



(11)

EP 4 503 333 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
05.02.2025 Bulletin 2025/06

(21) Application number: **23773585.7**

(22) Date of filing: **03.03.2023**

(51) International Patent Classification (IPC):
H01Q 3/32 ^(2006.01) **H01Q 3/34** ^(2006.01)
H01Q 1/12 ^(2006.01) **H01Q 1/20** ^(2006.01)
H01Q 1/24 ^(2006.01)

(86) International application number:
PCT/CN2023/079430

(87) International publication number:
WO 2023/179334 (28.09.2023 Gazette 2023/39)

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **24.03.2022 CN 202210296874**

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(54) **ELECTRIC DOWNTILT ANGLE ADJUSTMENT APPARATUS AND BASE STATION ANTENNA**

(57) The present invention relates to an electric downtilt angle adjustment apparatus and a base station antenna. The apparatus comprises a position selection transmission assembly and a phase shift assembly. The position selection transmission assembly comprises a support frame, a moving switching mechanism, a transmission gear, and a second guide shaft. The second guide shaft is mounted on the support frame, and multiple transmission intermediate wheels are mounted on the second guide shaft at intervals, the transmission gear being configured to drive the transmission intermediate wheels to rotate. The moving switching mechanism is mounted on the support frame. A driving member is disposed on the moving switching mechanism. The phase shift assembly comprises multiple driven members. The apparatus has the advantages of having a simple structure, being convenient to manufacture, low in cost, and light weight, having a small size, and having reliable quality.

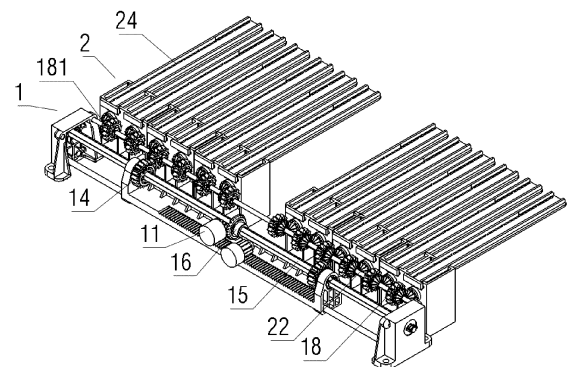


FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to the technical field of antennas, in particular to an electric downtilt angle adjustment apparatus and a base station antenna.

BACKGROUND

[0002] When the base station antenna is working, it usually needs to tilt downward at a certain angle relative to the horizontal line, and the size of this tilt angle can change the radiation range of the antenna. At present, the antenna downtilt is mainly adjusted by mechanical downtilt and electric downtilt. The electric downtilt can be controlled by remote electric adjustment, which has low cost, so it has been widely used.

[0003] With the increasing number of mobile communication terminal users, it is often required that the same antenna needs more communication bands, and the electrical downtilt angle of each communication band needs to be controlled independently, and the electrical downtilt angle can be changed by driving its corresponding phase shifter transmission mechanism. In the traditional transmission device, a driving motor is usually used to correspond to a phase shifter transmission mechanism. Because of the large number of control circuits and motors, this method is bound to cause problems such as high cost, complex structure, large space occupation and low reliability.

SUMMARY

[0004] The object of the present invention is to provide an antenna electrical downtilt angle adjustment apparatus which has a simple structure, is easy to manufacture, has a low cost, a light weight, a small size and a reliable quality, that is, a base station antenna using the antenna electrical downtilt angle adjustment apparatus.

[0005] In order to achieve the purpose of the present invention, the following technical solution is adopted:

A first aspect of the present invention provides an electric downtilt angle adjustment apparatus, which includes a position selection transmission assembly and a phase shift assembly, wherein the position selection transmission assembly comprises a support frame, a moving switching mechanism, a transmission gear and a second guide shaft; the support frame is provided with a second guide shaft, a plurality of transmission intermediate wheels are installed on the second guide shaft at intervals; the transmission gear is used for driving the transmission intermediate wheels to rotate, and a moving switching mechanism is installed on the support frame, and the moving switching mechanism is used for driving the transmission gear to move and switch

among the transmission intermediate wheels; the moving switching mechanism is provided with a driving member, and the driving member is used for driving the transmission gear to rotate;

The phase shift assembly comprises a plurality of driven members, the plurality of transmission intermediate wheels are respectively in one-to-one transmission connection with the driven members, and the driven members are respectively connected with the corresponding phase shifters to realize the adjustment of tilt angles of the phase shifters.

[0006] A further improvement is that the moving switching mechanism comprises a transmission shaft and a position selection rack, wherein both ends of the position selection rack are respectively provided with position selection fixing holes, and the position selection fixing holes at both ends are respectively provided with transmission gears; the transmission shaft passes through the position selection fixing holes and the holes of the transmission gears, and both ends are respectively connected with the support frame; and the position selection rack is provided with a position selection input gear, and the rotation of the position selection input gear is capable of driving the position selection rack and the transmission gear to slide along an axial direction of the transmission shaft.

[0007] A further improvement is that a circular shaft elastic arm is arranged on the transmission gear, and the circular shaft elastic arm is capable of rotating in the position selection fixing hole of the position selection rack; and an end part of the transmission gear is provided with a reverse buckle buckled on the position selection fixing hole.

[0008] A further improvement is that the driving member comprises a transmission input bevel gear and a first bevel gear; the first bevel gear is sleeved on the transmission shaft, the rotation of the first bevel gear is capable of driving the transmission shaft and the transmission gear to rotate synchronously, and the rotation of the transmission input bevel gear is capable of driving the first bevel gear to rotate.

[0009] A further improvement is that the second guide shaft is provided with a plurality of clamp grooves, and a backstop surface of the transmission intermediate wheel is provided with a clamp ring; after passing through the holes of the transmission intermediate wheels one by one, the second guide shaft is buckled in the corresponding clamp groove on the second guide shaft by the clamp ring.

[0010] A further improvement is that the phase shift assembly comprises a fixed seat located at one side of the position selection transmission assembly; the driven member comprises an internal thread strip and an external thread column, wherein the internal thread strip is installed in a guide groove of the fixed seat, and the external thread column is placed below the internal thread strip; the rotation of the transmission intermediate

wheel is capable of driving the external thread column to rotate, and the rotation of the external thread column is capable of driving the internal thread strip to slide in the guide groove.

[0011] A further improvement is that the driven member further comprises a third bevel gear, a second bevel gear is arranged on the transmission intermediate wheel, and the second bevel gear is meshed with the corresponding third bevel gear; the third bevel gear sequentially passes through a first circular hole of the fixed seat, a through hole of the external thread column and a second circular hole of the fixed seat; the third bevel gear is in transmission connection with the external thread column, and the third bevel gear is capable of rotating in the first circular hole and the second circular hole of the fixed seat.

[0012] A further improvement is that a damping ring is arranged between the third bevel gear and the first circular hole of the fixed seat.

[0013] A further improvement is that a rear part of the third bevel gear is provided with an elastic buckle, and the elastic buckle is buckled on an end face of the second circular hole of the fixed seat to prevent the third bevel gear from coming loose from the fixed seat.

[0014] A second aspect of the present invention provides a base station antenna, including the electric downtilt angle adjustment apparatus according to the first aspect.

[0015] The present invention has the following beneficial effects:

In the present invention, since the transmission shaft passes through the holes of the transmission gear and the first bevel gear respectively, and the transmission shaft is connected with the holes of the first bevel gear and the transmission gear in a spline way, the rotation of the transmission input bevel gear is capable of driving the rotation of the first bevel gear, thereby driving the synchronous rotation of the transmission shaft and the transmission gear. The rotation of the transmission gear is capable of driving the rotation of a certain transmission intermediate wheel meshed with it. Because the second bevel gear of the transmission intermediate wheel is meshed with the third bevel gear, and under the action of the clamp ring, the transmission intermediate wheel has been fixed along the axial direction of the second guide shaft and can only rotate along the axial center of the second guide shaft, while the rotation of the transmission intermediate wheel is capable of driving the rotation of the third bevel gear, thus driving the internal thread strip to move back and forth in the guide groove, and the end of the internal thread strip can be connected with the corresponding phase shifter, thus realizing the adjustment of the tilt angle of the phase shifter.

[0016] The electric downtilt angle adjustment apparatus provided by the present invention has the advantages of simple structure, convenient manufacture, low cost, light weight, small size and reliable quality.

[0017] According to the present invention, an lock hook

is arranged on the support frame, the two ends of the transmission shaft are provided with circular grooves, and the lock hook of the support frame is clamped in the circular grooves of the transmission shaft, so that the support frame can be prevented from falling off; the position selection transmission assembly is integrated, which is convenient for the turnover and installation of the position selection transmission assembly as a module on the production line.

[0018] According to the present invention, a damping ring is added between the third bevel gear and the first circular hole of the fixed seat, so that the internal thread strip can be prevented from sliding back and forth when the third bevel gear is in a non-working state, such as jitter in the product transportation process; and by arranging the elastic buckle, the elastic buckle is buckled on the end face of the second circular hole of the fixed seat, so that the third bevel gear can be prevented from loosening from the fixed seat, so that the phase shift assembly is integrated, and the turnover and installation of the phase shift assembly as a module on the production line are facilitated.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

FIG. 1 is a first structural schematic diagram of an electric downtilt angle adjustment apparatus according to an embodiment of the present invention;

FIG. 2 is an explosion schematic diagram of a position selection transmission assembly of the electric downtilt angle adjustment apparatus according to an embodiment of the present invention;

FIG. 3 is a schematic diagram of the assembly explosion of the transmission intermediate wheel of the electric downtilt angle adjustment apparatus according to the embodiment of the present invention;

FIG. 4 is a schematic structural diagram of a position selection transmission assembly of the electric downtilt angle adjustment apparatus according to an embodiment of the present invention;

FIG. 5 is an explosion schematic diagram of a phase shift assembly of the electric downtilt angle adjustment apparatus according to an embodiment of the present invention;

FIG. 6 is a sectional view of a phase shift assembly of the electric downtilt angle adjustment apparatus according to an embodiment of the present invention;

FIG. 7 is a second structural schematic diagram of the electric downtilt angle adjustment apparatus according to an embodiment of the present invention.

[0020] Description of reference numerals:

[0021] 1. Position selection transmission assembly; 2. Phase shift assemblies; 10. Position selection input gear; 11. Transmission input bevel gear; 12. Support frame; 13. Position selection rack; 14. Transmission gear; 141,

Circular shaft elastic arm; 142. Reverse buckle; 15. Transmission shaft; 16. First bevel gear; 17. First guide shaft; 18. Transmission intermediate wheel; 181, Second bevel gear; 182, Backstop surface; 19. Second guide shaft; 191, clamp groove; 20, clamp ring; 21. Fixed seat; 211. The first circular hole; 212, the second circular hole; 22. The third bevel gear; 221, snap; 23. External thread column; 24, internal thread; 25. Damping ring.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0022] In order to make the object, technical solution and advantages of the present invention more clear, the present invention will be further explained in detail with the attached drawings and specific embodiments. It should be understood that the specific embodiments described here are only for explaining the present invention, and do not limit the protection scope of the present invention.

[0023] It should be noted that when an element is referred to as "fixed to", "disposed on", "fixedly provided on" or "installed on" another element, it can be directly on another element or there can be an intervening element. When an element is considered to be "connected" to another element, it may be directly connected to another element or intervening elements may exist at the same time. Further, when an element is considered as "in transmission connection" with another element, it is only necessary that the two elements can realize power transmission, and the specific implementation method can be realized by using the prior art, which will not be repeated here. When an element and another element are perpendicular or nearly perpendicular to each other, it means that their ideal state is vertical, but due to the influence of manufacturing and assembly, there may be some vertical errors. The terms "vertical", "horizontal", "left" and "right" and similar expressions used herein are for illustration purposes only, and do not represent the only embodiment.

[0024] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by those skilled in the technical field of the present invention. The terminology used in the description of the present invention herein is only for the purpose of describing specific embodiments, and is not intended to limit the present invention. As used herein, the term "and/or" includes any and all combinations of one or more related listed items.

[0025] The terms "first" and "second" in the present invention do not represent the specific number and order, but are only used to distinguish names.

[0026] Hereinafter, an embodiment of the present invention will be described in detail with reference to FIGS 1- 7:

[0027] An embodiment of the first aspect of the present invention provides an electric downtilt angle adjustment apparatus. Referring to FIG. 1, the application solution of the present invention consists of the following compo-

nents:

The electric downtilt angle adjustment apparatus includes a position selection transmission assembly 1 and a phase shift assembly 2, wherein the position selection transmission assembly 1 can select the position for any transmission in the phase shift assembly 2, and the phase shift assembly 2 is capable of driving a corresponding phase shifter (not shown) to adjust the tilt angle; the position selection transmission assembly 1 includes a support frame 12, a moving switching mechanism, a transmission gear 14 and a second guide shaft 19; a second guide shaft 19 is mounted on the support frame 12, and a plurality of transmission intermediate wheels 18 are mounted on the second guide shaft 19 at intervals; the transmission gear 14 is used to drive the transmission intermediate wheels 18 to rotate, and a moving switching mechanism is mounted on the support frame 12, which is used to drive the transmission gear 14 to move and switch among the transmission intermediate wheels 18; the moving switching mechanism is provided with a driving member for driving the transmission gear 14 to rotate;

The phase shift assembly 2 includes a plurality of driven members, a plurality of transmission intermediate wheels 18 are respectively in transmission connection with a plurality of driven members in one-to-one correspondence, and a plurality of driven members are respectively connected with corresponding phase shifters for adjusting the tilt angle of the phase shifters.

[0028] The moving switching mechanism includes a transmission shaft 15 and a position selection rack 13, wherein both ends of the position selection rack 13 are respectively provided with positioning fixing holes 131, and the positioning fixing holes 131 at both ends are respectively provided with transmission gears 14; the transmission shaft 15 passes through the positioning fixing holes 131 and the holes of the transmission gear 14, and both ends are respectively connected with the support frame 12; and the position selection rack 13 is provided with a positioning input gear 10, and the rotation of the positioning input gear 10 is capable of driving the position selection rack 13 and the transmission gear 14 to slide along the axial direction of the transmission shaft 15.

[0029] The driving member includes a transmission input bevel gear 11 and a first bevel gear 16, and the first bevel gear 16 is sleeved on the transmission shaft 15. The rotation of the first bevel gear 16 is capable of driving the transmission shaft 15 and the transmission gear 14 to rotate synchronously, and the rotation of the transmission input bevel gear 11 is capable of driving the first bevel gear 16 to rotate.

[0030] Specifically, referring to FIG. 2, the transmission gear 14 is symmetrically installed on the position selec-

tion fixing holes 131 at both ends of the position selection rack 13. The transmission gear 14 is provided with a circular shaft elastic arm 141, which is capable of rotating in the position selection fixing hole 131 of the position selection rack 13, and the end of the transmission gear 14 is provided with a reverse buckle 142, which can be buckled on the position selection fixing hole 131.

[0031] Further, the transmission shaft 15 passes through the holes of the transmission gear 14, the first bevel gear 16 and another transmission gear 14 respectively, and the transmission shaft 15 can be matched with the transmission gear 14 and the first bevel gear 16 by a spline structure, therefore the rotation of the first bevel gear 16 is capable of driving the transmission shaft 15 and the transmission gear 14 to rotate synchronously.

[0032] Further, the support frame 12 is also provided with a first guide shaft 17, which passes through both ends of the position selection rack 13, and the position selection rack 13 is capable of driving the transmission gear 14 buckled on the fixing hole 131 to slide freely along the axial direction of the transmission shaft 15 (or the first guide shaft 17) as a whole, so that the sliding of the position selection rack 13 is more stable under the joint action of the first guide shaft 17 and the transmission shaft 15.

[0033] Referring to FIG. 3, the second guide shaft 19 is provided with a plurality of clamp grooves 191, and the backstop surface 182 of the transmission intermediate wheel 18 is provided with a clamp ring 20. After the second guide shaft 19 passes through the holes of the transmission intermediate wheels 18 one by one, the second guide shaft 19 is correspondingly buckled in the corresponding clamp groove 191 with the clamp ring 20, so that the transmission intermediate wheels 18 are evenly and symmetrically distributed on both sides of the second guide shaft 19. The transmission intermediate wheel 18 can freely rotate along the axis of the first guide shaft 17, and the clamp ring 20 is placed on the backstop surface 182 of the transmission intermediate wheel 18 to prevent the transmission intermediate wheel 18 from sliding to the other side along the axis direction of the second guide shaft 19. Further, the installation position and number of the clamp ring 20 and the transmission intermediate wheel 18 can be adjusted according to the requirements of antenna implementation, and the embodiment of the present invention adopts 12 paths for explanation.

[0034] Referring to FIG. 4, the support frame 12 is installed at both ends of the first guide shaft 17, the second guide shaft 19 and the transmission shaft 15, and plays a role in supporting and positioning the first guide shaft 17, the second guide shaft 19 and the transmission shaft 15.

[0035] Further, the transmission shaft 15 can freely rotate in the fixing holes at both ends of the support frame 12, and the support frame 12 is provided with lock hooks 121, and both ends of the transmission shaft 15 are provided with circular grooves 151, and the lock hooks

121 of the support frame 12 are clamped in the circular grooves 151 of the transmission shaft 15, so that the support frame 12 can be prevented from falling off, and the position selection transmission assembly 1 is integrated, which is convenient for the rotation and installation of the position selection transmission assembly 1 as a module on the production line.

[0036] Further, the rotation of the position selection input gear 10 is capable of driving the position selection rack 13 to slide along the axial direction of the transmission shaft 15 (or the first guide shaft 17), and the sliding of the position selection rack 13 is capable of driving the transmission gear 14 buckled on the position selection fixing hole 131 to move correspondingly. During the sliding process of the position selection rack 13, the transmission gear 14 can be sequentially meshed with the transmission intermediate wheels 18 fixed on the second guide shaft 19, thus completing the position selection of the transmission intermediate wheels 18 at different positions.

[0037] Further, the number of transmission gears 14 can be designed as one or several (the number of transmission gears 14 in this example is two) according to the efficiency requirement of gear shifting. When one of the transmission gears 14 is meshed with any transmission intermediate wheel 18, the transmission gears 14 in other positions need to be completely separated from the transmission intermediate wheel 18.

[0038] Referring to FIG. 5 and FIG. 6, the phase shift assembly 2 includes a fixed seat 21 located at one side of the position selection transmission assembly 1, and the driven member includes an internal thread strip 24 and an external thread column 23. The internal thread strip 24 is installed in a guide groove of the fixed seat 21, and the internal thread strip 24 can freely slide in the guide groove, and the external thread column 23 is placed below the internal thread strip 24. Besides the thread transmission mode shown in this example, other transmission modes such as worm gear and screw can be adopted between the external thread column 23 and the internal thread strip 24. The rotation of the transmission intermediate wheel 18 is capable of driving the external thread column 23 to rotate, and the rotation of the external thread column 23 is capable of driving the internal thread strip 24 to slide in the guide groove.

[0039] Further, the driven member also includes a third bevel gear 22, and a second bevel gear 181 is arranged on the transmission intermediate wheel 18; the second bevel gear 181 is meshed with the corresponding third bevel gear 22, and a damping ring 25 is arranged between the third bevel gear 22 and the first circular hole 211 of the fixed seat 21. The third bevel gear 22 passes through the damping ring 25, the first circular hole 211 of the fixed seat 21, the through hole of the external thread column 23 and the second circular hole 212 of the fixed seat 21 in turn, and the third bevel gear 22 is in a drivable connection with the external thread column 23. Specifically, the drivable connection between the third bevel

gear 22 and the external thread column 23 can be realized by cooperation of a spline structural. The third bevel gear 22 can freely rotate in the first circular hole 211 and the second circular hole 212 of the fixed seat 21. The rotation of the third bevel gear 22 is capable of driving the external thread column 23 to rotate together, and the rotation of the external thread column 23 is capable of driving the internal thread strip 24 to move back and forth in the guide groove of the fixed seat 21.

[0040] In this embodiment, the damping ring 25 is added between the third bevel gear 22 and the first circular hole 211 of the fixed seat 21, so that the internal thread strip 24 can be prevented from sliding back and forth when the third bevel gear 22 is in a non-working state, such as jitter during product transportation.

[0041] Preferably, the rear part of the third bevel gear 22 can also be designed with an elastic buckle 221, which is buckled on the end face of the second circular hole 212 of the fixed seat 21 to prevent the third bevel gear 22 from loosening from the fixed seat 21, so that the phase shift assembly 2 can be integrated, which is convenient for the turnover and installation of the phase shift assembly 2 as a module on the production line.

[0042] The working principle of the present invention is that the transmission shaft 15 passes through the holes of the transmission gear 14 and the first bevel gear 16 respectively, and the transmission shaft 15 is splined with the holes of the first bevel gear 16 and the transmission gear 14, so that the rotation of the transmission input bevel gear 11 drives the rotation of the first bevel gear 16, thereby driving the synchronous rotation of the transmission shaft 15 and the transmission gear 14. The rotation of the transmission gear 14 drives the rotation of a certain transmission intermediate wheel 18 engaged with it. Further, because the second bevel gear 181 of the transmission intermediate wheel 18 is meshed with the third bevel gear 22, and under the action of the clamp ring 20, the transmission intermediate wheel 18 has been fixed along the axial direction of the second guide shaft 19, and can only rotate along the axial center of the second guide shaft 19, while the rotation of the transmission intermediate wheel 18 can drive the third bevel gear 22 to rotate, thereby driving the internal thread strip 24 to move back and forth in the guide groove; and the end of the internal thread strip 24 can be connected with a corresponding phase shifter (not shown), so that the tilt angle of the phase shifter (not shown) can be adjusted.

[0043] Referring to FIG. 7, in other embodiments of the present invention, the phase shift assembly 2 can be designed as a group of one or more circuits (this example uses two circuits as a group to explain). According to the actual needs of the antenna, the phase shift assembly 2, the transmission intermediate wheel 18 and the clamp ring 20 can be increased or decreased accordingly in number, thus realizing the modularization of the product, improving the applicability of the product and saving the cost.

[0044] An embodiment of the second aspect of the

present invention proposes a base station antenna, which includes an electric downtilt angle adjustment apparatus as described in any of the embodiments of the first aspect. Since other parts of the base station antenna belong to the prior art, and can be realized by a person skilled in the art with reference to the prior art, which will not be described in detail here in this embodiment.

[0045] The technical features of the above embodiments can be combined at will. In order to make the description concise, not all possible combinations of the technical features in the above embodiments are described. However, as long as there is no contradiction between the combinations of these technical features, they shall be considered as the scope recorded in this specification.

[0046] The above-mentioned embodiments only express the specific embodiments of the present invention, and their descriptions are more specific and detailed, but they cannot be construed as limiting the patent scope of the present invention. It should be pointed out that for those skilled in the art, without departing from the concept of the present invention, several variations and improvements can be made, which all belong to the protection of the present invention.

Claims

1. An electric downtilt angle adjustment apparatus, comprising a position selection transmission assembly and a phase shift assembly, wherein the position selection transmission assembly comprises a support frame, a moving switching mechanism, a transmission gear and a second guide shaft; the support frame is provided with a second guide shaft, a plurality of transmission intermediate wheels are installed on the second guide shaft at intervals; the transmission gear is used for driving the transmission intermediate wheels to rotate, and a moving switching mechanism is installed on the support frame, and the moving switching mechanism is used for driving the transmission gear to move and switch among the transmission intermediate wheels; the moving switching mechanism is provided with a driving member, and the driving member is used for driving the transmission gear to rotate; The phase shift assembly comprises a plurality of driven members, the plurality of transmission intermediate wheels are respectively in one-to-one transmission connection with the driven members, and the driven members are respectively connected with the corresponding phase shifters to realize the adjustment of tilt angles of the phase shifters.
2. The electric downtilt angle adjustment apparatus according to claim 1, wherein the moving switching mechanism comprises a transmission shaft and a

position selection rack, wherein both ends of the position selection rack are respectively provided with position selection fixing holes, and the position selection fixing holes at both ends are respectively provided with transmission gears; the transmission shaft passes through the position selection fixing holes and the holes of the transmission gears, and both ends are respectively connected with the support frame; and the position selection rack is provided with a position selection input gear, and the rotation of the position selection input gear is capable of driving the position selection rack and the transmission gear to slide along an axial direction of the transmission shaft.

3. The electric downtilt angle adjustment apparatus according to claim 2, wherein a circular shaft elastic arm is arranged on the transmission gear, and the circular shaft elastic arm is capable of rotating in the position selection fixing hole of the position selection rack; and an end part of the transmission gear is provided with a reverse buckle buckled on the position selection fixing hole.
4. The electric downtilt angle adjustment apparatus according to claim 2, wherein the driving member comprises a transmission input bevel gear and a first bevel gear; the first bevel gear is sleeved on the transmission shaft, the rotation of the first bevel gear is capable of driving the transmission shaft and the transmission gear to rotate synchronously, and the rotation of the transmission input bevel gear is capable of driving the first bevel gear to rotate.
5. The electric downtilt angle adjustment apparatus according to claim 1, wherein the second guide shaft is provided with a plurality of clamp grooves, and a backstop surface of the transmission intermediate wheel is provided with a clamp ring; after passing through the holes of the transmission intermediate wheels one by one, the second guide shaft is buckled in the corresponding clamp groove on the second guide shaft by the clamp ring.
6. The electric downtilt angle adjustment apparatus according to claim 1, wherein the phase shift assembly comprises a fixed seat located at one side of the position selection transmission assembly; the driven member comprises an internal thread strip and an external thread column, wherein the internal thread strip is installed in a guide groove of the fixed seat, and the external thread column is placed below the internal thread strip; the rotation of the transmission intermediate wheel is capable of driving the external thread column to rotate, and the rotation of the external thread column is capable of driving the internal thread strip to slide in the guide groove.

7. The electric downtilt angle adjustment apparatus according to claim 6, wherein the driven member further comprises a third bevel gear, a second bevel gear is arranged on the transmission intermediate wheel, and the second bevel gear is meshed with the corresponding third bevel gear; the third bevel gear sequentially passes through a first circular hole of the fixed seat, a through hole of the external thread column and a second circular hole of the fixed seat; the third bevel gear is in transmission connection with the external thread column, and the third bevel gear is capable of rotating in the first circular hole and the second circular hole of the fixed seat.
8. The electric downtilt angle adjustment apparatus according to claim 7, wherein a damping ring is arranged between the third bevel gear and the first circular hole of the fixed seat.
9. The electric downtilt angle adjustment apparatus according to claim 7, wherein a rear part of the third bevel gear is provided with an elastic buckle, and the elastic buckle is buckled on an end face of the second circular hole of the fixed seat to prevent the third bevel gear from coming loose from the fixed seat.
10. A base station antenna, comprising the electric downtilt angle adjustment apparatus according to any one of claims 1 to 9.

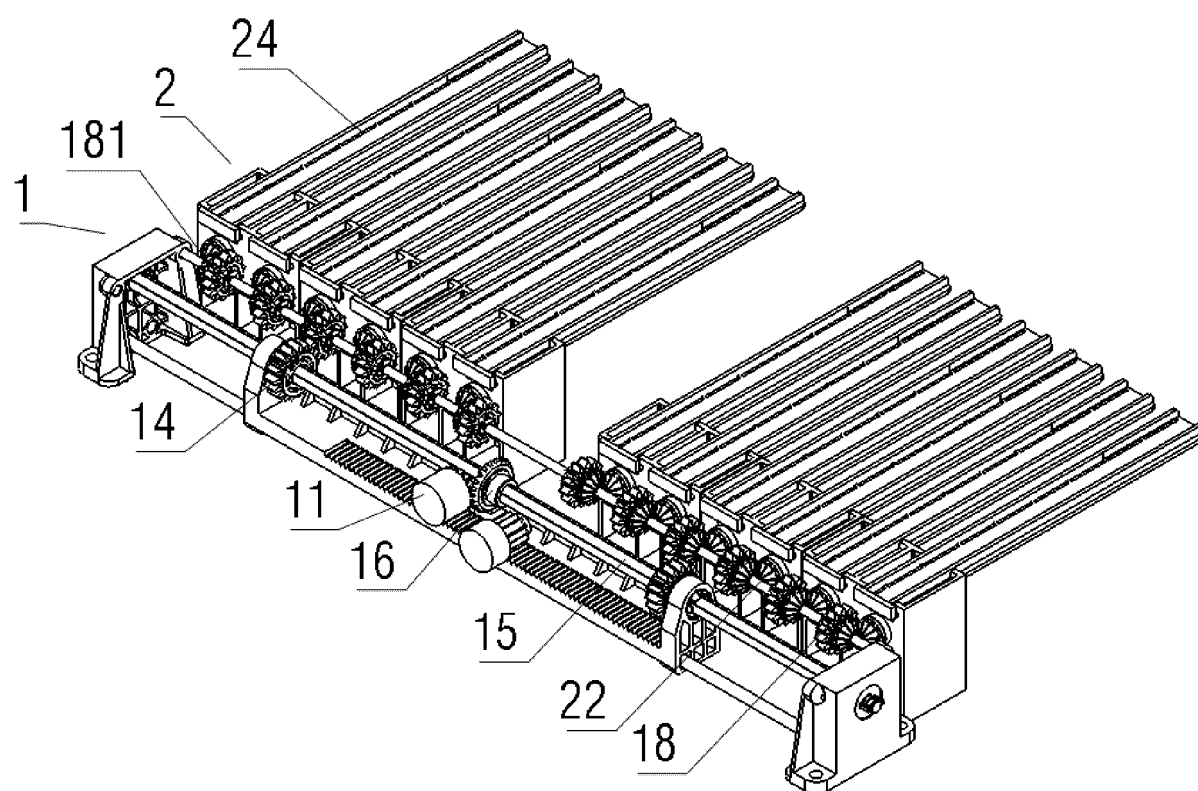


FIG. 1

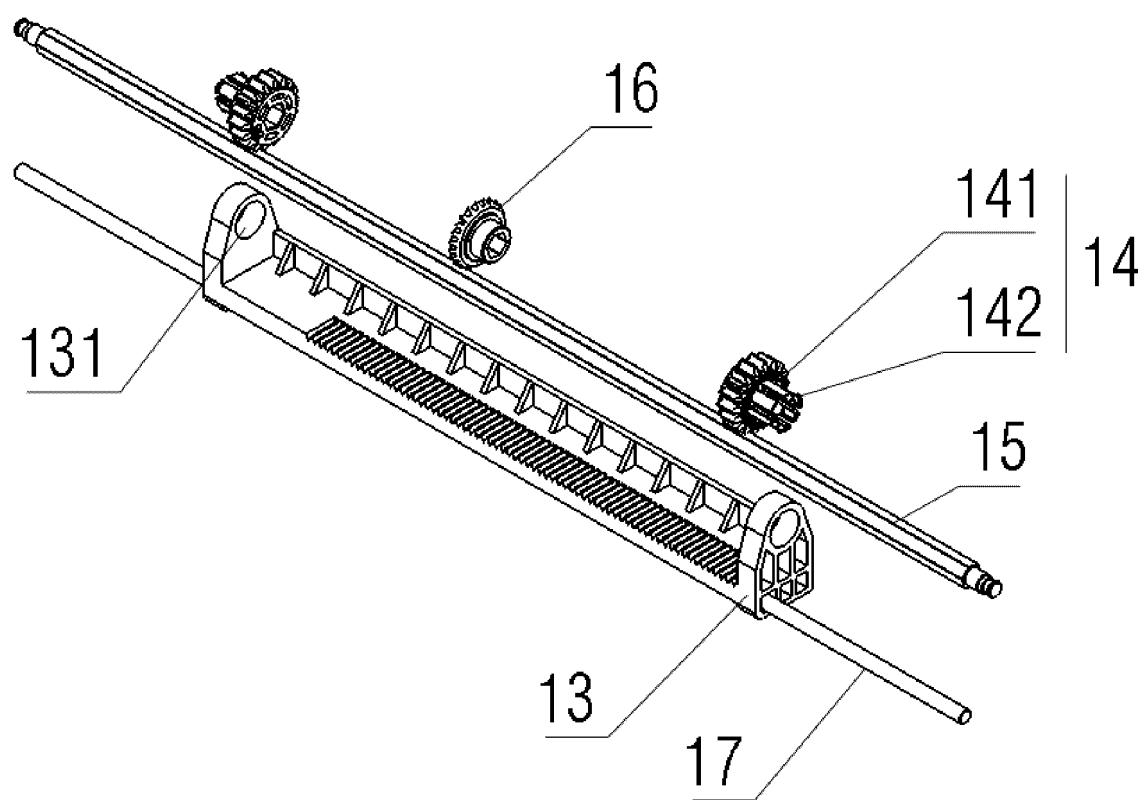


FIG. 2

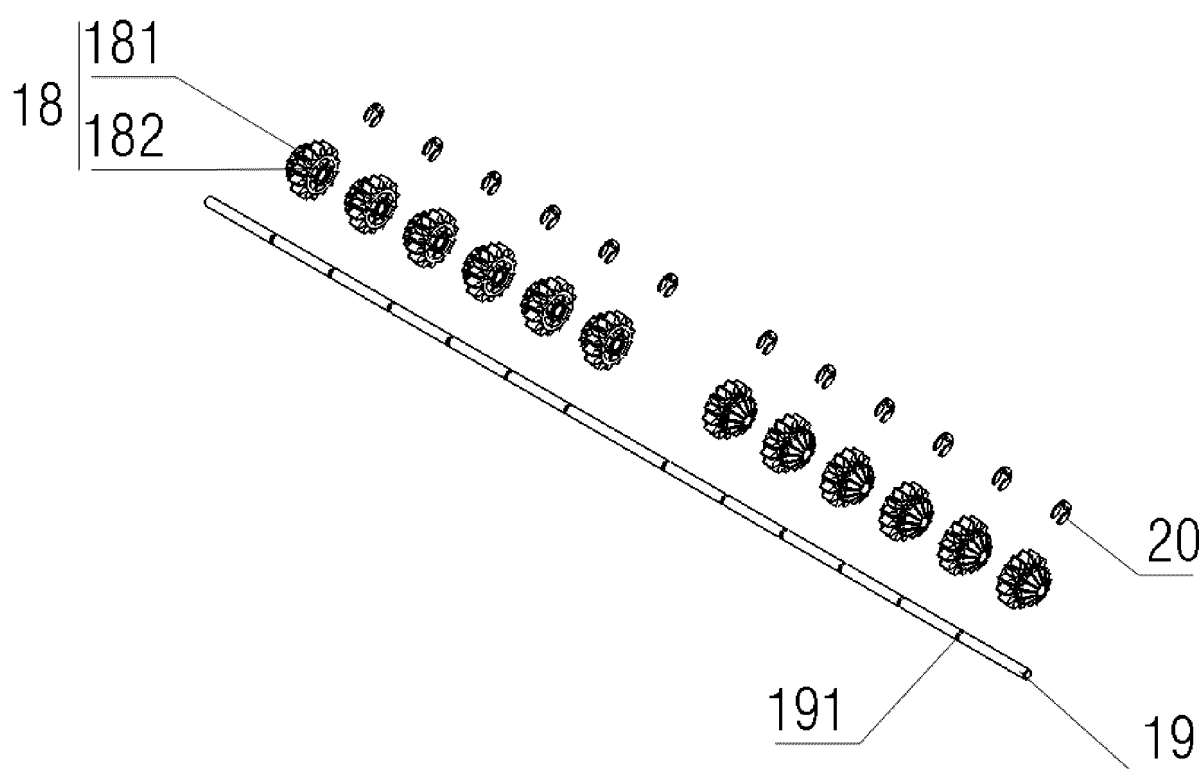


FIG. 3

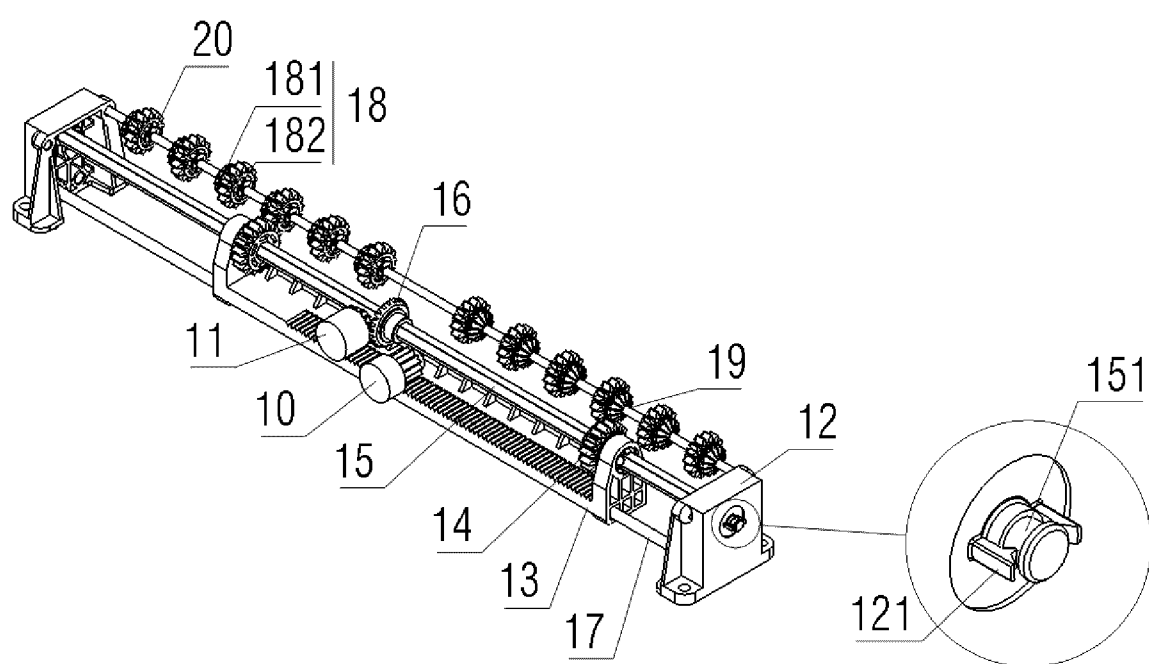


FIG. 4

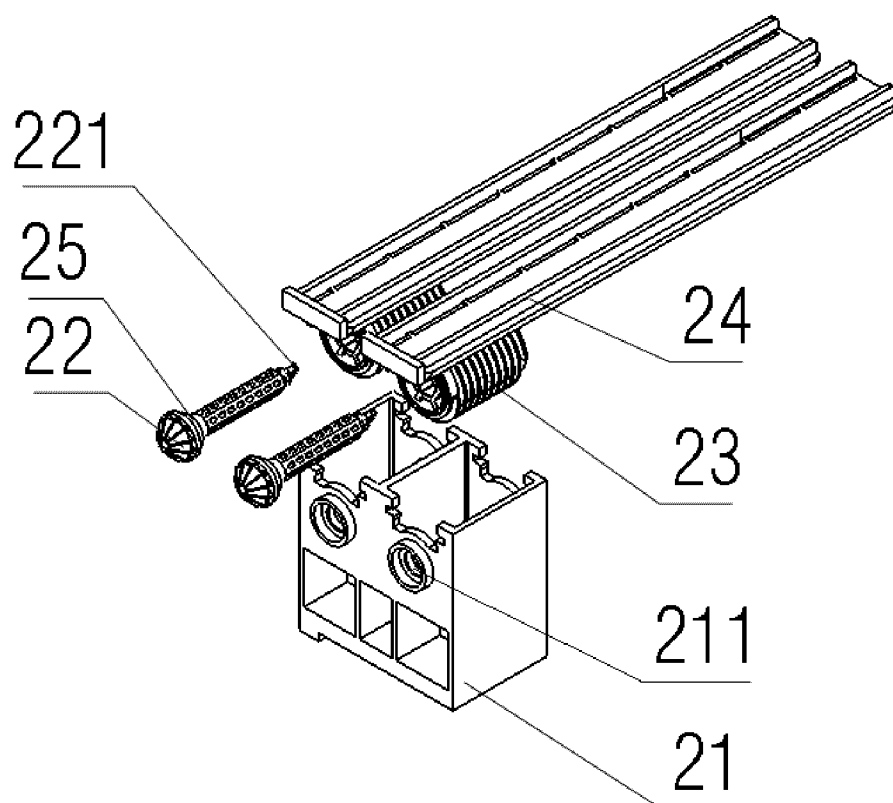


FIG. 5

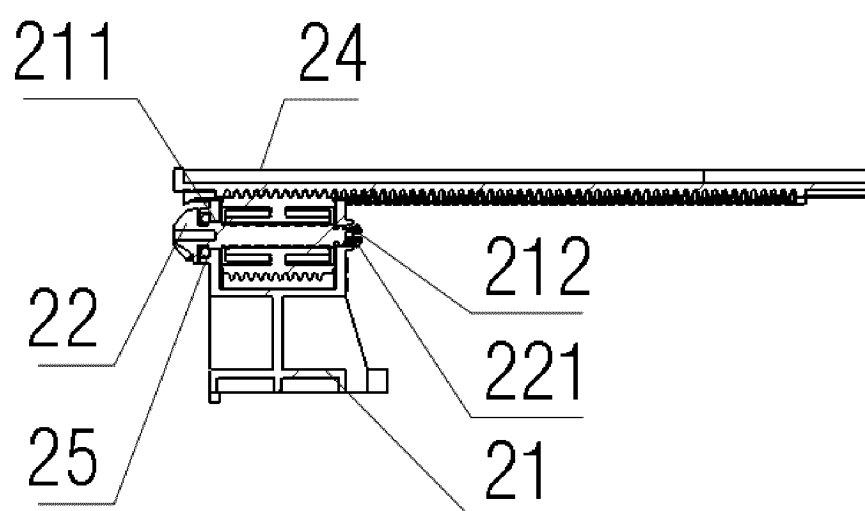


FIG. 6

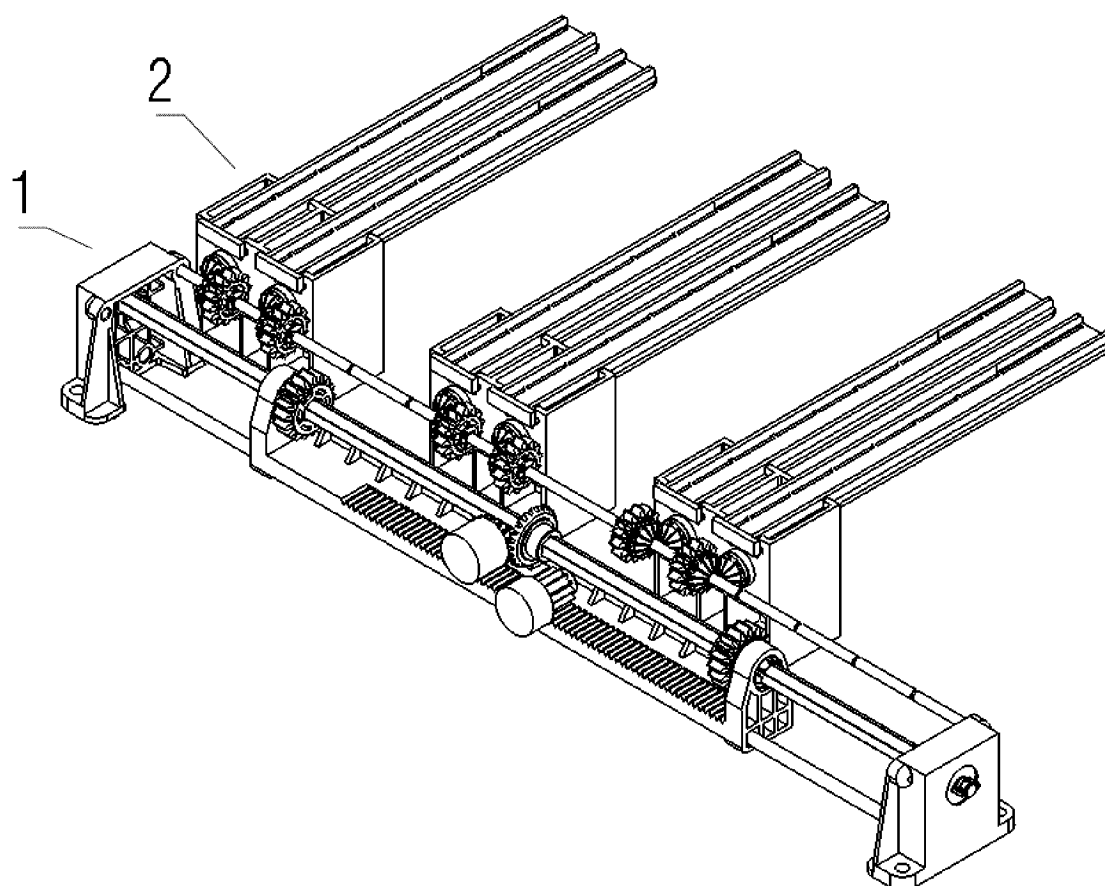


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/079430

A. CLASSIFICATION OF SUBJECT MATTER H01Q3/32(2006.01)i;H01Q3/34(2006.01)i;H01Q1/12(2006.01)i;H01Q1/20(2006.01)i;H01Q1/24(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC																		
B. FIELDS SEARCHED																		
Minimum documentation searched (classification system followed by classification symbols) IPC: H01Q																		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNTXT: CNKI; VEN; ENTXT: USTXT: WOTXT: EPTXT: IEEE: 基站, 天线, 电调, 倾角, 电下倾角, 调整, 调节, 控制, 移相器, 相位, 调相, 方位角, 选择, 切换, 换挡, 主动, 驱动, 从动, 传动, 齿轮, 齿条, base station, antenna?, electric+, downward, inclin+, tilt, angle, adjust+, control+, phase, shift+, Azimuth angle, select+, switch+, driven, transfer+, transmission, gear, rackbar																		
C. DOCUMENTS CONSIDERED TO BE RELEVANT																		
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																		
<table border="0"> <tr> <td style="vertical-align: top;"> * Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed </td> <td style="vertical-align: top;"> “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family </td> </tr> </table>	* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family																
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<table border="1"> <tr> <td>Date of the actual completion of the international search 16 May 2023</td> <td>Date of mailing of the international search report 27 May 2023</td> </tr> </table>	Date of the actual completion of the international search 16 May 2023	Date of mailing of the international search report 27 May 2023																
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<table border="1"> <tr> <td>Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088</td> <td>Authorized officer Telephone No.</td> </tr> </table>	Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.																
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INTERNATIONAL SEARCH REPORT

International application No. PCT/CN2023/079430

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2021118740 A1 (COMMSCOPE TECHNOLOGIES L.L.C.) 17 June 2021 (2021-06-17) entire document	1-10

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/079430

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 114465005 A	10 May 2022	None	
CN 216903355 U	05 July 2022	None	
CN 110165412 A	23 August 2019	WO 2020238074 A1	03 December 2020
CN 111682318 A	18 September 2020	None	
CN 109755747 A	14 May 2019	WO 2019091239 A1	16 May 2019
		US 2020212565 A1	02 July 2020
		US 11303019 B2	12 April 2022
WO 2021118740 A1	17 June 2021	US 2022384948 A1	01 December 2022
		US 11600920 B2	07 March 2023

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