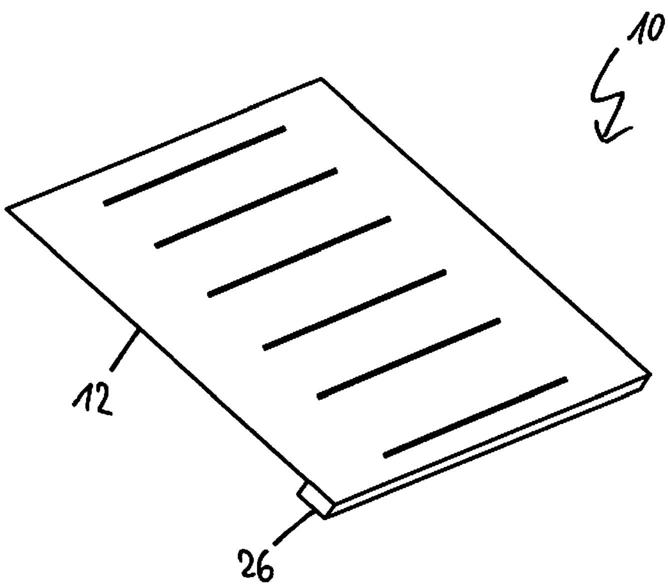

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 15 4888

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 Y	JP 2009 273011 A (DENSO WAVE INC) 19 November 2009 (2009-11-19) * figure 1 * * paragraph [0007] * * paragraph [0013] - paragraph [0027] * * figure 5 * -----	1,5-7, 13,14 8-12	INV. H01Q1/22 H01Q19/30 H01Q5/49
X Y	EP 1 494 318 A1 (BUFFALO INC [JP]) 5 January 2005 (2005-01-05) * paragraph [0007] * * paragraph [0025] * * paragraph [0022] * * figure 10 * * paragraph [0038] - paragraph [0040] * -----	1,2,5-7, 13-15 3,4,8-12	
X Y	GB 2 409 615 A (R F TAGS LTD [GB]; TURNER CHRISTOPHER GORDON GERV [GB]) 29 June 2005 (2005-06-29) * figure 8 * * page 15 - page 16 * * figure 4 * * page 14 * -----	1 3,4	TECHNICAL FIELDS SEARCHED (IPC)
Y	JP 2009 290325 A (NAT INST INF & COMM TECH) 10 December 2009 (2009-12-10) * figure 2b * * paragraph [0001] * -----	8-12	H01Q
A	US 2003/160730 A1 (ALSLIETY MAZEN K [US]) 28 August 2003 (2003-08-28) * paragraph [0009] - paragraph [0018] * * figure 2 * -----	1-15	
	-/--		

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	14 June 2018	Collado Garrido, Ana

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)

page 1 of 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 15 4888

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JEAN-MARIE FLOC H ET AL: "Dual-Band Printed Dipole Antenna with Parasitic Element for Compensation of Frequency Space Attenuation", INTERNATIONAL JOURNAL OF ELECTROMAGNETICS AND APPLICATIONS, vol. 2, no. 5, 31 December 2012 (2012-12-31), pages 120-128, XP055483480, ISSN: 2168-5037, DOI: 10.5923/j.ijea.20120205.05 * figure 13 * * page 125 * -----	1-15	
A	US 2014/198008 A1 (WALKER MICHAEL CLYDE [US]) 17 July 2014 (2014-07-17) * figure 2A * * paragraph [0042] - paragraph [0050] * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	14 June 2018	Collado Garrido, Ana

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)

page 2 of 2

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 15 4888

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.

14-06-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2009273011 A	19-11-2009	JP 5169457 B2	27-03-2013
		JP 2009273011 A	19-11-2009
EP 1494318 A1	05-01-2005	CN 1577973 A	09-02-2005
		EP 1494318 A1	05-01-2005
		JP 3783006 B2	07-06-2006
		JP 2005026943 A	27-01-2005
		KR 20050004043 A	12-01-2005
		TW I252648 B	01-04-2006
		US 2005024276 A1	03-02-2005
GB 2409615 A	29-06-2005	AU 2003269120 A1	30-04-2004
		GB 2393076 A	17-03-2004
		GB 2409615 A	29-06-2005
		US 2006163368 A1	27-07-2006
		US 2009015377 A1	15-01-2009
		US 2011140859 A1	16-06-2011
		US 2014217175 A1	07-08-2014
		WO 2004025554 A1	25-03-2004
JP 2009290325 A	10-12-2009	JP 5071903 B2	14-11-2012
		JP 2009290325 A	10-12-2009
US 2003160730 A1	28-08-2003	NONE	
US 2014198008 A1	17-07-2014	US 2011063181 A1	17-03-2011
		US 2013293434 A1	07-11-2013
		US 2014198008 A1	17-07-2014

EPO FORM P0459

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