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

(11) EP 1 702 387 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
09.04.2014 Bulletin 2014/15

(21) Application number: **04736152.2**

(22) Date of filing: **04.06.2004**

(51) Int Cl.:
H01Q 3/04 *(2006.01)* ***H01Q 1/42*** *(2006.01)*
H01Q 1/24 *(2006.01)* ***H01Q 25/00*** *(2006.01)*

(86) International application number:
PCT/KR2004/001344

(87) International publication number:
WO 2005/062419 (07.07.2005 Gazette 2005/27)

(54) ANTENNA BEAM CONTROL APPARATUS FOR BASE TRANSCEIVER STATION ANTENNAS

ANTENNENSTRAHLSTEUERVORRICHTUNG FÜR BASIS-SENDER/EMPFÄNGER-STATIONSANTENNEN

COMMANDE DE FAISCEAU D'ANTENNE E/R DE STATION DE BASE

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR

(30) Priority: **23.12.2003 KR 2003095761**

(43) Date of publication of application:
20.09.2006 Bulletin 2006/38

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(56) References cited:
EP-A- 0 546 515
WO-A-02/50950
WO-A-2005/060045
JP-A- S63 155 806
JP-A- 2001 237 628
JP-A- 2001 522 554
KR-A- 99 074 017
KR-A- 2003 018 954
US-A- 4 939 526
US-A- 5 223 845
US-A- 5 969 689
US-A1- 2001 015 707
US-B2- 6 486 845

- **"MECHANICALLY-STEERED, MOBILE SATELLITE-TRACKING ANTENNA" NTIS TECH NOTES, US DEPARTMENT OF COMMERCE. SPRINGFIELD, VA, US, 1 May 1990 (1990-05-01), pages 394,1-2, XP000137363 ISSN: 0889-8464**

Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates to base transceiver station antennas, and more particularly to an antenna beam control apparatus for base transceiver station antennas, which can enable the remote control of a horizontal azimuth angle of an antenna beam in correspondence to variation in environment of electromagnetic waves.

Background Art

[0002] In relation to construction of a cell in mobile communication systems, a mounting position of base transceiver station antennas is an important factor determining the coverage of the cell. Therefore, the antennas are mainly installed on the roof of buildings in highly-developed urban areas or to steel towers for base transceiver stations located in the suburbs, in order to maximize a travel distance of electromagnetic waves.

[0003] Considering mounting of such antennas, especially, outdoor antennas are mounted to upper ends of antenna, support poles installed in respective base transceiver stations, and indoor antennas are fixed to wall surfaces of buildings. In both cases, the antennas are fixed by making use of clamping devices.

[0004] Such antenna clamping devices for fixing antennas to wall surfaces or high antenna structures, however, have a serious problem in relation to installation thereof. That is, in most cases, the clamping devices may threaten worker safety since they require for a worker to perform installation operations using both hands for a long time in a considerably dangerous position standing on the high antenna structures. Furthermore, in order to vertically or horizontally displace the installed antennas, the worker has to start the installation operations all over again.

[0005] Fig. 1 is a perspective view illustrating a conventional antenna beam control apparatus for base transceiver station antennas. As shown in Fig. 1, the conventional antenna beam control apparatus comprises an antenna 10 containing a reflection plate (not shown) for transmitting and receiving electromagnetic waves, a rod-shaped support pole 20 for supporting the antenna 10, an upper connector member 30 for connecting upper sides of the support pole 20 and the antenna 10 to each other, and a lower connector member 40 for connecting lower sides of the support pole 20 and the antenna 10 to each other.

[0006] The upper connector member 30 is formed at one end thereof with a fixing screw portion 31, which is fixedly fastened to an upper end of the antenna 10. The other end of the upper connector member 30 is formed with an upper clamp 32, which is fixed to the support pole 20. Here, the upper clamp 32 is configured so that a distance between both clamping portions 32b thereof is variable to tighten or loosen the upper clamp 32 according to screwing or unscrewing operations of nuts 32a thereof. The upper connector member 30, additionally, comprises two connecting arms 33 and 34, which are hingedly connected to each other via a joint portion 35 formed at connecting ends thereof. Between the fixing screw portion 31 and the connecting arm 33, and between the upper clamp 32 and the connecting arm 34 are interposed hinge portions 33a and 34a, respectively, so as to secure relative rotation therebetween.

[0007] The lower connector member 40 is formed at one end thereof with a fixing screw portion 41, which is fixedly fastened to the lower end of the antenna 10. The other end of the lower connector member 40 is formed with a lower clamp 42, which is fixed to the support pole 20. Similarly to the upper clamp 32, the lower clamp 42 is configured so that a distance between both clamping portions 42b thereof is variable to tighten or loosen the lower clamp 42 according to screwing or unscrewing operations of nuts 42a thereof. The fixing screw portion 41 and the lower clamp 42 are hingedly connected to each other so as to secure relative rotation therebetween.

[0008] Considering again the upper convector member 30, the connecting arm 33 is provided at one lateral surface thereof with an angle display panel 36 for indicating an inclination angle of the antenna 10. The angle display panel 36 has an adjustment slot 36a formed along a center longitudinal axis thereof, and at both sides of the adjustment slot 36a are marked calibrations 36b for indicating the inclination angle. One end of the angle display panel 36 is fixed to the joint portion 35 by means of a fixed screw 35a, which penetrates through one side of the adjustment slot 36a, and the other end of the panel 36 is fixed to the lateral surface of the connecting arm 33 by means of a movable adjustment screw 33b, which penetrates through the other side of the adjustment slot 36a.

[0009] Now, an installation procedure of the conventional antenna beam control apparatus for base transceiver station antennas configured as stated above will be explained. First, in a state wherein the nuts 32a and 42a of the upper and lower clamps 32 and 42 are unscrewed, thereby causing distances between both the clamping portions 32b and between both the clamping portions 42b to be widen, the upper and lower clamps 32 and 42 coupled with the antenna 10 are fitted around the support pole 20. Then, the antenna 10 is rotated and oriented so as to conform to a direction of electromagnetic waves corresponding to each sector, in order to adjust a directional angle thereof. After completing adjustment in the directional angle of the antenna 10, the nuts 32a and 42a are screwed to allow the antenna 10 to be fixedly maintained relative to the support pole 20.

[0010] In this state, the adjustment screws 33b and 35a are unscrewed so as to allow the antenna 10 to move according to folding or unfolding operation of the upper connector member 30, in order to adjust the inclination of the antenna 10. After the inclination of the antenna 10 is adjusted as desired, the adjustment screws 35a and 33b are screwed to fix the antenna 10. In this case, the inclination of the antenna 10 is appreciated upon reading a value of the calibration 36a of the angle display panel 36 coinciding with the movable adjustment screw 33b.

[0011] In recent years, due to topographical variation of buildings in the vicinity of base transceiver stations or degradation in sound quality in traffic congestion regions, there has been increased a necessity of steering the directivity of an antenna beam.

[0012] Further, since several base transceiver stations exist around a mobile communication system, in case of installation and management of the base transceiver stations, positions thereof are selected in consideration of electromagnetic wave interference between adjacent base transceiver stations. For this, consequently, setting conditions of all base transceiver stations have to be considered together.

[0013] Furthermore, in relation to a horizontal azimuth angle of an antenna beam, namely, a horizontal steering, when an electrical horizontal steering, which is adapted to control and steer the phase of signals to be transmitted to respective reflectors, is performed, it may cause scan loss due to inadvertent change in the direction of the antenna beam, and may increase the generation of side-lobe. Therefore, in case of horizontal steering, it is effective to mechanically rotate an antenna itself in opposite directions.

[0014] The electrical steering, in addition, essentially requires the use of an array antenna wherein reflectors are arranged in at least two rows. Such an array antenna, however, has a problem of causing reduction in a horizontal width of an antenna beam, and excessively increases the size and cost of products.

[0015] The conventional antenna beam control apparatus for base transceiver station antennas as slated above is very dangerous and troublesome since a worker has to approach an antenna structure for the installation and management of the apparatus. Therefore, it is impossible for the conventional apparatus to frequently change the directivity of an antenna beam.

[0016] Further, since the conventional antenna is configured to be coupled to the support pole by means of the clamping devices attached to the exterior thereof, it requires a large installation space and results in deterioration in the appearance thereof.

[0017] Meanwhile, in relation to a vertical down-tilting, an electrical down-tilting using a phase shifter can maintain the shape of a horizontal beam, whereas a mechanical down-tilting can control only the center region of the horizontal beam, except for peripheral region of the horizontal beam. Therefore, it can be said that the electrical down-tilting is more effective.

[0018] The documents WO 02/50950 A1 and US 5 223 845 disclose an antenna beam control apparatus according to the prior art.

Disclosure of the Invention

[0019] Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide an antenna beam control apparatus for base transceiver station antennas which can steer a horizontal azimuth angle of an antenna beam by rotating at least one antenna reflection plate about a center axis thereof.

[0020] It is a further object of the present invention to provide an antenna beam control apparatus for base transceiver station antennas which can reduce the size of products and achieve eco-friendly and aesthetic products by incorporating all components inside a radome.

[0021] It is a further object of the present invention to provide an antenna beam control apparatus for base transceiver station antennas which can enable the remote control of a horizontal azimuth angle of an antenna beam through mechanical steering.

[0022] It is a further object of the present invention to provide an antenna beam control apparatus for base transceiver station antennas which can enable the remote control of a horizontal azimuth angle of an antenna beam through mechanical steering, thereby being capable of performing horizontal steering only by using an array antenna in a single row reflector pattern, resulting in reduction in size and price of products.

[0023] It is yet another object of the present invention to provide a hybrid type antenna beam control apparatus for base transceiver station antennas which can enable not only electrical vertical down-tilting but also mechanical horizontal steering by coupling an electrically tiltable antenna to an antenna enabling the remote control of horizontal steering through mechanical operation.

[0024] In accordance with the present invention, the above and other objects can be accomplished by the provision of an antenna beam control apparatus in accordance with claim 1.

Brief Description of the Drawings

[0025] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view illustrating a conventional antenna beam control apparatus;

Fig. 2 is an exploded sectional view illustrating an antenna beam control apparatus in accordance with a first embodiment of the present invention;

Fig. 3 is a sectional view illustrating an assembled state of the antenna beam control apparatus in accordance with the first embodiment of the present invention;

Fig. 4 is a plan view of the antenna beam control apparatus shown in Fig. 3;

Fig. 5 is a plan view illustrating an alternative embodiment of the antenna beam control apparatus shown in Fig. 3, wherein three antennas are mounted;

Fig. 6 is a sectional view illustrating an antenna beam control apparatus in accordance with a second embodiment not forming part of the present invention;

Fig. 7 is a plan view of the antenna beam control apparatus shown in Fig. 6;

Fig. 8 is a detailed plan view illustrating a gear shown in Fig. 6;

Fig. 9 is a detailed plan view illustrating a clamp shown in Fig. 6;

Fig. 10 is a plan view illustrating an alternative embodiment of the antenna beam control apparatus shown in Fig. 6, wherein three antennas are mounted;

Fig. 11 is a sectional view illustrating an antenna beam control apparatus in accordance with a third embodiment not forming part of the present invention;

Fig. 12 is a plan view of the antenna beam control apparatus shown in Fig. 11;

and

Fig. 13 is a plan view illustrating a state wherein two antenna reflection plates are rotated to define an angle therebetween.

Best Mode for Carrying Out the Invention

[0026] Now, preferred embodiments of the present invention will be explained in detail with reference to the accompanying drawings.

[0027] Figs. 2 and 3 are sectional views illustrating an antenna beam control apparatus for base transceiver station antennas in accordance with a first embodiment of the present invention, and Fig. 4 is a plan view of the antenna beam control apparatus.

[0028] As shown in Figs. 2 to 4, the antenna beam control apparatus comprises: cylindrical upper and lower caps 102 and 101; a motor box 161 used as driving means, which operates by receiving a control signal, thereby providing a rotation force; a bracket 111 which is mounted at an upper surface of the lower cap 101, and internally defines upper and lower receiving spaces, in the lower receiving space being fixedly received the motor box 161; a first bearing 121 configured to be inserted into the upper receiving space of the bracket 111; a first shaft 131 which is fitted at an inner peripheral surface of the first bearing 121 and is adapted to rotate by receiving the rotation force; a second bearing 122 mounted in the upper cap 102; a second shaft 132 which is fitted at an inner peripheral surface of the second bearing 122 and is adapted to rotate by receiving the rotation force; a second gear 142 which is fitted around the first shaft 131 and is adapted to receive the rotation force from the motor box 161; an antenna reflection plate 151 fixedly connected between the first and second shafts 131 and 132, onto which all constituent components, functioning as an antenna, are mounted to transmit and receive electromagnetic waves; a driving control unit 171 adapted to control the driving of the motor box 161 by making use of external control signals; and a radome 181 connected between the upper and lower caps 102 and 101.

[0029] The motor box 161 contains a motor and a reduction gear coupled to each other, and a first gear 141 is connected to a rotating shaft protruding upward from the interior of the motor box 161. In this case, the reduction gear is separable from the motor if necessary.

[0030] As means for fixing the antenna reflection plate 151, at an upper end of the first shaft 131 and a lower end of the second shaft 132 are provided protrusions, respectively, which are centrally formed with grooves, respectively. As upper and lower ends of the antenna reflection plate 151 are fitted in the grooves of the protrusions, and then are fastened thereto by using screws, the antenna reflection plate 151 is fixed inside the apparatus.

[0031] Alternatively, although the upper and of the first shaft 131 and the lower end of the second shaft 132 are provided with protrusions, the antenna reflection plate 151 is attached to one side of the respective protrusions, and an opposite side of the protrusions is provided with a fixing member, so that the antenna reflection plate 151 is positioned between the protrusions and the fixing member. In this state, as screws are fastened therethrough, the antenna reflection plate 151 is fixed inside the apparatus.

[0032] The bracket 111 is fixed to an upper surface of the lower cap 101 by fastening screws after the motor box 161 is received therein.

[0033] The bracket 111 may be substituted for a receiving space centrally defined in the upper cap 102.

[0034] Therefore, the motor box 161 may be attached to the upper surface of the lower cap 101 or a lower surface of the upper cap 102.

[0035] The antenna reflection plate 151 is positioned so that it is centered on the first and second shafts 131 and 132. In this way, the antenna reflection plate 151 is adapted to rotate about the center axis thereof.

[0036] Now, the operation of the antenna beam control apparatus for base transceiver station antennas in accordance with the first embodiment of the present invention will be explained in detail.

[0037] If the environment of the electromagnetic waves is changed due to an increase in high-storied buildings in the vicinity of base transceiver stations, establishment of new base transceiver stations, or temporary traffic increase, the driving control unit 171 outputs a control signal, namely, a driving voltage to the motor box 161 according to external control signals for optimal cell planning, thereby controlling rotation of the antenna reflection plate 151 in opposite directions.

[0038] If the control signal from the driving control unit 171 is inputted, the motor inside the motor box 161 is driven, and thus the reduction gear is rotated, thereby causing the rotating shaft connected to the reduction gear to rotate.

[0039] According to such a rotation of the rotating shaft, the first gear 141, connected to the rotating shaft, is rotated, and consequently, the second gear 142 connected with the first gear 141 is rotated.

[0040] Through the rotation of the second gear 142, the first shaft 131 is rotated. In this case, the first bearing 121 acts to facilitate the rotation of the first shaft 131.

[0041] If the first shaft 131 is rotated, the antenna reflection plate 151 connected with the first shaft 131, as well as the second shaft 132 rotate together with the first shaft 131. In this way, the antenna reflection plate 151 is rotatable in opposite directions,

[0042] Since a center portion of the antenna reflection plate 151 is fixed to the first and second shafts 131 and 132, the antenna reflection plate 151 rotates about the center portion thereof.

[0043] As shown in Fig. 5, if three of the apparatus of the first embodiment are mounted inside the radome, the antenna beam control apparatus is usable as a three-sector antenna, and if six of the apparatus are mounted, the antenna beam control apparatus is usable as a six-sector antenna.

[0044] With such a configuration as stated above, the present invention can control a horizontal azimuth angle of all antenna beams to be reflected to respective sectors.

[0045] Fig. 6 is a sectional view illustrating an antenna beam control apparatus in accordance with a second non claimed embodiment, and Fig. 7 is a plan view of the antenna beam control apparatus shown in Fig. 6. As shown in Figs. 6 and 7, the antenna beam control apparatus of the present embodiment comprises: cylindrical upper and lower caps 202 and 201; an antenna reflection plate 251, onto which all constituent components, functioning as an antenna, are mounted to transmit and receive electromagnetic waves; a support pole 211 fixedly connected between the upper and lower caps 202 and 201; a first bearing 221 used as a rotator, which is fitted around a lower portion of the support pole 221; a first fixing member 231 for fixing the first bearing 221; a second gear 242 which is fitted around an outer peripheral surface of the first bearing 221 and adapted to rotate by receiving a rotation force; a third bearing 223 fitted to an upper end region of the support pole 211; a second bearing 222 fitted to a certain region between the third and first bearings 223 and 221; second and third fixing members 232 and 233 for fixing the second and third bearings 222 and 223, respectively; first and second clamps 291 and 292 which are fitted around outer peripheral surfaces of the second and third bearings 222 and 223, respectively, and are adapted to support the antenna reflection plate 251; a motor box 261 which is mounted at an upper surface of the lower cap 201 and used as driving means for providing the rotation force to the second gear 242; a driving control unit 271 adapted to control the driving of the motor box 261 by receiving external control signals; and a radome 281 connected between the upper and lower caps 202 and 201.

[0046] The first fixing member 231 consists of a pair of cylindrical prominent and depressed sections.

[0047] The motor box 261 contains a motor and a reduction gear coupled to each other, and a first gear 241 is connected to a rotating shaft protruding upward from the interior of the motor box 161. In this case, the reduction gear is separable from the motor if necessary.

[0048] The second gear 242 may be selected from among various kinds of gears in consideration of a gear ratio with the first gear 241. In the present embodiment, as shown in Fig. 8, the second gear 242 has a fan-shaped hole, and along an outer periphery and a center portion of the second gear 242 is formed a groove for supporting the antenna reflection plate 251. At an inner peripheral surface of the fan-shaped hole defined in the second gear 242 is formed gear teeth, thereby allowing the inner peripheral surface of the second gear 242 to engage and rotate together with an outer peripheral surface of the first gear 241.

[0049] The antenna reflection plate 251 is supported by the first and second clamps 291 and 292, and is fixed at an upper surface of the second gear 242.

[0050] As shown in Fig. 9, each of the first and second clamps 291 and 292 has three horizontal protrusions, which extend toward the antenna reflection plate 261 so as to be connected to three points placed at a rear surface of the antenna reflection plate 251.

[0051] Now, the operation of the antenna beam control apparatus for base transceiver station antennas in accordance with the second non claimed embodiment will be explained.

[0052] First, the driving control unit 271 outputs a control signal, namely, a driving voltage to the motor box 261 according to external control signals, thereby controlling rotation of the antenna reflection plate 251 in opposite directions.

[0053] If the control signal from the driving control unit 271 is inputted, the motor inside the motor box 261 is driven, and thus the reduction gear is rotated, thereby causing the rotating shaft connected to the reduction gear to rotate.

[0054] According to such a rotation of the rotating shaft, the first gear 241 connected to the rotating shaft is rotated, and consequently, the second gear 242 engaged with the first gear 241 is rotated.

[0055] Through the rotation of the second gear 242, the antenna reflection plate 251, fixed at the upper surface of the second gear 242, is rotated. In this way, the antenna reflection plate 251 is rotatable in opposite directions.

[0056] In the present embodiment, since the antenna reflection plate 251 is supported relative to the support pole 211 by means of the first and second clamps 291 and 292, and the first and second clamps 291 and 292 are fitted around the second and third bearings 222 and 223 used as rotators, the antenna reflection plate 251 is easily rotatable according to the rotation of the second gear 242.

[0057] In a state wherein to the rear surface of the antenna reflection plate 251 is connected the support pole 211 so as to support the antenna reflection plate 251, and to the support pole 211 is mounted the rotators and the clamps 291 and 292 for supporting the antenna reflection plate 251, the antenna reflection plate 251 is rotatable about the support pole 211.

[0058] As shown in Fig. 10, if three of the apparatus of the second embodiment are mounted, the antenna beam control apparatus is usable as a three-sector antenna, and if six of the apparatus are mounted, the antenna beam control apparatus is usable as a six-sector antenna.

[0059] With such a configuration as stated above, the present invention can control a horizontal azimuth angle of all antenna beams to be reflected to respective sectors.

[0060] Fig. 11 is a sectional view illustrating an antenna beam control apparatus in accordance with a third non claimed embodiment, and Fig. 12 is a plan view of the antenna beam control apparatus shown in Fig. 11. As shown in Figs. 11 and 12, the antenna beam control apparatus comprises: cylindrical upper and lower caps 302 and 301; first and second bearings 321 and 322 mounted to the lower and upper caps 301 and 302, respectively, for facilitating rotation; first and second rotating plates 311 and 312 coupled to the first and second bearings 321 and 322, respectively; a second gear 342 which is mounted to the first rotating plate 311 and is adapted to rotate by receiving a rotation force; third and fifth bearings 323 and 325 provided at an upper surface of the first rotating plate 311; fourth and sixth bearings 324 and 326 provided at a lower surface of the second rotating plate 312; first and third shafts 331 and 333 fitted at inner peripheral surfaces of the third and fifth bearings 323 and 325, respectively; second and fourth shafts 332 and 334 fitted at inner peripheral surfaces of the fourth and sixth bearings 324 and 326; a first antenna reflection plate 351 connected between the first and second shafts 331 and 332, onto which all constituent components, functioning as an antenna, are mounted to transmit and receive electromagnetic waves; a second antenna reflection plate 352 connected between the third and fourth shafts 333 and 334, onto which all constituent components, functioning as an antenna are mounted to transmit and receive electromagnetic waves; third and fourth gears 343 and 344 coupled to the first and third shafts 331 and 333, respectively; first, second and third motor boxes 361, 362 and 363 used as driving means for providing the rotation force to the second, third and fourth gears 342, 343 and 344, respectively; driving control units 371 adapted to control the driving of the first, second and third motor boxes 361, 362 and 363 by receiving external control signals; and a radome 381 connected between the upper and lower caps 302 and 301.

[0061] Now, the operation of the antenna beam control apparatus for base transceiver stations in accordance with the third non claimed embodiment will be explained.

[0062] If a control signal from the driving control unit 371 is inputted, the motor inside the first motor box 361 is driven, and thus the reduction gear is rotated, thereby causing the rotating shaft connected to the reduction gear to rotate.

[0063] According to such a rotation of the rotating shaft, the first gear 341, connected to the rotating shaft, is rotated, and consequently, the second gear 342 connected with the first gear 241 is rotated.

[0064] Such a rotation of the second gear 342 causes the rotation of the first rotating plate 311 coupled to the second gear 342.

[0065] If the first rotating plate 311 is rotated, accordingly, the second rotating plate 312 is rotated.

[0066] In this case, the first and second rotating plates 311 and 312 rotate about a center axis between the first and second antenna reflection plates 351 and 352 in a state they are aligned in a line.

[0067] Therefore, according to the rotation of the first and second rotating plates 311 and 312, the first and second antenna reflection plates 351 and 352 are rotatable in opposite directions while maintaining a constant rotating direction, thereby enabling steering of a horizontal azimuth angle of an antenna beam.

[0068] Since the first rotating plate 311 is fitted at the inner peripheral surface of the first bearing 321 used as a rotator, it is easily rotatable.

[0069] Meanwhile, consideration the operation of the present embodiment, if the control signal from the driving control unit 371 is inputted, the motor inside the second motor box 362 is driven, and consequently, the third gear 343 is rotated.

[0070] According to such a rotation of the third gear 343, the first shaft 331 is rotated, accordingly, the second shaft 332 is rotated.

[0071] Since the first and second shafts 331 and 332 are coupled with the first antenna reflection plate 351, consequently, the first antenna reflection plate 351 is rotated in opposite directions.

[0072] In the same manner, if the control signal from the driving control unit 371 is inputted, the motor inside the third motor box 363 is driven, and consequently the fourth gear 344 is rotated.

[0073] According to such a rotation of the fourth gear 344, the third shaft 333 is rotated, accordingly, the fourth shaft 334 is rotated.

[0074] Since the third and fourth shafts 333 and 334 are coupled with the second antenna reflection plate 352, consequently, the second antenna reflection plate 352 is rotated in opposite directions.

[0075] In this case, the first and second shafts 331 and 332 rotate about a center axis of the first antenna reflection plate 351, and the third and fourth shafts 333 and 334 rotate about a center axis of the second antenna reflection plate 352.

[0076] According to the present embodiment, furthermore, by tilting the first and second antenna reflection plates 351 and 352, which are originally aligned in a line, to define a certain angle therebetween, it is possible to control a horizontal beam width of an antenna beam.

[0077] According to the third non claimed embodiment as stated above, both a horizontal azimuth angle and a horizontal width of an antenna beam can be controlled.

[0078] If three of the apparatus in accordance with the third embodiment are mounted, the antenna beam control apparatus is usable as a three-sector antenna, and if six of the apparatus are mounted, the antenna beam control apparatus is usable as a six-sector antenna.

[0079] In the present embodiment, the antenna reflection plates may comprise a mechanically titable antenna reflection plate, and an electrically tiltable antenna reflection plate.

[0080] When such an electrically tiltable antenna reflection plate is additionally used, the resultant antenna can function as a hybrid-type antenna capable of electrically steering vertical down-tilting, as well as mechanically steering a horizontal azimuth angle.

[0081] Although there are various kinds of antenna housings, the present invention explains only a structure wherein a cylindrical radome is scaled by upper and lower caps. However, it should be understood that other shapes of antenna housings may be properly applied in the present invention.

[0082] It is apparent that, in the preferred embodiments of the present invention, positions of gears and motor boxes, which serve to provide a rotation force, is appropriately variable as occasion demands.

[0083] In addition, instead of the gears, timing belts may be used.

Industrial Applicability

[0084] As apparent from the above description, the present invention provides an antenna beam control apparatus for base transceiver station antennas which can enable steering of a horizontal azimuth angle of an antenna beam by allowing at least one antenna reflection plate to be mechanically rotated in opposite directions.

[0085] Further, by virtue of the fact that all constituent components are incorporated inside a radome, the size of products can be generally reduced, and it is possible to achieve eco-friendly products.

[0086] Furthermore, by aligning two antenna reflection plates in a line so that they rotate about a center axis therebetween or they rotate about their respective center axes, it is possible to control a horizontal azimuth angle of an antenna beam, and achieve beam forming of the antenna beam.

[0087] When at least one antenna reflection plate is rotatable in opposite directions through mechanical steering, and thus it forms an electrically tiltable antenna, it is possible to achieve not only vertical down-tilting but also steering of a horizontal azimuth angle by using an array antenna in a single row radiator pattern. This has an effect of reducing the size and manufacturing cost of products.

[0088] The present invention, further, enables the remote control of such a horizontal azimuth angle of the antenna beam.

Claims

1. An antenna beam control apparatus for steering a horizontal azimuth angle of base transcriver station antennas comprising:

> an antenna reflection plate (151);
> rotation means for rotating the antenna reflection plate (151) about a vertical center axis thereof, thereby enabling steering of the horizontal azimuth angle of an antenna beam;
> driving means for driving the rotation means, the driving means comprising a motor box (161);
> during control means (171) for controlling the driving means according to external control signals; and
> a radome (181) containing the antenna reflection plate and all the above means therein, the center axis of the antenna reflection plate (151) being arranged centrally in the radome (181),
> wherein the antenna, beam control apparatus comprises:
>
> > cylindrical upper and lower caps (101, 102), the radome being connected between the upper and lower caps (101, 102),
> > a bracket (111) mounted at an upper surface of the lower cap (101) and internally defining upper and lower receiving spaces, the motor box (161) being fixedly received in the lower receiving space,
> > a first bearing (121) inserted in the upper receiving space of the bracket (111),
> > a first shaft (131) fitted at an inner peripheral surface of the first bearing (121) and adapted to rotate by receiving a rotation force from the motor box,
> > a second bearing (122) mounted in the upper cap (102),
> > a second shaft (132) fitted at an inner peripheral surface of the second bearing (122) and adapted to rotate by receiving the rotation force, an upper end of the first shaft (131) and a lower end of the second shaft (132) being provided with protrusions, respectively, upper and lower ends of the antenna reflection plate (151) being fitted in the protrusions to fixedly connect the antenna reflection plate (151) between the first and second shafts (131, 132)

2. . The antenna beam control apparatus according to claim 1, wherein the protrusions are centrally formed with grooves, respectively, the upper and lower ends of the antenna reflection plate (151) being fitted in the grooves of the protrusions.

3. . The antenna beam control apparatus according to claim 1, wherein the antenna reflection plate (151) is attached to one side of the respective protrusions, an opposite side of the respective protrusions being provided with a fixing member, the antenna reflection plate (151) being positioned between the protrusions a.nd the fixing member.

4. . The antenna beam control apparatus according to any of the preceding claims, comprising a first gear (141) connected to a rotating shaft protruding upward from an interior of the motor box (161) and a second gear (142) fitted around the first shaft (131) and adapted to receive the rotation force from the motor, the reduction gear being superable from the motor if necessary.

Patentansprüche

1. Antennenstrahlsteuervorrichtung zum Lenken eines horizontalen Azimut-Winkels für Basis-Sender/Empfänger-Stationsantennen, umfassend:

eine Antennenreflektionsplatte (151);
Drehmittel zum Drehen der Antennenreflektionsplatte (151) um eine vertikale Mittelachse davon, wodurch eine Lenkung des horizontalen Azimut-Winkels eines Antennenstrahls ermöglicht wird;
Antriebsmittel zum Antreiben des Drehmittels, wobei das Antriebsmittel einen Motorkasten (161) umfasst;
Antriebssteuermittel (171) zum Steuern des Antriebsmittels gemäß externen Steuersignalen; und
ein Radom (181), welches die Antennenreflektionsplatte und alle der obigen Mittel darin enthält, wobei die Mittelachse der Antennenreflektionsplatte (151) mittig in dem Radom (181) angeordnet ist,
wobei die Antennenstrahlsteuervorrichtung umfasst:

eine zylindrische obere und untere Kappe (101, 102), wobei das Radom zwischen der oberen und unteren Kappe (101, 102) angeordnet und damit verbunden ist,
eine Halterung (111), welche an einer oberen Fläche der unteren Kappe (101) angebracht ist und intern einen oberen und unteren Aufnahmeraum definiert, wobei der Motorkasten (161) fest in dem unteren Aufnahmeraum aufgenommen ist,
ein erstes Lager (121), welches in dem oberen Aufnahmeraum der Halterung (111) eingesetzt ist,
eine erste Welle (131), welche in eine Innenumfangsfläche des ersten Lagers (121) eingepasst ist und ausgestaltet ist, sich durch Aufnehmen einer Drehkraft von dem Motorkasten zu drehen,
ein zweites Lager (122), welches in der oberen Kappe (102) befestigt ist,
eine zweite Welle (132), welche in eine Innenumfangsflä-che des zweiten Lagers (122) eingepasst ist und ausgestaltet ist, sich durch Aufnehmen der Drehkraft zu drehen, wobei ein oberes Ende der ersten Welle (131) und ein unteres Ende der zweiten Welle (132) jeweils mit Vorsprüngen versehen sind, wobei ein oberes und unteres Ende der Antennenreflektionsplatte (151) in die Vorsprünge eingepasst ist, um die Anten-nenreflektionsplatte (151) zwischen der ersten und zweiten Welle (131, 132) anzuordnen und fest damit zu verbinden.

2. Antennenstrahlsteuervorrichtung nach Anspruch 1, wobei die Vorsprünge jeweils mittig mit Nuten ausgebildet sind, wobei das obere und untere Ende der Antennenreflektionsplatte (151) in die Nuten der Vorsprünge eingepasst sind.

3. Antennenstrahlsteuervorrichtung nach Anspruch 1, wobei die Antennenreflektionsplatte (151) an einer Seite der jeweiligen Vorsprünge angebracht ist, wobei eine gegenüberliegende Seite der jeweiligen Vorsprünge mit einem Befestigungselement versehen ist, wobei die Antennenreflektionsplatte (151) zwischen den Vorsprüngen und dem Befestigungselement angeordnet ist.

4. Antennenstrahlsteuervorrichtung nach einem der vorhergehenden Ansprüche, umfassend ein erstes Zahnrad (141), welches mit einer Drehwelle verbunden ist, welche nach oben von einem Inneren des Motorkastens (161) hervorragt, und ein zweites Zahnrad (142), welches um die erste Welle (131) angebracht ist und ausgestaltet ist, die Drehkraft von dem Motor aufzunehmen, wobei das Untersetzungsgetriebe von dem Motor falls erforderlich trennbar ist.

Revendications

1. Appareil de commande de faisceau d'antenne pour orienter un angle d'azimut horizontal d'antennes de station émettrice-réceptrice de base comprenant :

une plaque de réflexion d'antenne (151) ;
des moyens de rotation pour faire tourner la plaque de réflexion d'antenne (151) autour d'un axe

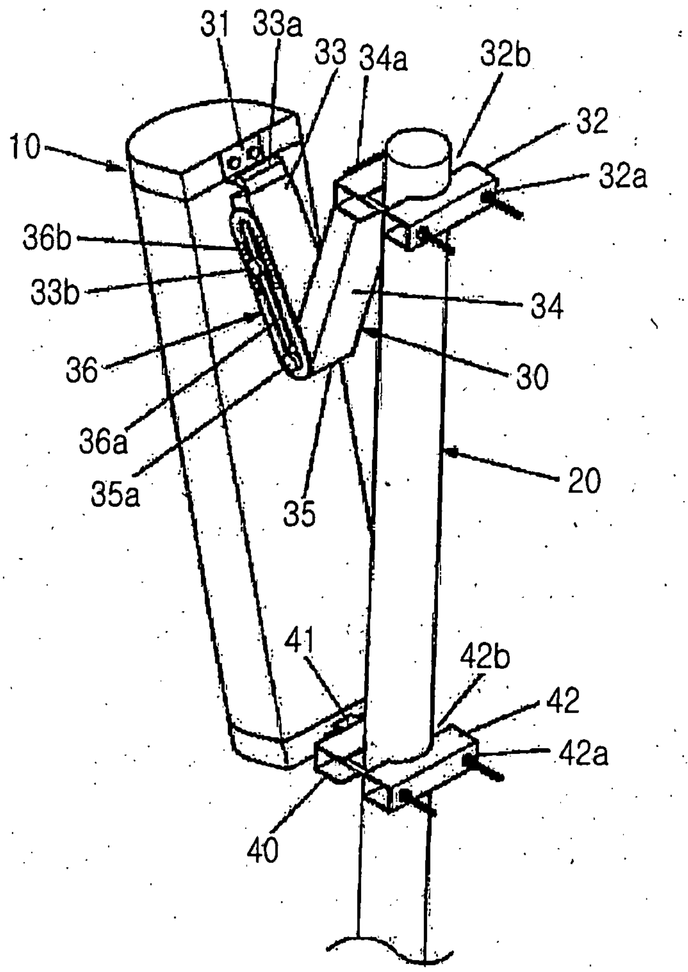
central vertical de celle-ci, permettant de ce fait l'orientation de l'angle d'azimut horizontal d'un faisceau d'antenne ;
des moyens d'entraînement pour entraîner les moyens de rotation, les moyens d'entraînement comprenant un bloc moteur (161) ;
des moyens de commande d'entraînement (171) pour commander les moyens d'entraînement conformément à des signaux de commande externes ; et
un radôme (181) contenant la plaque de réflexion d'antenne et tous les moyens ci-dessus dans celui-ci, l'axe central de la plaque de réflexion d'antenne (151) étant agencé au centre dans le radôme (181),
dans lequel l'appareil de commande de faisceau d'antenne comprend :

des capots supérieur et inférieur (101, 102) cylindriques, le radôme étant relié entre les capots supérieur et inférieur (101, 102),
un support (111) monté sur une surface supérieure du capot inférieur (101) et définissant intérieurement des espaces de réception supérieur et inférieur, le bloc moteur (161) étant reçu de manière fixe dans l'espace de réception inférieur,
un premier palier (121) inséré dans l'espace de réception supérieur du support (111),
un premier arbre (131) monté au niveau d'une surface périphérique intérieure du premier palier (121) et conçu pour tourner en recevant une force de rotation du bloc moteur,
un deuxième palier (122) monté dans le capot supérieur (102),
un deuxième arbre (132) monté au niveau d'une surface périphérique intérieure du deuxième palier (122) et conçu pour tourner en recevant la force de rotation, une extrémité supérieure du premier arbre (131) et une extrémité inférieure du deuxième arbre (132) étant pourvues de protubérances, respectivement, les extrémités supérieure et inférieure de la plaque de réflexion d'antenne (151) étant insérées dans les protubérances de manière à relier de manière fixe la plaque de réflexion d'antenne (151) entre les premier et deuxième arbres (131, 132).

2. Appareil de commande de faisceau d'antenne selon la revendication 1, dans lequel les protubérances comportent au centre des rainures, respectivement, les extrémités supérieure et inférieure de la plaque de réflexion d'antenne (151) étant insérées dans les rainures des protubérances.

3. Appareil de commande de faisceau d'antenne selon la revendication 1, dans lequel la plaque de réflexion d'antenne (151) est fixée à un côté des protubérances respectives, un côté opposé des protubérances respectives étant pourvu d'un élément de fixation, la plaque de réflexion d'antenne (151) étant positionnée entre les protubérances et l'élément de fixation.

4. Appareil de commande de faisceau d'antenne selon l'une quelconque des revendications précédentes, comprenant un premier pignon (141) relié à un arbre rotatif faisant saillie vers le haut d'un intérieur du bloc moteur (161) et un deuxième pignon (142) monté autour du premier arbre (131) et conçu pour recevoir la force de rotation du moteur, l'engrenage de réduction pouvant être séparé du moteur, si nécessaire.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33a
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32b
32
32a
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36a
35a
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42b
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42a
40

FIG.1

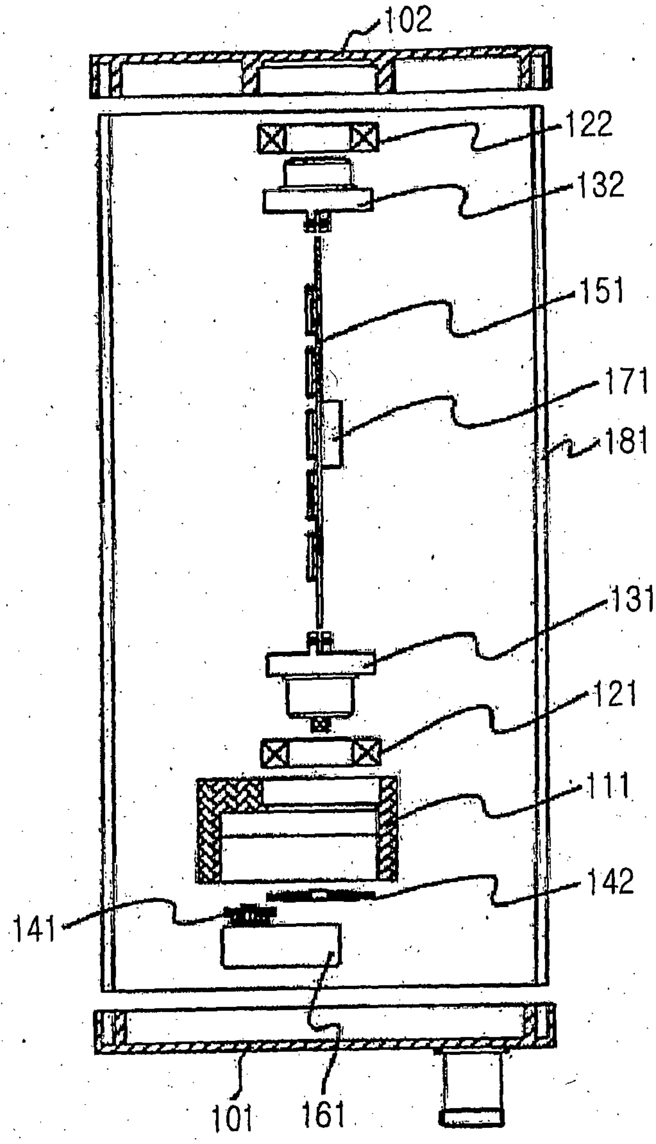
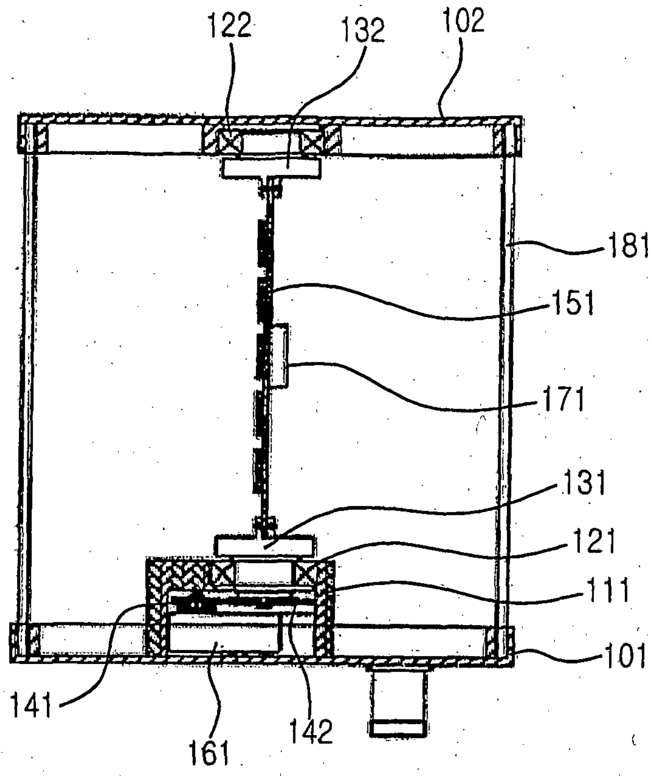


FIG.2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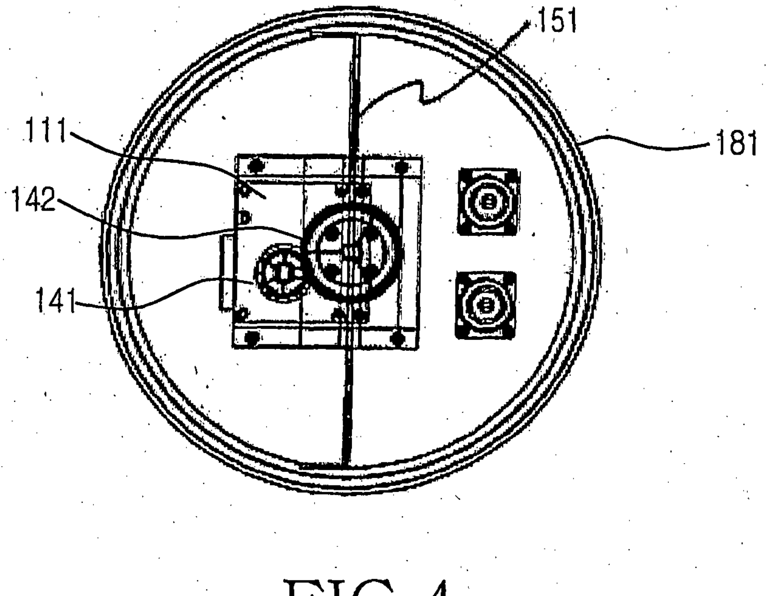
141
161
142

FIG.3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181
142
141

FIG.4

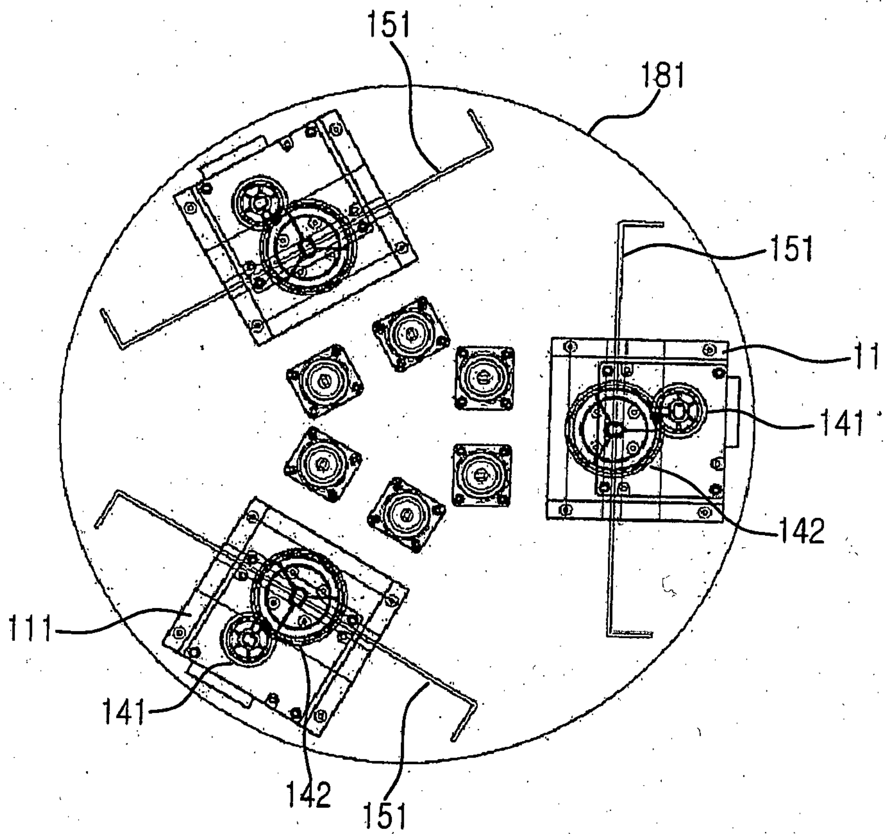

FIG.5

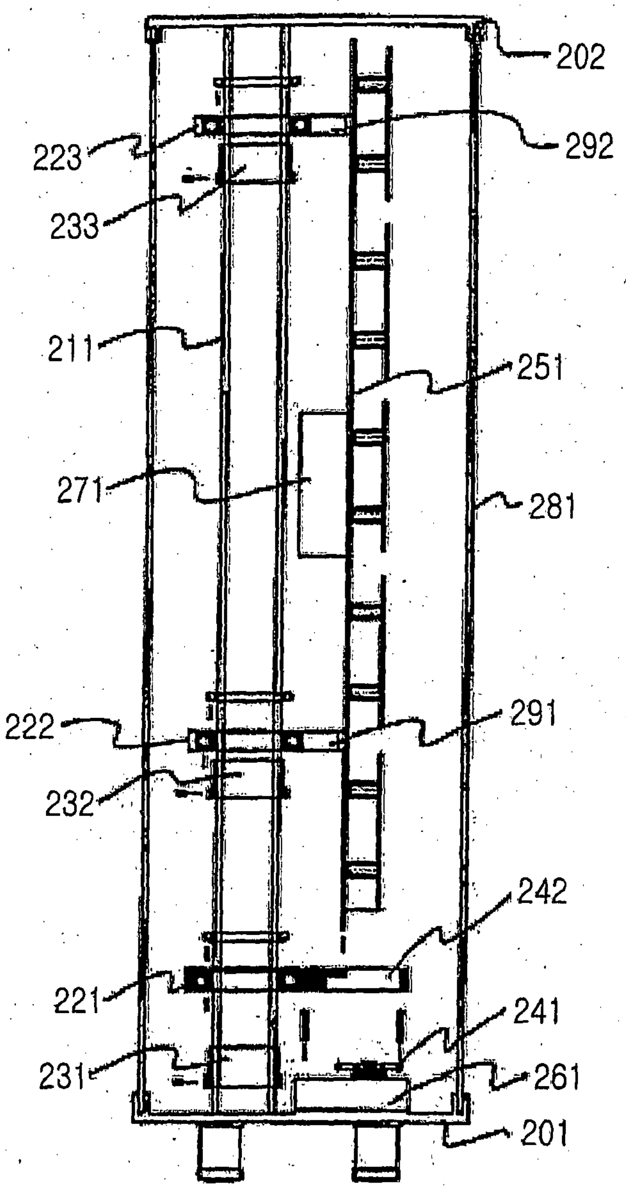
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FIG.6

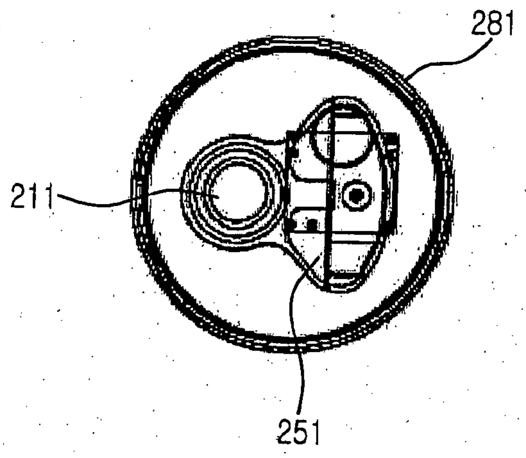

FIG.7

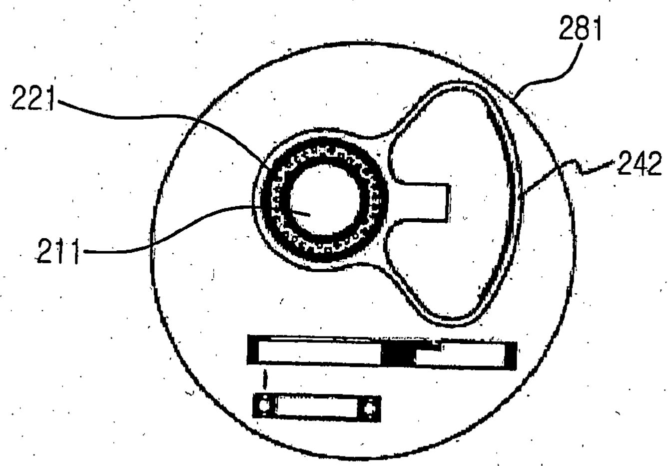

FIG.8

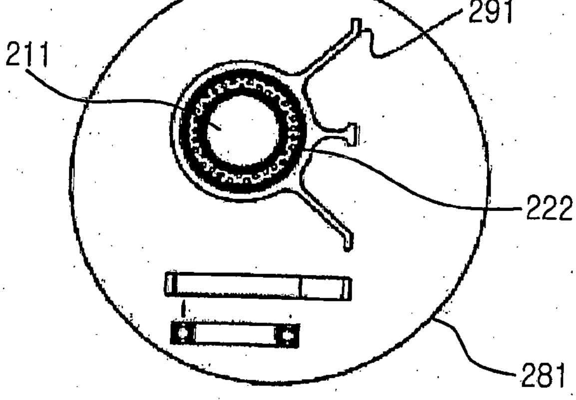

FIG.9

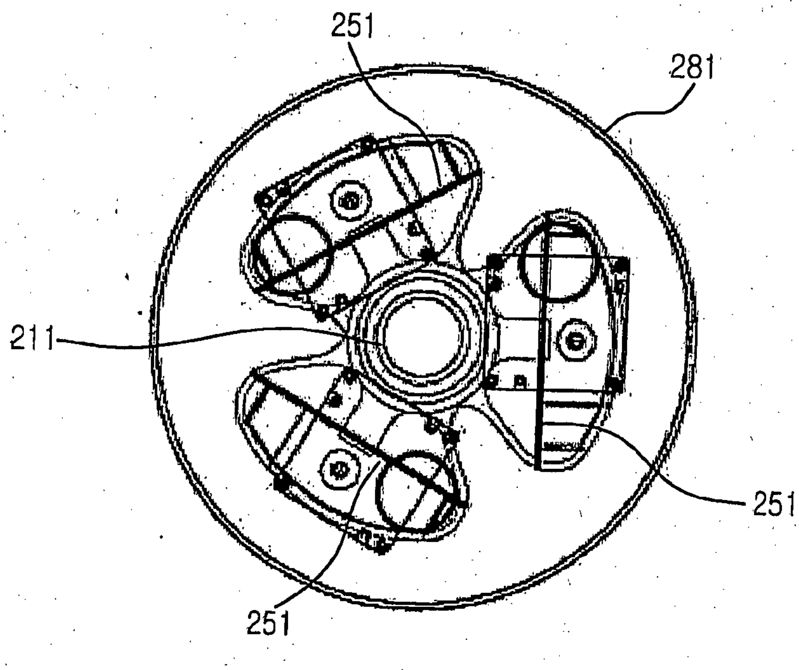

FIG.10

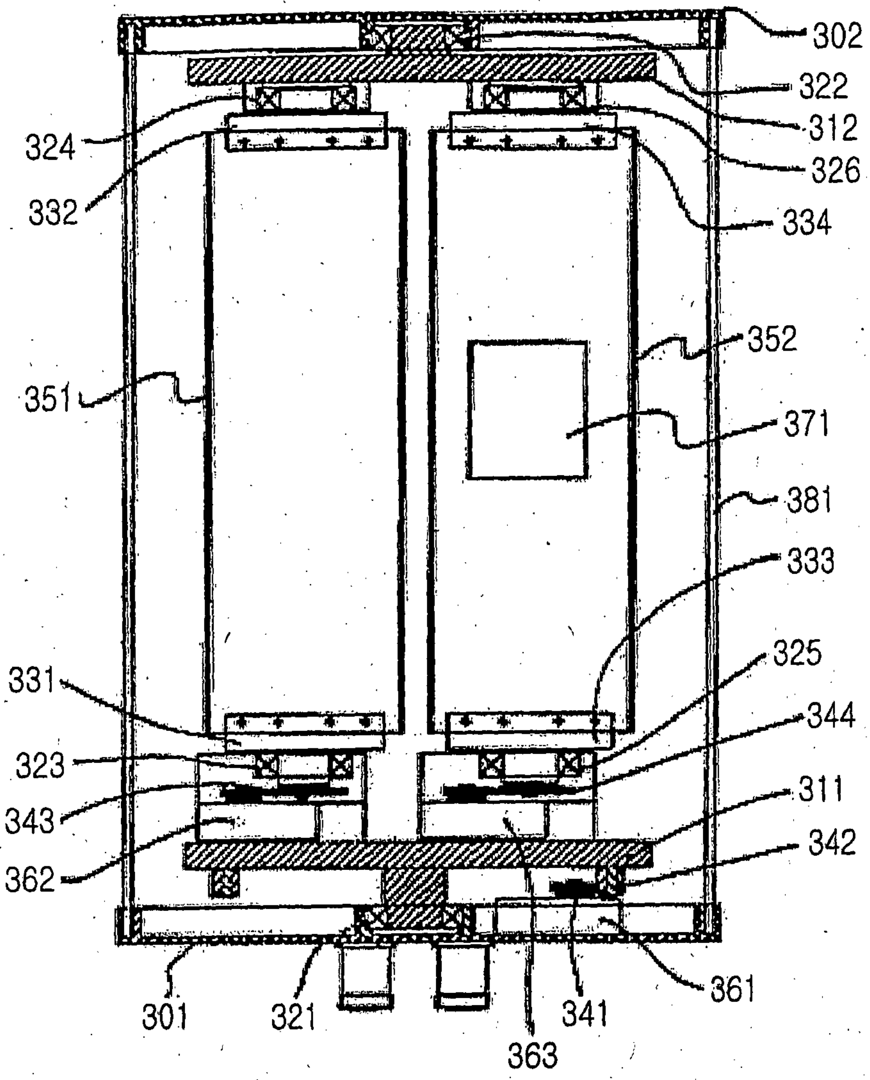
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FIG.11

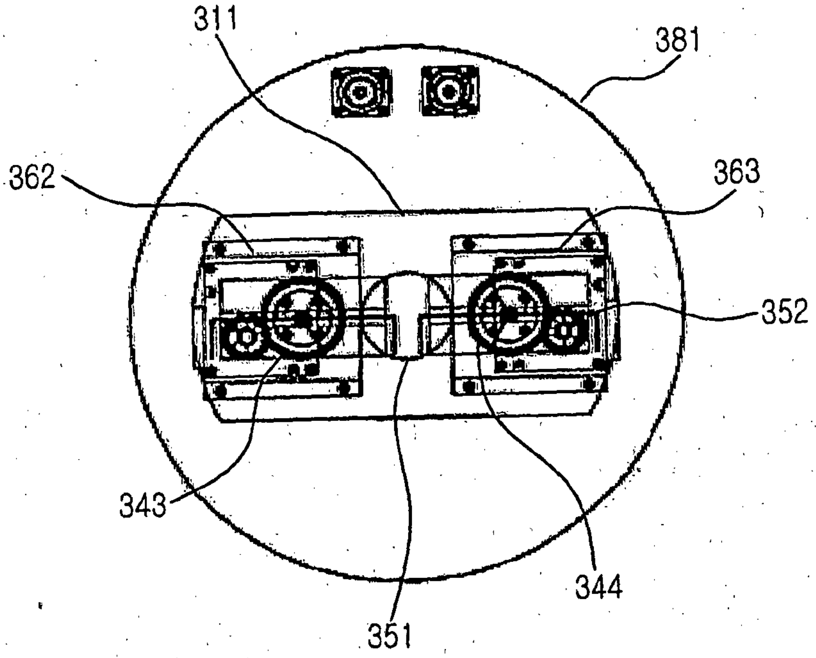

FIG.12

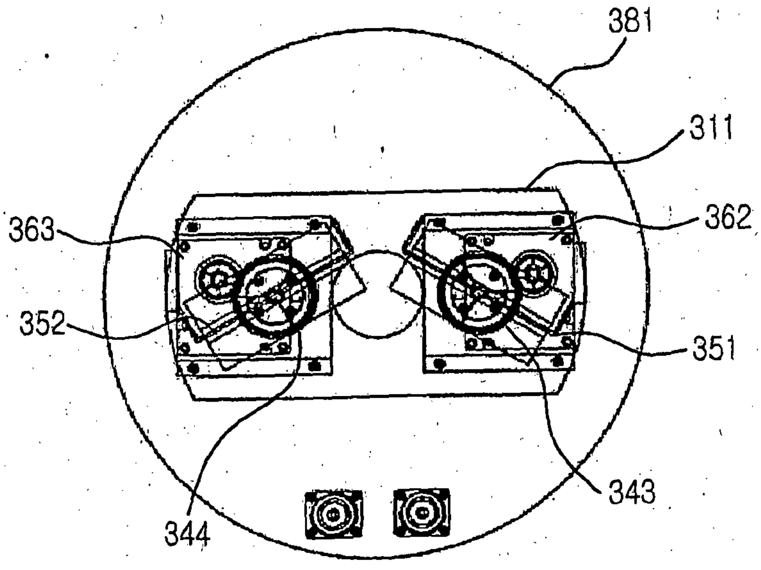

FIG.13

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0250950 A1 **[0018]**
- US 5223845 A **[0018]**