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(54) **Multi reflector antenna terminal**

(57) A multi reflector antenna terminal (100) is disclosed comprising:
- a support base (2) adapted to be rotated around a first rotation axis (A);
- a reflecting system (4,5,6) mechanically coupled to the support base (2) and adapted to be rotated around a second rotation axis (B) with respect to the support base (2), the second rotation axis (B) being independent from the first rotation axis (A);
- at least one radiofrequency chain (9,18) adapted to receive and/or transmit an electromagnetic signal through the reflecting system (4,5,6).

The reflecting system (4,5,6) comprises:
- a main reflector (4) rotatably coupled to the rotating base (2) and adapted to be rotated around the second rotation axis (B) with respect to the support base (2);
- a subreflector (5) and a third reflector (6), both mechanically coupled to the main reflector (4) and adapted to be rotated jointly with the main reflector (4) in its rotation around the second axis (B), wherein the third reflector (6) is adapted to be rotated around a third rotation axis (C) with respect the main and subreflector (4).

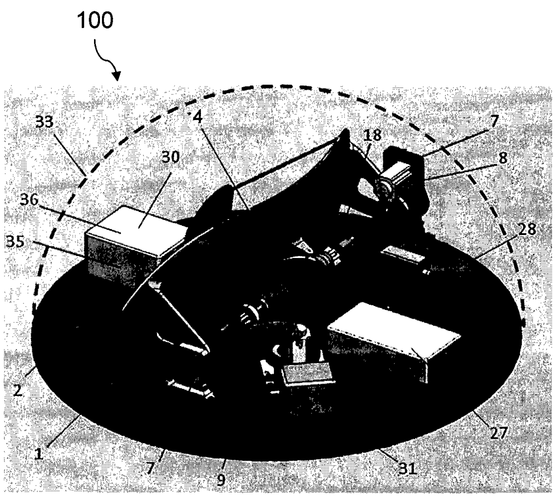

FIG. 1

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Description

[0001] The present disclosure relates to the technical field of telecommunications and in particular to a multi reflector antenna terminal.

[0002] A multi reflector antenna terminal is already known from WO 2008/015647 A2. In particular, WO 2008/015647 A2 discloses a dual reflector mechanical pointing low profile antenna particularly, but not only, suitable to be employed on high speed vehicles such as trains and aircrafts. Said low profile antenna comprises a main reflector, a sub-reflector and a feed which are mounted on a rotating mechanical support.

[0003] The object of the present disclosure is to make available an antenna terminal that, with respect to the prior art antenna disclosed in US WO 2008/015647 A2, can join one or more of the following additional functionalities:

- mechanical switch off;
- operation on different frequency bands in a selective way;
- redundancy that allows to guarantee the operation of the antenna terminal even in case of failure of the feed;
- fine tuning of the pointing direction and/or compensation of possible degradation effects due to the ageing of the antenna terminal.

[0004] The above object is reached by an antenna as defined in claim 1 in its most general form and in the dependent claims in particular and advantageous embodiments thereof.

[0005] Further features and advantages of the new multi reflector antenna terminal will become more apparent from the following detailed description of exemplary but non-limiting embodiments thereof, as illustrated in the attached figures, in which:

- Fig. 1 shows a schematic perspective view of an embodiment of a multi reflector antenna terminal;
- Fig. 2 shows a schematic top plan view of the antenna terminal of figure 1;
- Fig. 3 shows another schematic view of the antenna terminal of figure 1;
- Figs. 4 and 5 show two additional schematic perspective views of the antenna of figure 1;
- Figure 6 shows another schematic perspective view of an enlarged part of the antenna terminal of figure 1, wherein the antenna terminal is shown in a first operating condition;
- Figure 7 shows another schematic perspective view of an enlarged part of the antenna terminal of figure 1, wherein the antenna terminal is shown in a second operating condition; and
- Figure 8 shows a schematic perspective view of a part of the antenna of figure 1.

[0006] In the attached figures identical or similar elements are indicated with the same reference numbers/symbols.

[0007] With reference to the above indicated figures a particular and non-limiting example of a multi reflector antenna terminal 100 is disclosed. Said multi reflector antenna terminal 100 comprises a reflecting system 4,5,6 including three reflectors and in particular a main reflector 4, a secondary reflector 5 (or subreflector 5) and a third reflector 6. In the foregoing description the third reflector 6 will be also indicated as "rotating mirror 6".

[0008] The multi reflector antenna terminal 100 is particularly, but not only, suitable for being employed in satellite telecommunications, direct TV broadcasting and wideband multimedia applications. According to an embodiment said antenna terminal 100 is a part of an outdoor unit, in turn located on a moving vehicle such as a train, an aircraft, a watercraft or a terrestrial motor vehicle.

[0009] The reduced dimensions of the antenna terminal 100, deriving from a suitable choice of the optical system, facilitate its use in all situations of satellite and terrestrial connections from vehicles in motion. The antenna terminal 100 is capable of transmitting and/or receiving even under critical linking conditions with a satellite and/or a base station.

[0010] According to an embodiment the multi reflector antenna terminal 100 is a "low profile" antenna terminal, i.e. an antenna terminal having horizontal dimensions greater than its vertical dimensions.

[0011] In the foregoing description a non-limiting embodiment will be disclosed wherein the antenna terminal 100 is a terminal adapted for transmitting uplink electromagnetic signals to one or more satellites and/or for receiving downlink electromagnetic signals to one or more satellites.

[0012] With reference to the attached figures, according to the embodiment shown, the antenna terminal 100 comprises a first support base 1 and a second support base 2 which is rotatably coupled to the first support base 1 in order to be rotated around a first rotation axis A with respect to the support base 1. In a normal condition of operation, the first rotation axis A is a vertical or substantially vertical axis.

[0013] The first 1 and second 2 support bases are preferably substantially plate-shaped and in the following description they will be respectively indicated, without for this reason introducing any limitation, as "fixed plate 1" and "rotating plate 2".

[0014] According to the example shown, the antenna terminal 100 comprises a motor 34, also indicated as azimuth motor, which is adapted to rotate the rotating plate 2 around the first rotation axis A for scanning the electromagnetic beam in the azimuth plane.

[0015] The reflecting system 4,5,6 is mechanically coupled, for example rotatably hinged, to the rotating plate 2 in order to be rotated around a second rotation axis B with respect to the rotating plate 2. Accordingly, the rotating plate 2 supports the reflecting system 4,5,6 and in general also the remaining devices and components configured for receiving and/or transmitting electromagnetic signals. The second rotating axis B is independent from the first rotating axis A.

[0016] According to the particular embodiment shown, the main reflector 4 is rotatably coupled to the rotating plate 2, in the example shown by means of two supporting elements 7 which are fixed to the rotating plate 2. By means of such supporting elements 7 the main reflector 4 is rotatably hinged to the rotating plate 2. The antenna terminal 100 also comprises a motor 8, for example an electric rotating motor 8, which is coupled to the main reflector 4 and that is adapted to be controlled in order to rotate the main reflector 4 around the rotation axis B. In a normal condition of operation, the axis B is a horizontal or substantially horizontal axis. In the example shown, the motor 8 is fixed to one of the two supporting elements 7.

[0017] The rotating mirror 6 is mechanically coupled to the main reflector 4, and supported by such reflector 4, and is adapted to be rotated around a third rotation axis C with respect the main reflector 4.

[0018] According to an embodiment, the rotating mirror 6 is rotatably hinged to the main reflector 4 on the opposite side of the latter with respect to the side of the main reflector 4 that is faced to the secondary mirror 5. The sequence of the reflectors along a propagation path of the received and/or transmitted electromagnetic signals is the following: main reflector 4, subreflector 5, third reflector 6 and/or vice versa.

[0019] The antenna terminal 100 comprises a motor (not shown in the figures), for example a rotating electric motor, which is adapted to be controlled in order to rotate the rotating mirror 6 around the rotation axis C. For example, as shown in figures 5 and 6 the rotating mirror 6 is pivotally hinged to the main reflector 4 by means of two brackets and said rotating electric motor (not shown in the figures) is fixed to one of said brackets and has a shaft connected to the rotating mirror.

[0020] According to an embodiment, it is possible to foresee that the rotating mirror 6 can be also moved in order to translate with respect the main reflector 4.

[0021] According to one advantageous embodiment, the main reflector 4 includes a hole or a notch F so as to allow the transmission of the electromagnetic signal between the rotating mirror 6 and the subreflector 5. In a preferred embodiment, the hole or notch F is placed in the shadow zone projected by the subreflector 5 on the main reflector 4 along the axis Z of figure 8, so as to minimize the efficiency loss of the antenna terminal 100. The axis Z in the operation is generally intended to be aligned with the main direction of propagation of the received and/or transmitted electromagnetic signal.

[0022] According to the embodiment shown, the secondary mirror 5 is fixedly mounted to the main reflector 4. For example, the secondary mirror 5 is supported by at least one arm fixed to the main reflector 4. With reference to figure 2, in the example shown the subreflector 5 is fixed by means of four arms to the main reflector 4.

[0023] It is clear that the whole reflecting system 4,5,6, due to the connection arrangement among the reflectors and between the main reflector 4 and the rotating plate 2, following a rotation of the main reflector 4 around the rotation axis B is adapted to perform the scanning of the electromagnetic beam in the elevation plane. The subreflector 5 and the rotating mirror 5 are adapted to be rotated jointly with the main reflector 4 during its rotation around the second rotation axis B.

[0024] The rotating mirror 6 can be provided with one or more reflecting surfaces. In the particular and non-limiting example shown, the rotating mirror 6 is provided with two opposite reflecting surfaces and has preferably the general shape of a dish.

[0025] The antenna terminal 100 comprises at least one radio frequency chain 9, 18 mounted on the rotating plate 2 and adapted to cooperate with the reflecting system 4,5,6 6 for the transmission and/or the reception of electromagnetic signals. The at least one radio frequency chain 9, 18 is mechanically coupled to the rotating plate 2 and is adapted to be stationary with respect the support base 2 in the rotation of the reflecting system around the second axis B. For the purpose of the present description "stationary" means that the radio frequency chain 9, 18 does not rotate around the rotation axis B of the reflecting system 4,5,6. Thanks to this embodiment, there is no use of RF rotary joints and this advantageously reduces the gain losses.

[0026] In the example shown in the figures, without for this reason introducing any limitation, two radio frequency chains 9, 18 are provided.

[0027] For example, the radio frequency chain 9 comprises an illuminator 10, a polarization rotator 11, an orthomode transducer (OMT) 12, a filter 13, a low noise frequency down-converter and a low noise amplifier representing together a low noise block (LNB) 14, a waveguide to coaxial cable adapter 15. In the embodiment shown, the antenna terminal 100 comprises:

- a supporting bracket 16 for the radio frequency chain 9 which is fixed to the rotating plate 2 and is provided with ball bearings; and
- a motor 17 adapted to rotate the radio frequency chain 9 around a fourth rotation axis D in order to achieve the polarization alignment.

[0028] According to an embodiment the antenna terminal 100 comprises an amplifier and an high frequency converter 27, or block up converter (BUC) 27, coupled to the radiofrequency chain 9 for the signal transmission through the radiofrequency chain 9.

[0029] If provided, the second radio frequency chain 18 may similarly comprise an illuminator 19, a polarization rotator 20, an orthomode transducer (OMT) 21, a filter 22, a low noise frequency down-converter and a low noise amplifier representing together a low noise block (LNB) 23, a waveguide to coaxial cable adapter 24.

[0030] In the embodiment shown, the antenna terminal 100 comprises:

- a supporting bracket 25 for the radio frequency chain 18 which is fixed to the rotating plate 2 and is provided with ball bearings; and
- a motor 26 adapted to rotate the radio frequency chain 18 around a fifth rotation axis E in order to achieve the polarization alignment.

[0031] According to an embodiment the antenna terminal 100 comprises an amplifier and an high frequency converter 28, or block up converter (BUC) 28, coupled to the radiofrequency chain 18 for the signal transmission through the radiofrequency chain 18.

[0032] According to an embodiment, the illuminator(s) 10, 19 is (are) designed so as to have an irradiation diagram having a very high circular symmetry. In this way, since the illumination of the rotating mirror 6 does not change it is possible to avoid gain losses when changing the elevation angle.

[0033] According to the embodiment the rotating mirror 6 has the function of deviating of about 90 degrees the transmitted and/or received electromagnetic signal for redirecting it towards the secondary mirror 5 and/or the illuminators 10,19.

[0034] Like in the embodiment represented in the figures, with particular reference to figure 5, when two radio frequency chains 9, 18 are provided in the antenna terminal 100 it is possible to arrange the illuminators 10, 19in such a way that they are opposed to each other and aligned along a same rotation axis. In this case the rotation axis E and D are the same axis even if it is important to observe that each of the illuminators 10,19 can be independently rotated from the other due to the rotation of the respective radio frequency chains. In a preferred embodiment, all the above described rotation axes A, B, C, D and E are mutually independent.

[0035] Thanks to the provision of the rotating mirror 6 and depending on the number of the radio frequency chains 9, 18 it is advantageously possible to provide the antenna unit 100 with one or more advanced functionalities.

[0036] In fact in a first example, not shown in the figures, only one radio frequency chain is provided, for example the radio frequency chain 9, and the rotating mirror 6 is preferably provided with only one reflecting surface. During the operation the rotating mirror 6 can be rotated around the rotation axis C for example between a working angular position and a rest angular position, for mechanically turning-on and switching-off the antenna terminal 100 respectively. In the working position the rotating mirror 6 is oriented in such a way that a reflecting surface of the mirror 6 is oriented for optimizing the transmission of the electromagnetic signal between the radio frequency chain 9 and the secondary mirror 5. In the rest position the rotating mirror 6 is oriented in such a way that reflecting surface of the mirror 6 is oriented for minimizing the transmission of the electromagnetic signal between the radio frequency chain 9 and the secondary mirror. For example the rotating mirror 6 is provided with a surface, preferably an absorbing surface, opposite to the reflecting surface and in the rest position such surface can face the secondary mirror 5 or the input/output port, or illuminator 10, of the radiofrequency chain 9. This feature can be used as a redundancy of the radiation emission switch off, in case of failure of the primary switch off equipment, consisting of a reference signal at the input of BUCs 27 and 28.

[0037] In a second example, the antenna terminal 100 is provided with two radio frequency chains 9, 18 and the rotating mirror 6 is adapted to be rotated around the axis C between two angular positions respectively for selectively enabling the operation of one 9 or the other 18 radiofrequency chain. If the two radio frequency chains 9, 18 are configured to operate on the same frequency band, the antenna terminal 100 according to the second example is such to guarantee the continuity of operation of the antenna terminal 100 even in the case in which there is the failure of one of the two radio frequency chains. If the two radio frequency chains 9, 18 are aligned along a same axis, and the rotating mirror 6 is interposed between said chains 9, 18, a rotation of the mirror 6 of 90 degrees may be operated in order to selectively enable the operation of one 9 or the other 18 radiofrequency chain. In this case, the rotating mirror 6 can be provided with only one reflecting surface.

[0038] According to a third example that will be described in more detail with respect the previous ones, the antenna terminal 100 may be provided with two radio frequency chains 9, 18 and the rotating mirror 6 can be rotated among two angular positions respectively for selectively enabling the operation of one or the other radiofrequency chain 9 or 18. If the two radio frequency chains 9, 18 are configured to operate on different frequency bands, the antenna terminal 100 according to the third example can selectively operate on different frequency bands, being therefore a dual-band antenna terminal 100. For example, one of the two radio frequency chains 9, 18 can be designed to operate on the Ka band and the other radio frequency chain can be designed to operate on the Ku band.

[0039] According to an advantageous embodiment it is possible to foresee in a multi-band antenna terminal 100 according to the above described third example that the rotating mirror 6 is provided with two reflecting surfaces, one of which is numerically optimized in its shape for the frequency band of one of the two frequency chain 9 and the other of which is independently numerically optimized in its shape for the frequency band of the other radio frequency chain 18. If the two radio frequency chains 9,18 are aligned along a same axis and the rotating mirror 6 is interposed between said chains 9, 18, a rotation of the mirror 6 of 90 degrees may be operated in order to selectively enable the operation of one 9 or the other 18 radiofrequency chain.

[0040] It is important to observe that independently from, or jointly to, the above described additional functionalities provided thanks to the provision of the rotating mirror 6, and independently from the number of radio-frequency chains, the rotating mirror 6 can also be rotated to advantageously allow a fine tuning of the pointing direction of the reflecting system 4,5,6 and/or to compensate possible degradation effects due to the ageing of the antenna terminal 100.

[0041] According to an embodiment, the hole or notch F is placed on the lower part of the main reflector 4, so as to be relatively close to the rotating plate 2. Accordingly, also the at least one radio frequency chain 9,18 is placed close to the rotating plate 2 by means of the brackets 16, 25. This expedient advantageously reduces the mechanical stress of the system during the pointing and tracking of the antenna terminal 100. This effect is further improved when also the rotation axis B of the main reflector 4 is relatively close to the rotating plate 2, for example at a maximum distance of 10 cm from the rotating plate 2.

[0042] During operation of a preferred embodiment of the antenna terminal 100, for example during the transmission of a signal, one illuminator 10,19 is such to transmit said signal, in the form of a spherical wave, towards the rotating mirror 6 which reflects said signal towards the secondary mirror 5 in such a way as to avoid significant unbalances in the illumination intensity of the border of said secondary mirror 5. The latter transforms the spherical, or pseudo-spherical wavefront, coming from the rotating mirror 6 in an astigmatic wavefront so making unequal the curvature rays of the reflected wavefront with respect to the principal planes XZ and YZ of figure 8. The wavefront coming from the subreflector 5 illuminates the main reflector 4.The main reflector 4 is such to transform the astigmatic wavefront in a planar wavefront. Such wavefront may also be inclined with respect the axis Z, for reducing or eliminating a partial shade region introduced by the subreflector 5. In order to obtain this in the design of the surfaces of the main reflector 4 and the subreflector 5 it is required to force the uniformity of the optical path for every possible ray emitted by the source of the electromagnetic signal according to the "stationary phase" principle. According to a preferred embodiment this is obtained by designing the reflecting surface of the main reflector 4 as a quartic surface, i.e. a surface that in the Cartesian coordinate system XYZ of figure 8 is represented in implicit form in polynomials of x,y,z of degree 4 that in most of the cases cannot be made not explicit with respect to z in the XYZ reference system of figure 8. According to a preferred embodiment, before the shaping, i.e. the numerical optimization, the principal sections of the surfaces of the main reflector 5 and the subreflector 5 are conical sections. In particular, the principal sections of the main reflector 4 are both parabolas but with different focal lengths, while the principal sections of the subreflector 5 are both hyperboles but with different focal lengths.

[0043] According to an embodiment, the antenna unit 100 is configured like a three-reflector beam waveguide antenna. This expedient together with the shaping of the reflecting surfaces allows to design significantly compact mechanical pointing low profile antennas. Said low profile antennas may also have an asymmetrical profile, that is to say that they may have a radiating aperture whose width is greater than the height, such as for example an elliptical, or a super-elliptical or a rectangular aperture. Moreover the above combination of expedients allows to minimize the number of reflectors (the minimum number is three) in small and medium sized antennas, that is to say antenna having dimensions generally comprised in the range 30-100 wavelengths, without significantly impacting on the overall efficiency of the antenna.

[0044] According to possible embodiments the antenna unit 100 may be further provided with a tracking system comprising one or more of the following components: a low loss radio frequency connection 29, an antenna control unit 30 (ACU), an inertial measurement unit 31 (IMU), a GPS receiver 32, a narrow band receiver 35, a device for the extraction of the reference signal 36 to be tracked, a protection radome 33.

[0045] As is evident form the above description, the antenna terminal 100 is such to fully attain the proposed objects, since it is capable to add one or more advanced functionalities to the prior art antennas. The antenna unit may be designed so as to be very compact and may perform the elevation scanning moving only the reflecting system 4,5,6 and not the radio-frequency electronic components. Moreover since the at least one radio frequency chain 9,18 does not rotate together the reflecting system 4,5,6 around the rotation axis B, radio frequency joints are not required so it is possible to avoid gain losses.

[0046] Naturally, in order to satisfy contingent and specific requirements, a person skilled in the art may apply to the above-described multi reflector antenna units many modifications and variations, all of which, however, are included within the scope of protection of the invention as defined by the following claims.

Claims

1. Multi reflector antenna terminal (100) comprising:

- a support base (2) adapted to be rotated around a first rotation axis (A);
- a reflecting system (4,5,6) mechanically coupled to the support base (2) and adapted to be rotated around a second rotation axis (B) with respect to the support base (2), the second rotation axis (B) being independent from the first rotation axis (A);
- at least one radiofrequency chain (9,18) adapted to receive and/or transmit an electromagnetic signal through the reflecting system (4,5,6);

wherein the reflecting system (4,5,6) comprises:

- a main reflector (4) rotatably coupled to the support base (2) and adapted to be rotated around the second rotation axis (B) with respect to the support base (2);
- a subreflector (5) and a third reflector (6), both mechanically coupled to the main reflector (4) and adapted to be rotated jointly with the main reflector (4) in its rotation around the second axis (B), wherein the third reflector (6) is adapted to be rotated around a third rotation axis (C) with respect to the main (4) reflector and the subreflector (5).

2. Multi reflector antenna terminal according to claim 1, wherein the sequence of the reflectors along a propagation path of the electromagnetic signal is the following one: main reflector (4), subreflector (5), third reflector (6) or vice versa.

3. Multi reflector antenna terminal (100) according to claims 1 or 2, wherein the third reflector (6) is rotatably hinged to the main reflector (4) on the opposite side of the latter with respect to the side of the main reflector (4) that is faced to the subreflector (5).

4. Multi reflector antenna terminal (100) according to any one of the previous claims, wherein the at least one radio frequency chain (9,18) is mechanically coupled to the support base (2) and is adapted to be stationary with respect the support base (2) during the rotation of the reflecting system (4,5,6) around the second axis (B).

5. Multi reflector antenna terminal (100) according to claim 4, wherein the at least one radio frequency chain (9,18) is adapted to be rotated around a further rotation axis (D,E) with respect to the support base (2).

6. Multi reflector antenna terminal (100) according to any one of the previous claims, wherein the at least one radio frequency chain comprises a first (9) and a second (18) radio frequency chain, and wherein the third reflector (6) is adapted to rotate around the third axis (C) between a first angular position and a second angular position in order to selectively enable the operation of said first (9) or said second (18) radiofrequency chain respectively.

7. Multi reflector antenna terminal (100) according to claim 6, wherein the first radio frequency chain (9) is designed to operate in a first frequency band and the second radio frequency chain (18) is designed to operate in a second frequency band different from the first frequency band.

8. Multi reflector antenna terminal (100) according to claim 7, wherein the first frequency band is the Ka band and the second frequency band is the Ku band.

9. Multi reflector antenna terminal (100) according to claims 7 or 8, wherein the third reflector (6) comprises a first and a second reflecting surface respectively adapted to cooperate with the first (9) and the second (18) frequency chain.

10. Multi reflector antenna terminal (100) according to claim 9, wherein said surfaces are opposite surfaces.

11. Multi reflector antenna terminal (100) according to claims 9 or 10, wherein the shape of the first reflecting surface is numerically optimized for the operation in the first frequency band and the shape of the second surface is numerically optimized, independently from the first surface, for the operation in the second frequency band.

12. Multi reflector antenna terminal (100) according to any one of the previous claims, wherein the main reflector comprises a notch or a hole (F) in order to allow the propagation of said electromagnetic signal between the subreflector (5) and the third reflector (6).

13. Multi reflector antenna terminal (100) according to claim 12, wherein said notch or hole (F) is placed on a shadow region projected from the subreflector (5) on the main reflector (5).

14. Multi reflector antenna terminal (100) according to claims 12 or 13, wherein said notch or hole (F) is placed on a portion of the main reflector (4) which is relatively close to the support base (2).

15. Multi reflector antenna terminal (100) according to any one of the previous claims, wherein said antenna terminal is a three reflector beam waveguide low profile antenna terminal.

16. Multi reflector antenna terminal (100) according to any one of the previous claims, wherein said rotation axes (A, B, C, D, E) are mutually independent.

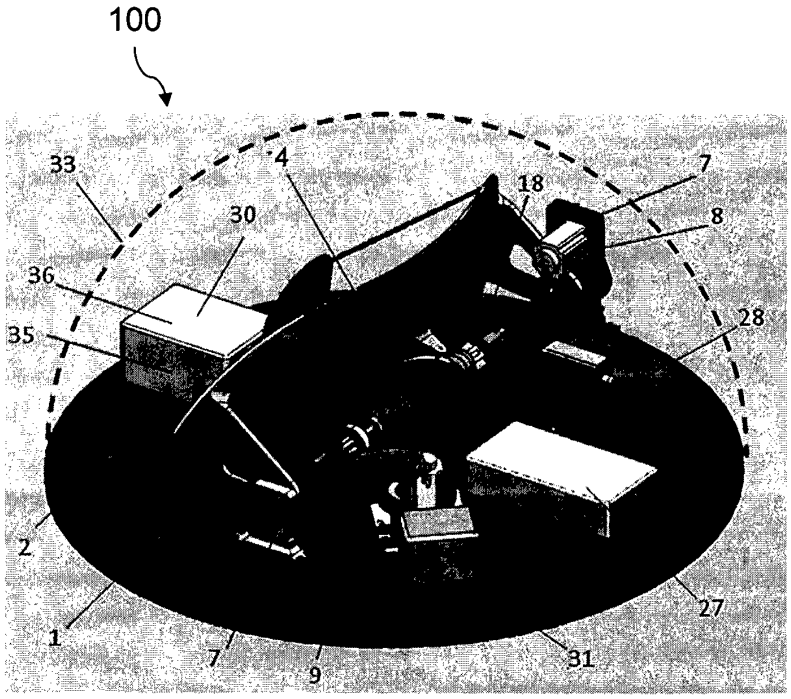

FIG. 1

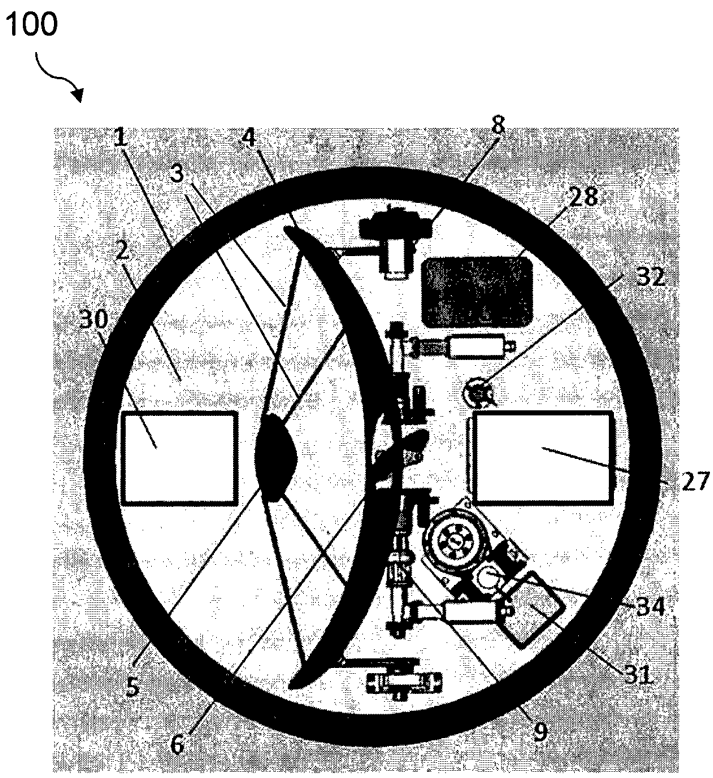

FIG. 2

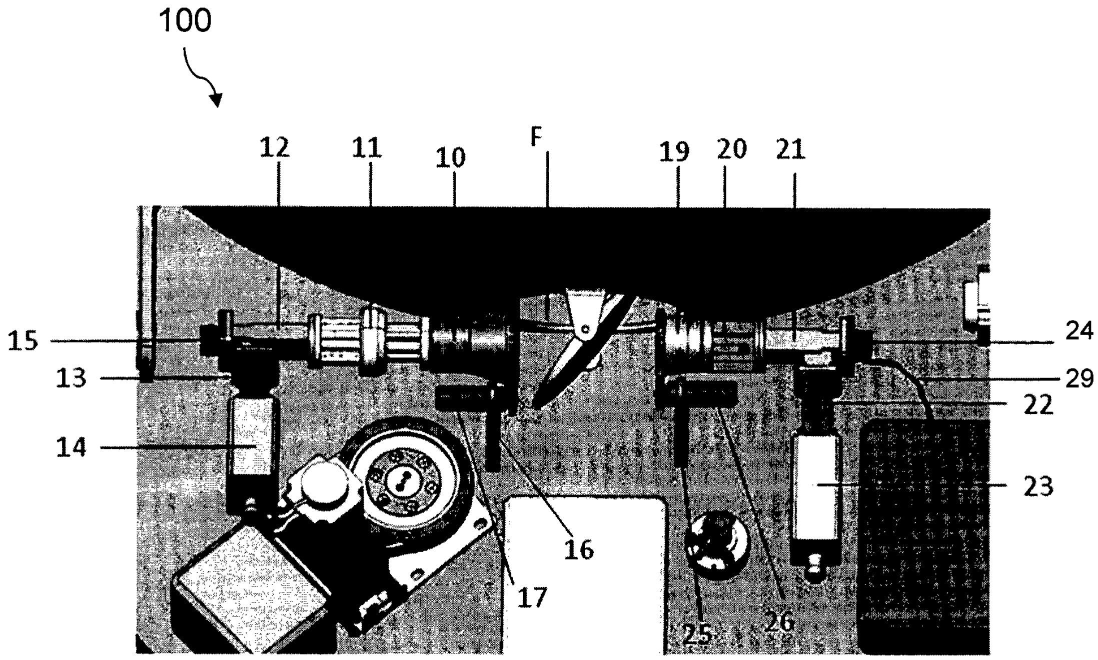

FIG. 3

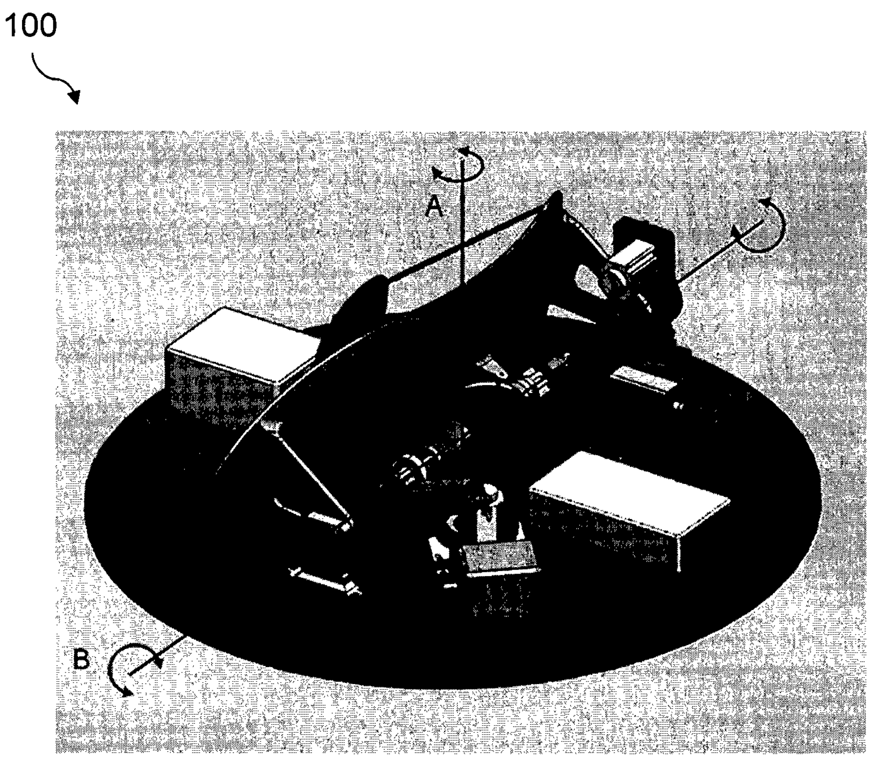

FIG. 4

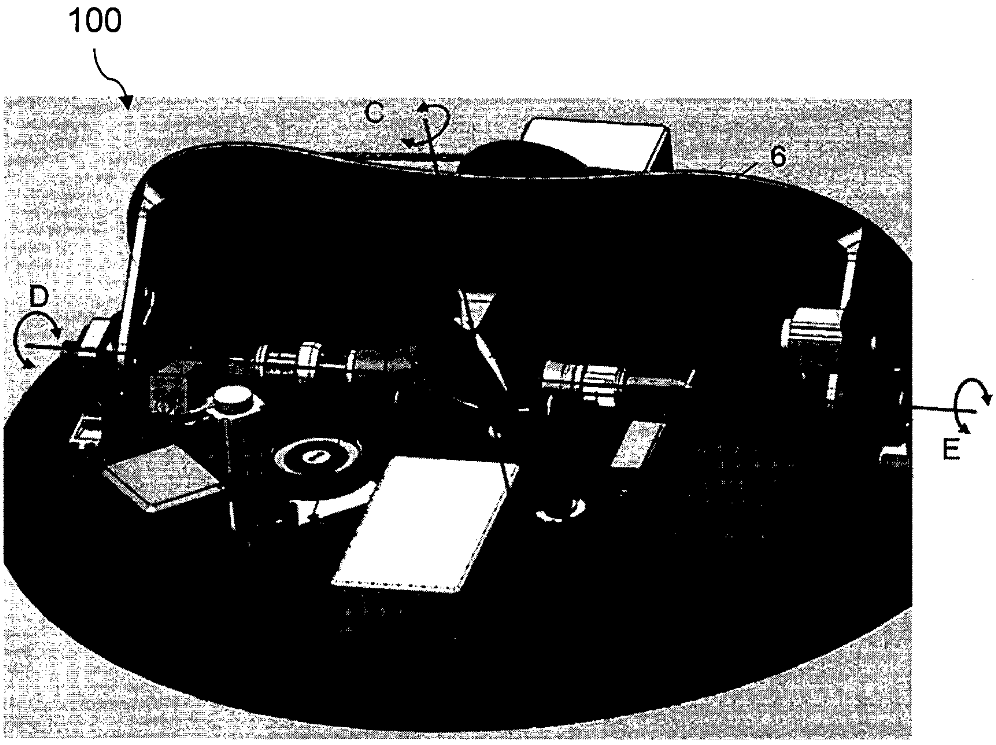

FIG. 5

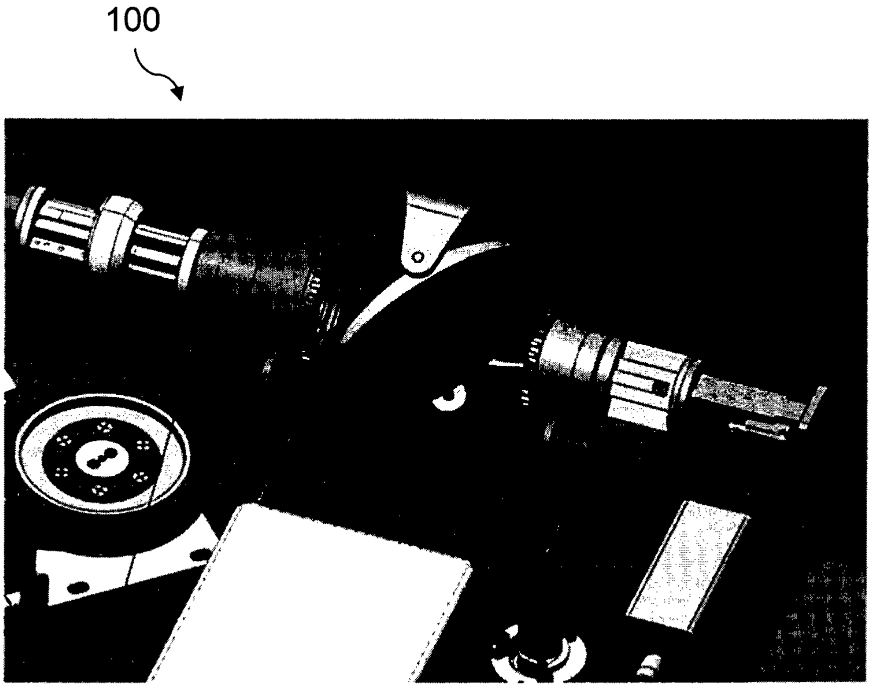

FIG. 6

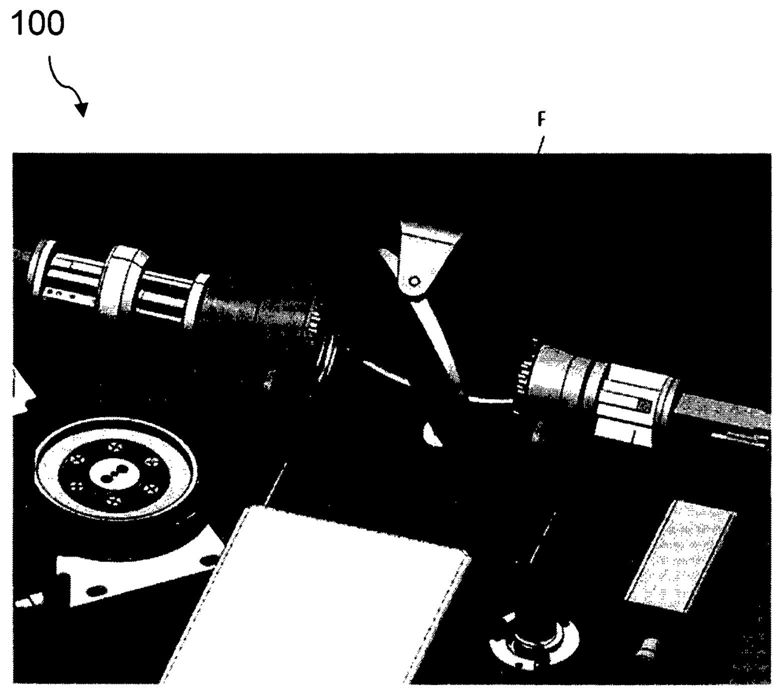

FIG. 7

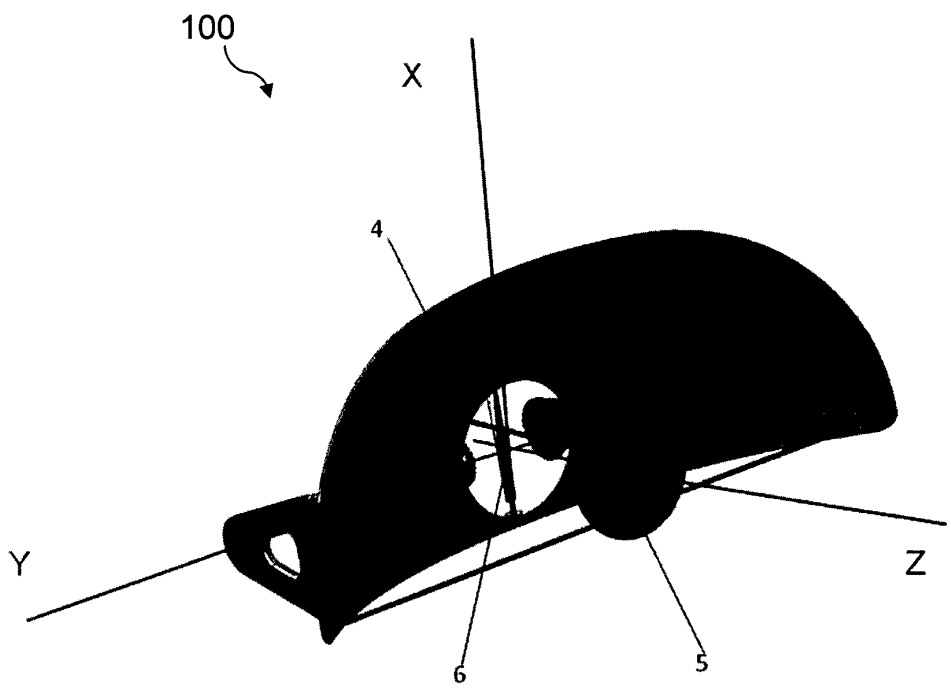

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 13 42 5011

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2006/262022 A1 (DESARGANT GLEN J [US] ET AL) 23 November 2006 (2006-11-23) * abstract; figures 3-5 * * paragraphs [0002] - [0011], [0023] - [0035] * -----	1-16	INV. H01Q1/32 H01Q3/08 H01Q3/20 H01Q19/17 H01Q19/19
Y	DE 23 21 613 A1 (ROHDE & SCHWARZ) 14 November 1974 (1974-11-14) * abstract; figure 1 * * pages 1-5 * -----	1-16	
A	DE 24 54 133 A1 (SIEMENS AG) 20 May 1976 (1976-05-20) * abstract; figures 1-3 * * pages 1-6 * -----	1-16	

TECHNICAL FIELDS SEARCHED (IPC)

H01Q

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	12 June 2013	Hüschelrath, Jens

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2008015647 A2 **[0002] [0003]**