



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.08.2018 Bulletin 2018/34

(51) Int Cl.:
H01Q 1/10 (2006.01) **H01Q 5/371** (2015.01)
H01Q 1/08 (2006.01) **H01Q 3/02** (2006.01)
H01Q 9/12 (2006.01) **H01Q 9/14** (2006.01)

(21) Application number: **17157228.2**

(22) Date of filing: **21.02.2017**

(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

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(54) **TUNEABLE ANTENNA AND METHOD FOR USAGE OF SUCH A TUNEABLE ANTENNA**

(57) The present invention refers to an antenna (1) for detecting electromagnetic waves. Said antenna (1) preferably comprises at least a first branch (30) for detecting electromagnetic waves, wherein said first branch (30) comprises at least a first detection element (4) and a second detection element (6), wherein the first detection element (4) and the second detection element (6)

are physically connected with each other, an actuation means (5) for pivoting the second detection element (6) with respect to the first detection element (4) and a processor means (2) for operating the actuation means (5) in dependency of the detected electromagnetic waves or in dependency of radiation data, wherein the processor means (2) is connected to the first branch (30).

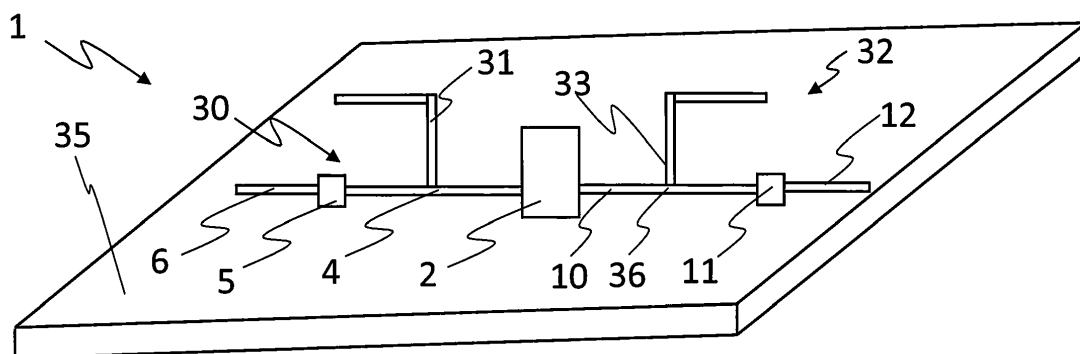


Fig. 2a

Description

[0001] The present invention refers to an antenna for detecting electromagnetic waves according to claim 1 and according to claim 10 the present invention refers to a device comprising such an antenna and according to claim 11 to a method for operating an antenna.

Background of the Invention

[0002] Document WO 2004/097976 A2 discloses a tunable antenna. Said tuneable antenna comprises an electrically conductive antenna element having at least one antenna element portion having a respective communications frequency for radiating or receiving radio signals at the respective communications frequency; and a tuning element switchable between at least a first operation state and a second operation state relative to the antenna element, the tuning element including a capacitance element, a dielectric or a conductive tuning element arranged to couple to at least one antenna element portion to tune the communications frequency or frequencies of at least one antenna element portion to different communications frequencies corresponding to the tuning element positions. Thus, the antenna presented in WO 2004/097976 A2 can provide limited alteration of radiation characteristics to antenna.

Object of the Invention

[0003] It is the object of the present invention to provide an improved and efficient antenna, a device comprising such an antenna and a method for operating an antenna.

Description of the Invention

[0004] The before mentioned object is solved by an antenna for detecting electromagnetic waves according to claim 1. The inventive antenna comprises at least a first branch for detecting and/or sending electromagnetic waves, wherein said first branch comprises at least a first detection element and a second detection element, wherein the first detection element and the second detection element are physically connected with each other, an actuation means for pivoting the second detection element with respect to the first detection element and a processor means for operating the actuation means in dependency of the detected electromagnetic waves or in dependency of radiation data, wherein the processor means is connected to the first branch.

[0005] Radiation data is hereby preferably data provided by a wireless communication unit, like NFC or Bluetooth or WLAN or GSM etc., wherein said data preferably comprises adjustment data for adjusting the shape of the antenna to fit or to better fit to the requirements of the respective communication unit, in particular wavelength.

[0006] In this system, the main structure of the antenna changes and thus it can be modified. So, the performance

variation is less limited in comparison to the state of the art, thus many different antenna demands of the various systems can be satisfied. Furthermore, the inventive antenna does not only extend in longitudinal direction, form changes take place in at least 2D manner respectively in multiple directions.

[0007] This solution is beneficial since in particular in the telecommunication industry new communication protocols emerge fast. Every new technology has its own benefits and base stations and mobile devices are providing all the possible of them. For this reason, the antenna according to the present invention is adequate and cost effective for all technologies. Also, this antenna respectively system can save space and decrease the overall size of the device respectively system without using multiple antennas or with using less antennas. The detection elements are preferably comprising or consisting of metal.

[0008] Further preferred embodiments are subject-matter of the dependent claims and/or the following specification parts.

[0009] According to a preferred embodiment of the present invention the actuation means is a micro motor and processor means is a microchip, wherein actuation means and processor means are preferably connected, in particularly electrically and/or signally connected. This solution is beneficial since very small structures can be controlled efficiently.

[0010] At least one further branch is provided according to a further preferred embodiment of the present invention, wherein said further branch comprises at least two detection elements, wherein at least one of these detection elements is pivotable with respect to the other detection element. This embodiment is beneficial since multiple branches, in particular more than two or three or more than three or four or more than four or five or more than five or ten or more than ten, allow a larger antenna arrangement.

[0011] At least the first branch and/or the second branch comprises according to a further preferred embodiment of the present invention multiple pivotable detection elements, wherein each pivotable detection element is physically coupled with an actuation means, in particular micro motor. It is conceivable that multiple detection elements, in particular pivotable detection elements and/or none pivotable detection elements, are connected to one actuation means. This embodiment is beneficial since a very high flexibility can be set up. Preferably are more than two, in particular more than four or more than ten or more than twenty pivotable detection elements provided.

[0012] Furthermore, at least the first branch and preferably multiple branches forms according to a further preferred embodiment of the present invention a row of multiple pivotable detection elements, wherein one micro motor is arranged between two adjacent pivotable detection elements for causing a relative movement between said adjacent detection elements. Preferably, be-

tween each pair of adjacent and moveable respectively pivotable detection elements is an actuation means provided and connected to said pair of moveable respectively pivotable detection elements. One or multiple actuation means are preferably movable in particular pivotable due to an actuation of another actuation means.

[0013] At least the first branch and preferably multiple branches comprises according to a further preferred embodiment of the present invention sub-branches, wherein at least one sub-branch forms a row of multiple pivotable detection elements, wherein one micro motor is arranged between two adjacent pivotable detection elements for causing a relative movement between said adjacent detection elements. This embodiment is beneficial since each sub-branch is preferably operated in dependency of the other sub-branch of said main branch or independently. Thus, a very flexible antenna arrangement is provided. A sub-branch is each row of detection elements behind a junction.

[0014] At least the first branch and preferably multiple branches, in particular sub-branches, comprises according to a further preferred embodiment of the present invention more than two micro motors. Actuation means, in particular micro motors, are preferably operated via a bus system or via power and/or signal connections arranged on a carrier substrate, in particular a printed circuit board.

[0015] Said detection elements are according to a further preferred embodiment of the present invention longitudinal extending pins made of metal or comprising metal, wherein all detection elements of one branch are having the same length or wherein at least one detection element of one branch differs in its length from at least one further detection element of the same branch, in particular of the same sub-branch. The diameter of each detection element is preferably smaller than 50% of its length, in particular than 20% or 10% or 5% or 3% or 1% or 0,5% of its length. This embodiment is beneficial since individual branches or sub-branches can be differently designed and/or orientated. Thus, the overall antenna design respectively designs can be fit to specifications of carrier substrates or housing parameters.

[0016] At least one and preferably a plurality or the majority of the detection elements extend according to a preferably embodiment of the present invention in longitudinal direction less than 20mm, in particular less than 10mm or less than 5mm or less than 1 mm. This embodiment is beneficial since the overall size of the present antenna can be very small.

[0017] At least one branch further comprises according to a further preferred embodiment of the present invention slideable detection elements which are movable in one preferably straight direction back and forth, wherein each slidable detection element is coupled with a micro motor for causing the displacement. Thus, these detection elements are preferably not pivotable. However, it is conceivable that combined detection elements are provided which are movable in longitudinal direction and

which are also pivotable.

[0018] The before mentioned object is also solved by a device, in particular mobile device, comprising at least one antenna according to the present invention. Thus, this invention can be applied to many applications of wireless communication technologies. It could be used in many mobile or base station devices, which can support different communication protocols. Besides, this antenna can be used in object tracking or identification systems. Furthermore, drones or radars or mobile phones or tablet PC or smart watches or TVs or can be other possible applications. The device can be understood as a device providing a possibility for user interaction, like a touch screen or buttons, or can be understood as printed circuit board (PCB) comprising such an antenna.

[0019] The before mentioned object is also solved by a method for operating an antenna, in particular an antenna according to any of claims 1 to 10. Said method preferably comprises at least the steps: Providing an antenna for detecting and/or sending electromagnetic waves, wherein the antenna comprises at least a first branch for detecting electromagnetic waves, wherein said first branch comprises at least a first detection element and a second detection element, wherein the first detection element and the second detection element are physically connected with each other, an actuation means for pivoting the second detection element with respect to the first detection element and a processor means for operating the actuation means in dependency of the detected electromagnetic waves, wherein the processor means is connected to the first branch, detecting electromagnetic waves with the first branch, analyzing the properties of the detected electromagnetic waves by said processor means, operating the actuation means for adjusting the shape of the first branch in dependency of said properties.

[0020] According to a further preferred embodiment of the present invention the method further comprises the steps: Providing data representing properties of electromagnetic waves to be detected and operating the actuation means for adjusting the shape of the first branch in dependency of said properties. These steps are preferably carried out before or after, in particularly before, the steps: Detecting electromagnetic waves with the first branch, analyzing the properties of the detected electromagnetic waves by said processor means, operating the actuation means for adjusting the shape of the first branch in dependency of said properties.

[0021] The present invention alternatively may refer to a method for operating an antenna, in particular an antenna according to any of claims 1 to 10, wherein said method preferably comprises at least the steps: Providing an antenna for detecting and/or sending electromagnetic waves, wherein the antenna comprises at least a first branch for detecting electromagnetic waves, wherein said first branch comprises at least a first detection element and a second detection element, wherein the first detection element and the second detection element are

physically connected with each other, an actuation means for pivoting the second detection element with respect to the first detection element and a processor means for operating the actuation means in dependency of the detected electromagnetic waves, wherein the processor means is connected to the first branch, providing data representing properties of electromagnetic waves to be detected, operating the actuation means for adjusting the shape of the first branch in dependency of said properties.

[0022] Movements of mechanical parts, in particular detection elements, of the antenna are preferably controlled by a processor means, in particular a microchip, and can be moved by an actuation means, in particular micro motor. Microchip preferably communicates and receives from the system the necessary antenna radiation characteristics, and calculates required mechanical design of the antenna. Corresponding to that microprocessor controls micro motors to move the pins respectively detection elements, thus the mechanical parts of the antenna.

[0023] According to a further preferred embodiment of the present invention switching between different shapes of said first branch takes place in dependency of multiple data transmission schemes, wherein data is transmitted according to each scheme in dependency of a predefined protocol, wherein said protocols differ from each other. This embodiment is beneficial, since multiple differing data transmission schemes can be processed. Thus, e.g. WLAN and/or Bluetooth and/or ZigBee and/or NFC and/or GSM and/or others can be detected, in particular one after the other.

[0024] The inventive method further comprises according to a further preferred embodiment of the present invention the steps of switching between different shapes of said first branch in dependency of multiple data transmission schemes. Data is preferably transmitted according to each scheme in dependency of a predefined protocol, wherein said protocols differ from each other and switching between different shapes of a further branch in dependency of multiple data transmission schemes, wherein data is transmitted according to each scheme in dependency of a predefined protocol, wherein said protocols differ from each other, wherein the first branch is formed in a first shape and wherein the further branch is formed in a second shape, wherein the first shape and the second shape differ from each other, wherein the first shape is set up to detect a first electromagnetic wavelength or wavelength range and wherein the second shape is set up to detect a second electromagnetic wavelength or wavelength range, wherein both wavelengths and/or wavelength ranges are detected at the same time. This embodiment is beneficial since electromagnetic waves having different wavelength or wavelength ranges can be detected at the same time. Thus, data from different sources, e.g. NFC and Bluetooth, can be detected at the same time by the same antenna.

[0025] Further benefits, goals and features of the

present invention will be described by the following specification of the attached figures, in which exemplarily components of the invention are illustrated. Components of the systems and methods according to the inventions, which match at least essentially with respect to their function can be marked with the same reference sign, wherein such components do not have to be marked or described multiple times with respect to said figures.

[0026] In the following the invention is just exemplarily described with respect to the attached figures.

Brief Description of the Drawing

[0027]

Fig. 1a shows schematically an example for of an antenna according to the present invention;

Fig. 1b shows a further schematically example of an antenna according to the present invention;

Fig. 1c shows antenna of fig. 1b in a different setting/configuration;

Fig. 2a shows antenna of fig. 1b arranged on a PCB;

Fig. 2b shows the arrangement of fig. 2a in a different setting/configuration; and

Fig. 3 shows a device comprising an inventive antenna.

[0028] Fig. 1a shows a first example of an antenna 1 according to the present invention. The inventive antenna comprises at least one processor means 2, in particular a microchip. It is hereby conceivable that the processor means 2 is a processor means that further processes different tasks, in particularly like operating a smart device. The shown antenna 1 comprises two branches 30, 32. It is hereby conceivable that the inventive antenna 1 only comprises one branch 30 or more than one branch, in particularly more than two branches 30, 32. The first branch 30 comprises multiple detection elements 4, 6, 8 for detecting and/or sending electromagnetic waves. The first detection element 4 is preferably arranged in a fix manner with respect to processing means 2, thus a relative movement between first detection means 4 and processor means 2 is preferably prevented. However, it is alternative possible that an actuation means is provided between processor means 2 and detection element 4 for moving, in particularly pivoting detection element 1 with respect to processor means 2.

[0029] A second detection element 6 is preferably arranged in a movable, in particularly pivotable, manner. The second detection element 6 is coupled via a first actuation means 5 with the first detection means 4, in particularly with a longitudinal ending of said first detection means 6.

[0030] The first actuation means 5, in particularly all actuation means causing a relative movement between detection elements, are preferably micro motors.

[0031] The second detection means 6 is connected to a second actuation means 7, wherein said second actuation means connects longitudinal ends of the second detection means 6 and third detection means 8. Thus, third detection means 8 is preferably movable, in particularly pivotable, with respect to second detection element 6.

[0032] Second and third detection elements 6, 8 are preferably movable via first actuation means 5 with respect to first detection element 4.

[0033] Second branch 32 is configured in an analogous manner to first branch 30. Thus, fourth detection element 10 is preferably connected via third actuation means 11 to fifth detection element 12 and fifth detection element 12 is preferably connected via fourth actuation means 13 to sixth detection element 14.

[0034] It is hereby possible that individual branches 30, 32 are configured differently. Thus, one branch 30 can be longer or more complex, in particularly having sub-branches, in comparison to a further branch 32. Furthermore, detection elements 4, 6, 8, 10, 12, 14 can preferably be understood as detection and/or sending elements. The individual detection elements 4, 6, 8, 10, 12, 14, respectively some or a majority, can also be shaped differently, in particular with different diameters and/or different length and/or different contours.

[0035] Fig. 1b shows a further schematic example of an inventive antenna 1. The first branch 30 has a sub-branch 31. Said sub-branch 31 is coupled with first detection element 2. First sub-branch 31 preferably forms an inclined, in particular rectangular, arrangement, wherein that rectangular arrangement is formed by one or multiple, in particular two, detection elements. Similar as in fig. 1a a second detection element 6 is coupled via first actuation means 5 to first detection element 4.

[0036] Second branch 32 is preferably configured in an analogous manner to first branch 30. The second branch 32 has a sub-branch 33. Said sub-branch 33 is coupled with fourth detection element 10. Second sub-branch 33 preferably forms an inclined, in particular rectangular, arrangement, wherein that rectangular arrangement is formed by one or multiple, in particular two, detection elements. Similar as in fig. 1a a fifth detection element 12 is coupled via third actuation means 11 to fourth detection element 4. The "fourth detection element" indicates the first detection element of second branch 32. In analogous manner indicates "third actuation means" the first actuation means of second branch 32 and "fifth detection element" the second detection element of second branch 32.

[0037] However, design of sub-branch 31 can be different. Sub-branch 31 can comprise actuation means as well. Further sub-branches per branch 30, 32 are possible.

[0038] Fig. 1c shows antenna 1 of fig. 1b, wherein at

both actuation means 5, 11 are operated, thus detection elements 6 and 12 are moved, in particular pivoted. In this configuration detection elements form two rectangles. It is possible that the individual actuation means are operated independently of each other.

[0039] Fig. 2a and fig. 2b are showing antennas 1 of fig. 1b and 1c in a schematic arrangement on a printed circuit board 35.

[0040] Fig. 3 shows a device 40, in particular a smart device or robot or drone etc., preferably having an input and/or output unit 42, in particular a touch screen, and preferably a housing 44. Said device 40 preferably operates multiple wireless communication technologies and comprises at least one tunable antenna 1 according to the present invention.

[0041] Thus, the present invention refers to an antenna 1 for detecting electromagnetic waves. This antenna preferably comprises one or multiple branches, in particular at least a first branch 30 for detecting electromagnetic waves, wherein said first branch 30 comprises at least a first detection element 4 and a second detection element 6, wherein the first detection element 4 and the second detection element 6 are physically connected with each other, an actuation means 5 for pivoting the second detection element 6 with respect to the first detection element 4 and a processor means 2 for operating the actuation means 5 in dependency of the detected electromagnetic waves or in dependency of radiation data, wherein the processor means 2 is connected to the first branch 30.

[0042] An antenna 1 with many mechanical parts connected together with moving pins 4, 6, 8, 10, 12, 14 are moved by micro motors 5, 7, 9, 11 and controlled by microchip 2 as a control module of the system. Control module cooperates with the system to determine necessary movements of the mechanical parts, in particular detection elements, for best appropriate radiation characteristic to the system. With this approach an antenna 1 which can resonate at multiple frequency regions can be obtained. Also, different radiation characteristics like polarization can be easily changed to the required one. Additionally, negative effects of the objects that are in close region of the antenna 1 can be handled by small mechanical movements to get better reception and change the antenna 1 radiation characteristics.

Reference numbers

[0043]

1	antenna
2	processor means
4	first detection element
5	first actuation means
6	second detection means
7	second actuation means
8	third actuation means
10	fourth detection means

11 fourth actuation means
 12 fifth detection means
 13 fifth actuation means
 14 sixth detection means
 30 first branch
 31 first sub-branch
 32 second branch
 33 second sub-branch
 35 printed circuit board
 40 device
 42 input and/or output unit
 44 housing

Claims

1. Antenna (1) for detecting electromagnetic waves, at least comprising a first branch (30) for detecting electromagnetic waves, wherein said first branch (30) comprises at least a first detection element (4) and a second detection element (6), wherein the first detection element (4) and the second detection element (6) are physically connected with each other, an actuation means (5) for pivoting the second detection element (6) with respect to the first detection element (4) and a processor means (2) for operating the actuation means (5) in dependency of the detected electromagnetic waves or in dependency of radiation data, wherein the processor means (2) is connected to the first branch (30).
2. Antenna according to claim 1, **characterized in that** the actuation means (5) is a micro motor and processor means (2) is a microchip.
3. Antenna according to claim 1 or claim 2, **characterized in that** at least one further branch (32) is provided, wherein said further branch (32) comprises at least two detection elements (10, 12), wherein at least one of these detection elements (12) is pivotable with respect to the other detection element (10).
4. Antenna according to any of the before mentioned claims, **characterized in that** at least the first branch (30) and/or the second branch (32) comprises multiple pivotable detection elements (6, 8, 12, 14), wherein each pivotable detection element (6, 8, 12, 14) is physically coupled with a micro motor.
5. Antenna according to any of the before mentioned

claims,

characterized in that

at least the first branch (30) and preferably multiple branches (30, 32) forms a row of multiple pivotable detection elements (6, 8; 12, 14), wherein one micro motor (7; 13) is arranged between two adjacent pivotable detection elements (6, 8; 12, 14) for causing a relative movement between said adjacent detection elements (6, 8; 12, 14).

6. Antenna according to any of the before mentioned claims, **characterized in that** at least the first branch (30) and preferably multiple branches (30, 32) comprises sub-branches (31, 33), wherein at least one sub-branch (31) forms a row of multiple pivotable detection elements, wherein one micro motor is arranged between two adjacent pivotable detection elements for causing a relative movement between said adjacent detection elements.
7. Antenna according to any of the before mentioned claims, **characterized in that** at least the first branch (30) and preferably multiple branches (30, 32) comprises more than two micro motors (5, 7; 11, 13).
8. Antenna according to any of the before mentioned claims, **characterized in that** said detection elements (4, 6, 8; 10, 12, 14) are longitudinal extending pins made of metal, wherein all detection elements (4, 6, 8; 10, 12, 14) of one branch (30, 32) are having the same length or wherein at least one detection element of one branch (30, 32) differs in its length from at least one further detection element of the same branch (30, 32), in particular of the same sub-branch (31, 33).
9. Antenna according to any of the before mentioned claims, **characterized in that** at least one of the detection elements (4, 6, 8; 10, 12, 14) extends in longitudinal direction less than 20mm, in particular less than 10mm or less than 5mm or less than 1 mm.
10. Antenna according to any of the before mentioned claims, **characterized in that** at least one branch (30, 32) further comprises slideable detection elements which are moved in one preferably straight direction back and forth, wherein each slidable detection element is coupled with a micro motor for causing the displacement.

11. Device (40), in particular mobile device, comprising at least one antenna (1) according to claims 1 to 10.
12. Method for operating an antenna (1), in particular according to any of claims 1 to 10, at least comprising the steps:

Providing an antenna (1) for detecting electromagnetic waves, wherein the antenna (1) comprises at least a first branch (30) for detecting electromagnetic waves, wherein said first branch (30) comprises at least a first detection element (4) and a second detection element (6), wherein the first detection element (4) and the second detection element (6) are physically connected with each other, an actuation means (2) for pivoting the second detection element (6) with respect to the first detection element (4) and a processor means (2) for operating the actuation means (2) in dependency of the detected electromagnetic waves or in dependency of radiation data, wherein the processor means (2) is connected to the first branch (30),
 Detecting electromagnetic waves with the first branch (30),
 Analyzing the properties of the detected electromagnetic waves by said processor means (2),
 Operating the actuation means (2) for adjusting the shape of the first branch (30) in dependency of said properties.

13. Method according to claim 12,
characterized by steps
 Providing data representing properties of electromagnetic waves to be detected,
 Operating the actuation means (2) for adjusting the shape of the first branch (30) in dependency of said properties.

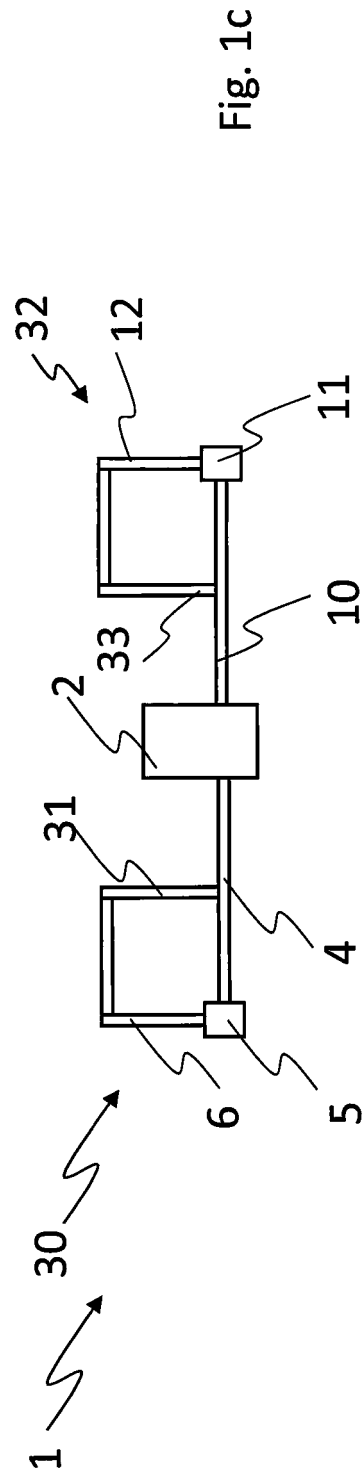
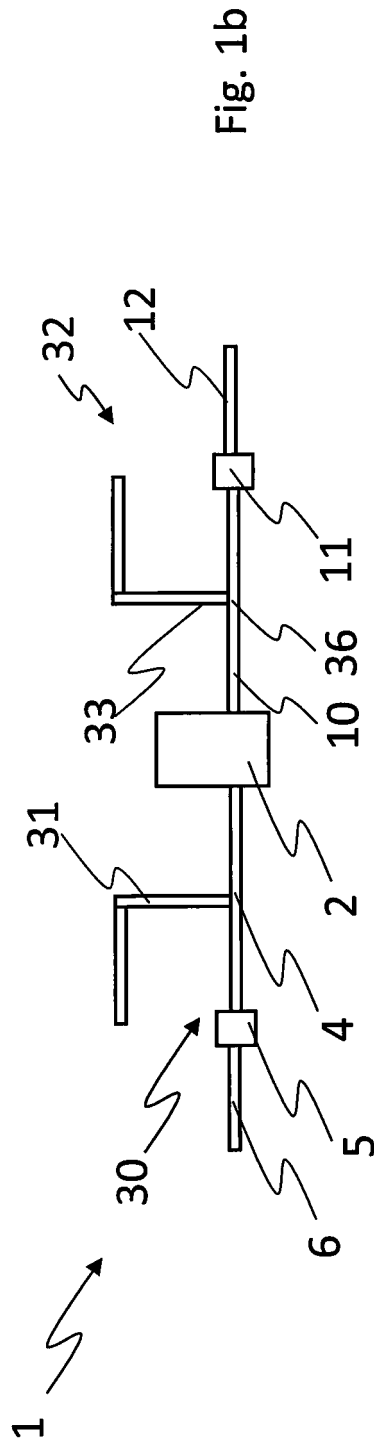
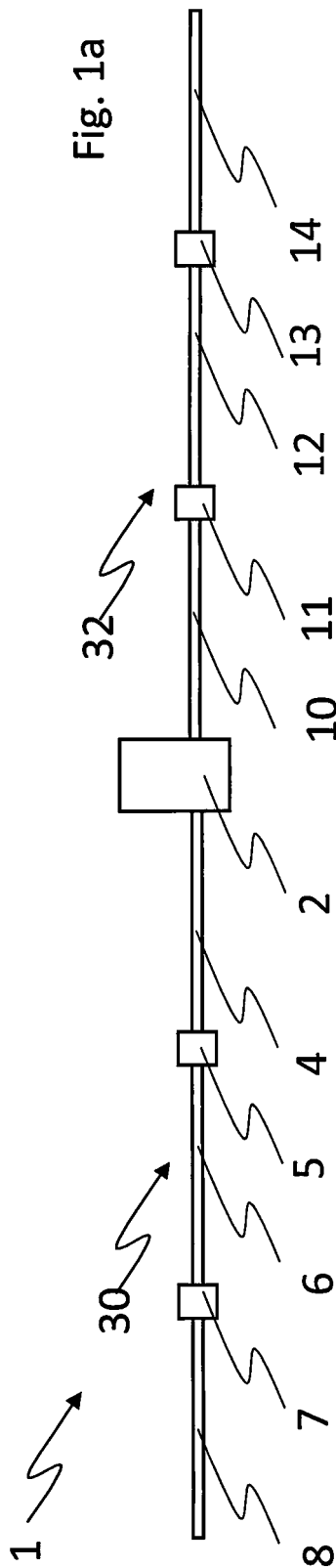
14. Method according to claim 13,
characterized by step:

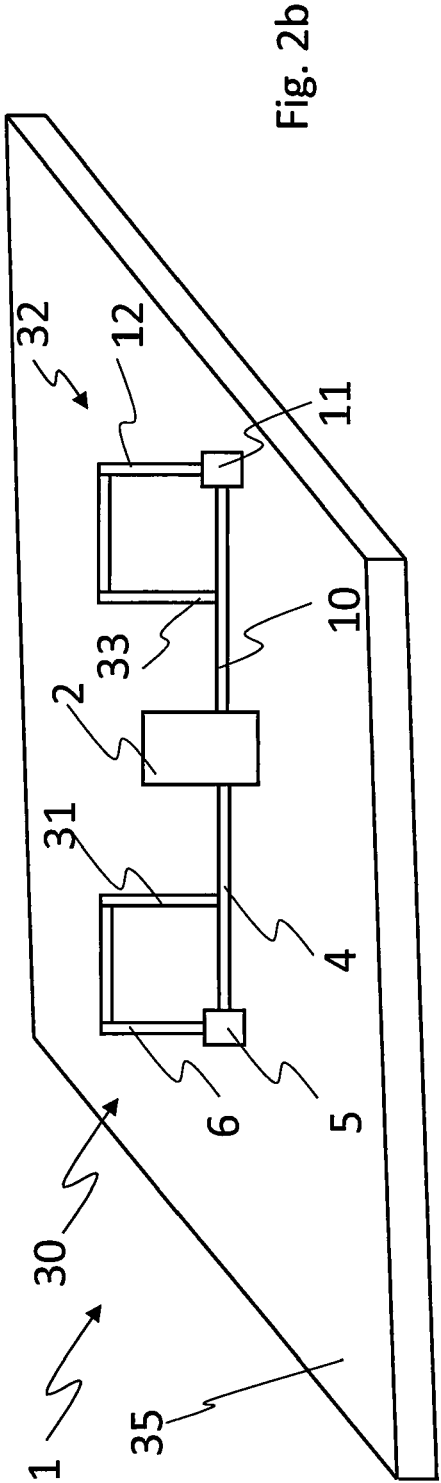
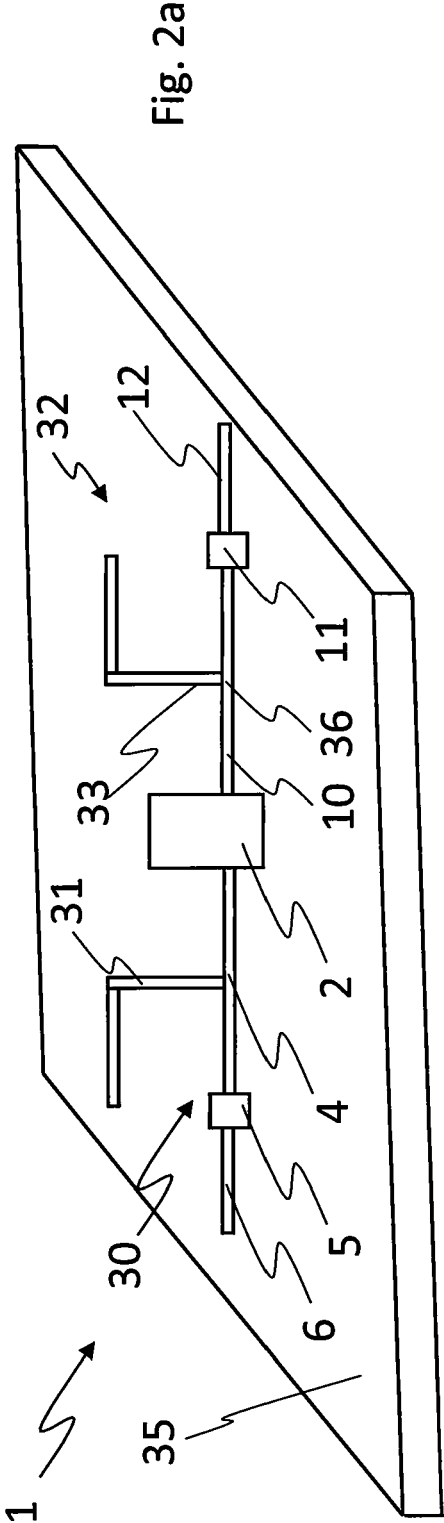
Switching between different shapes of said first branch (30) in dependency of multiple data transmission schemes, wherein data is transmitted according to each scheme in dependency of a predefined protocol, wherein said protocols differ from each other.

15. Method according to any of claims 12 to 14,
characterized by steps:

Switching between different shapes of said first branch (30) in dependency of multiple data transmission schemes, wherein data is transmitted according to each scheme in dependency of a predefined protocol, wherein said protocols differ from each other and

switching between different shapes of a further branch (32) in dependency of multiple data transmission schemes, wherein data is transmitted according to each scheme in dependency of a predefined protocol, wherein said protocols differ from each other
 wherein the first branch (30) is formed in a first shape and wherein the further branch (32) is formed in a second shape, wherein the first shape and the second shape differ from each other,
 wherein the first shape is set up to detect a first electromagnetic wavelength or wavelength range and wherein the second shape is set up to detect a second electromagnetic wavelength or wavelength range,
 wherein both wavelengths and/or wavelength ranges are detected at the same time.





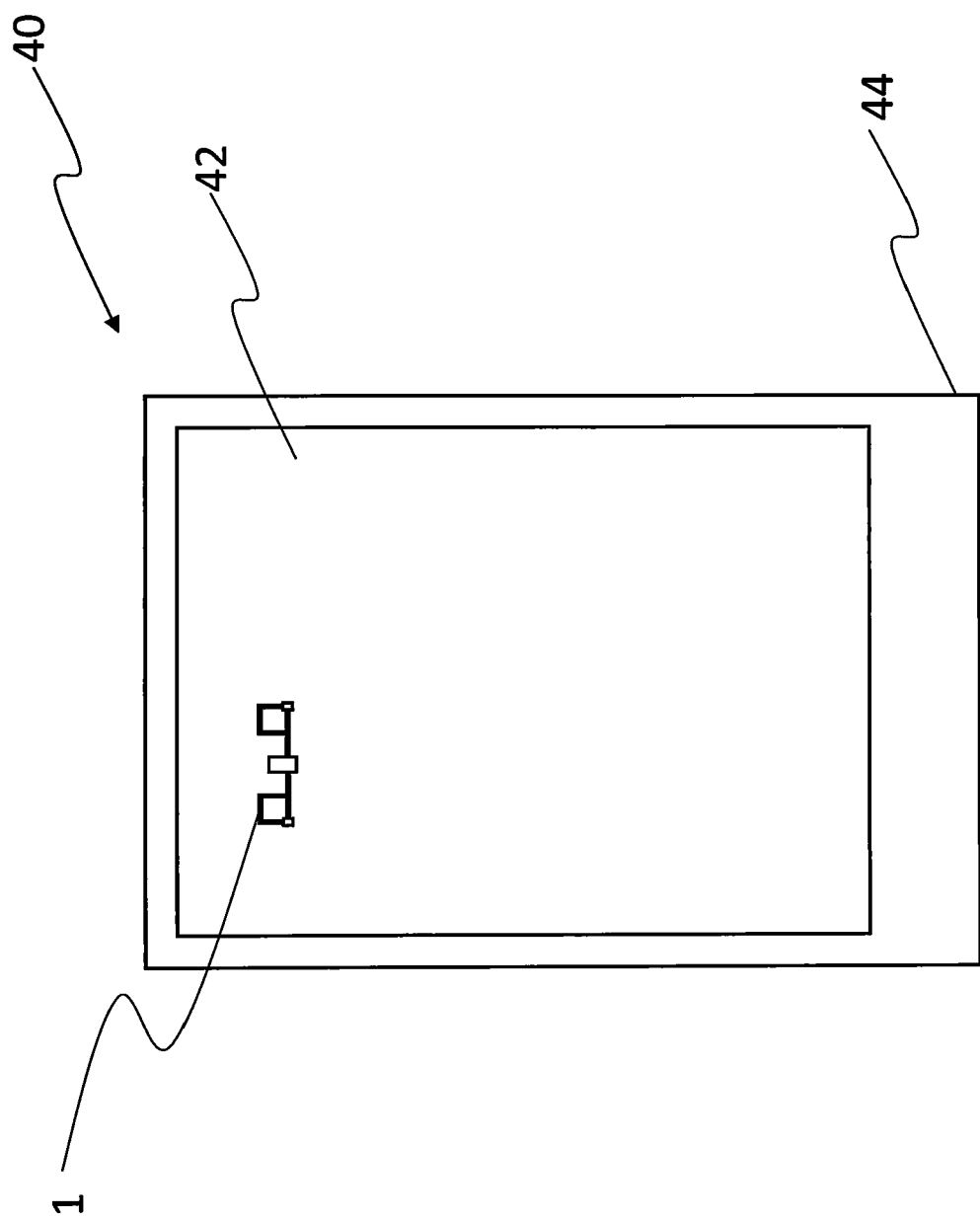


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 17 15 7228

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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 25 July 2017	Examiner Culhaoglu, Ali
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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