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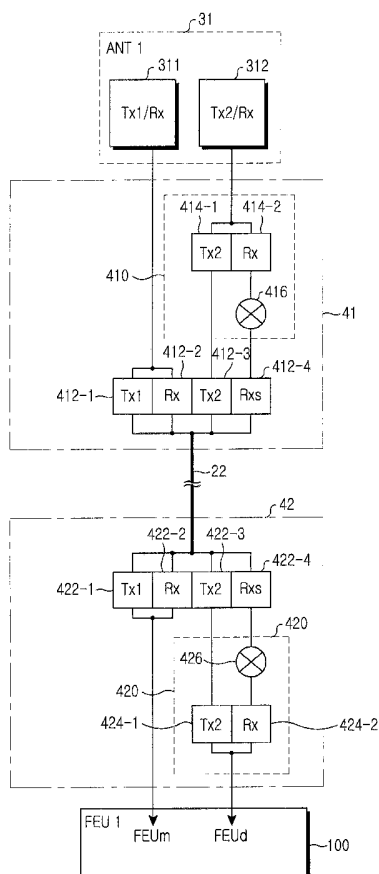
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(54) Title: APPARATUS FOR SHARING ANTENNA CABLE OF BASE STATION

(57) Abstract: An apparatus for sharing an antenna cable in a base station having at least two antennas is provided. In the antenna cable sharing apparatus, an antenna front-end sharer, installed at the front end of the antennas, separates a transmission signal and provides the separated transmission signals to corresponding antennas. The antenna front-end sharer also combines signals received through the antennas into one separable received signal and transmits the combined received signal through one antenna cable. A base station front-end sharer, installed at the front end of the base station, separates the combined signal received through the antenna cable and provides the separated received signals to a base station body. The base station front-end sharer also combines transmission signals received from the base station body and transmits the combined transmission signal through the antenna cable.





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Title of the Invention

Apparatus for Sharing Antenna Cable of Base Station

Field of the Invention

5 The present invention relates generally to a base station in a mobile communication system, and in particular, to an apparatus for sharing an antenna cable in a base station.

Description of the Related Art

10 A mobile communication system includes a plurality of base station transceiver systems for providing services to mobile terminals (i.e. mobile stations) located in their service areas, base station controllers, a base station manager system for managing a plurality of base station controllers, and a mobile switching center. The mobile communication system covers its whole service area
15 through appropriate layout of the base station transceiver systems.

FIG. 1 schematically illustrates the typical installation of antennas and antenna cables in a base station. Referring to FIG. 1, in a mobile communication system, the base station is provided with a plurality of antenna devices 31, 32 and
20 33 installed geographically higher than the surroundings, for example, on the roof of a tall building 2, a base station body 10 at an appropriate position inside or outside of the building 2, and a plurality of antenna cables 20 connecting the antenna devices 31, 32 and 33 to the base station body at an appropriate position inside or outside of the building 2.

25 In the mobile communication base station system, the service area (i.e. cell) of one base station is typically divided into a plurality of sectors (three or six sectors), for example, α sector, β sector, and γ sector and the frequency assignment (FA) of the base station is reused for each sector. In this way, the whole service area is covered. Each sector is provided with at least one transmit/receive antenna. In the illustrated case of FIG. 1, the first, second and
30 third antenna devices 31, 32 and 33 are provided for α sector, β sector, and γ sector.

35 In the radio channel environment of the mobile communication system,

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unlike a wired channel environment, a transmission signal is distorted due to various factors such as multipath interference, shadowing, wave attenuations, time-variant noise, and interference. Multipath fading is closely related to a reflector or the mobility of a user, that is, a user terminal and the actual
5 transmission signal is mixed with an interference signal at a receiver. Among approaches against the fading, spatial diversity is effective in which diversity gain is acquired by use of two or more receive antennas. If a signal received through an antenna is attenuated due to fading, the diversity gain is achieved using a signal received through another antenna.

10 In this context, a mobile communication system such as IS-95, CDMA2000 or WCDMA adopts the spatial diversity scheme for two spaced vertical antennas for different sectors in a base station. Three or more vertical antennas are not used because the diversity effect is small at present compared to the increase of complexity. In FIG. 1, the first, second and third antenna devices
15 31, 32 and 33 for α sector, β sector, and γ sector each have one main transmit/receive antenna and one diversity antenna.

FIG. 2 is a circuit block diagram of the base station illustrated in FIG. 1.
20 Referring to FIG. 2, the first, second and third antennas 31, 32 and 33 each have a main transmit/receive antenna 311 and a receive diversity antenna 312 and are connected to first, second and third front end units (FEUs) 100, 110 and 120, respectively in the base station body 10 via the antenna cables 20. The main transmit/receive antenna 311 and the Receive diversity antenna 312 of the first
25 antenna device 31 are connected to an FEUm 102 and an FEUd 104 in the first FEU 100, respectively via corresponding antenna cables. The main transmit/receive antenna 311 and the Receive diversity antenna 312 in each of the second and third antenna devices 32 and 33 are connected to an FEUm and an FEUd in the second or third FEU 110 or 120, respectively via corresponding
30 antenna cables. The FEUm 102 and the FEUd 104 each have a duplexer and a low noise amplifier (LNA), for radio signal processing at the front end of the base station body 10.

As illustrated in FIGs. 1 and 2, since each base station is equipped with
35 more transmit and/or receive antennas for each sector due to the spatial diversity

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scheme, the number of antenna cables used is increased. As a result, the antenna cables 20 require more space for installation, accompanied by installation difficulty and the increase of repair and maintenance cost. Moreover, the outward look of the base station is not good.

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Detailed Description of the Invention

Accordingly, an object of the present invention is to provide an apparatus for sharing an antenna cable in a base station in order to reduce installation space, facilitates installation, and reduces repair and maintenance cost.

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According to one aspect of the present invention, the above object is achieved by an apparatus for sharing an antenna cable in a base station having at least two antennas. In the apparatus, an antenna front-end sharer is provided at the front end of the antennas, separates a transmission signal, provides the separated transmission signals to corresponding antennas, combines signals received through the antennas to be separable, and transmits the combined signal through the antenna cable. A base station front-end sharer is provided at the front end of a base station body, separates the combined reception signal received through the antenna cable, provides the separated reception signals to the base station body at a rear end, combines transmission signals received from the base station body, and provides the combined transmission signal through the antenna cable.

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It is preferred that the antenna front-end sharer includes at least one filter for filtering the signals received through the antennas according to a reception frequency band, at least one frequency converter for converting the frequency of a predetermined signal among the filtered signals to a predetermined frequency band, and a filtering portion for filtering the received signals and the converted signal and combining the filtered signals, and the base station front-end sharer includes a filtering portion for separating the combined reception signal received through the antenna cable by filtering and at least one frequency converter for converting the frequencies of the signals filtered by the at least one filter to an original frequency band.

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According to another aspect of the present invention, the above object is achieved by an apparatus for sharing an antenna cable in a base station having a

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plurality of receive antennas. In the apparatus, an antenna front-end sharer is provided at the front end of the receive antennas, combines signals received through the receive antennas to be separable, and transmits the combined reception signal through the antenna cable. A base station front-end sharer is provided at the front end of a base station body, separates the combined reception signal received through the antenna cable, and provides the separated reception signals to the base station body at a rear end.

It is preferred that the antenna front-end sharer includes a plurality of filters for filtering the signals received through the receive antennas according to a reception frequency band, a plurality of frequency converters for converting the frequency of the filtered signals to predetermined frequency bands, and a filtering portion for filtering the converted signals according to corresponding frequency bands, and the base station front-end sharer includes a filtering portion for separating the combined reception signal received through the antenna cable by filtering and a plurality of frequency converters for converting the frequencies of the signals filtered by the filters to an original frequency band.

Brief Description of the Drawings

FIG. 1 schematically illustrates the typical installation of antennas and antenna cables in a base station;

FIG. 2 is a circuit block diagram of the base station illustrated in FIG. 1;

FIG. 3 is a circuit block diagram of a base station antenna cable sharing apparatus according to an embodiment of the present invention;

FIG. 4 illustrates the transmission/reception bands and frequency conversion band of the base station antenna cable sharing apparatus illustrated in FIG. 3; and

FIG. 5 is a circuit block diagram of a base station antenna cable sharing apparatus according to another embodiment of the present invention.

Embodiments

Preferred embodiments of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

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FIG. 3 is a circuit block diagram of a base station antenna cable sharing apparatus according to an embodiment of the present invention. For notational simplicity, the antenna cable sharing apparatus is described in the context of the main transmit/receive antenna 311 and the Receive diversity antenna 312 of the first antenna device 31 for one sector, for example, α sector in the base station. Referring to FIG. 3, the antenna cable sharing apparatus is comprised of an antenna front-end sharer 41 installed at the front end of the first antenna device 31, for separating a transmission signal, providing the separated transmission signals to the main transmit/receive antenna 311 and the receive diversity antenna 312, combining signals received through the main transmit/receive antenna 311 and the Receive diversity antenna 312 separably, and providing the combined received signal via one antenna cable 22, and a base station front-end sharer 42 installed at the front end of the base station body, for separating the combined signal received via the antenna cable 22, providing the separated signals to the first FEU 100, combining transmission signals received from the first FEU 100, and providing the combined transmission signal to the antenna cable 22.

Referring to FIG. 3, the transmission frequency band of the main transmit/receive antenna 311 in the first antenna device 31 is Tx1, the transmission frequency band of the receive diversity antenna 312 is Tx2 different from Tx1, and the reception frequency bands of the two antennas 311 and 312 are identical, Rx. While it is shown in FIG. 3 that a signal in the Tx2 band is sent through the receive diversity antenna 312 in the embodiment of the present invention, for the purpose of clarifying the scope of the present invention, the receive diversity antenna 312 is generally confined to signal reception in a base station using receive diversity.

Signals to be sent or received through the main transmit/receive antenna 311 and the receive diversity antenna 312 of the first antenna device 31 are separated and combined in the antenna front-end sharer 41. The antenna front-end sharer 41 is provided with a frequency conversion portion 410. The frequency conversion portion 410 includes a filter 414-2 for filtering a signal received from the receive diversity antenna 312 in the Rx band and a frequency converter 416 for converting the filtered signal to a predetermined frequency band, for example, Rxs. The antenna front-end sharer 41 further includes a plurality of filters 412-1

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and 412-2 for passing the Tx1 and Rx bands of the main transmit/receive antenna 311 and a filter 412-4 for filtering the signal of the Rxs band. It also can have filters 412-3 and 414-1 for filtering the Tx2 band of the receive diversity antenna 312.

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In the thus-configured antenna front-end sharer 41, a signal of the Rx band received via the receive diversity antenna 312 is converted to a signal in the Rxs frequency band and sent via the single antenna cable 22. The frequency conversion of the signal received via the receive diversity antenna 312 is done to enable separation at the rear end from a signal received via the main transmit/receive antenna 311 that passes through the antenna cable 22 together with the signal received via the receive diversity antenna 312. As schematically illustrated in FIG. 4, because the Tx1 and Tx2 bands are different from each other in the transmission and reception bands of the base station, signals in the two bands can be separated through filtering. However, the whole Rx band is used for signal reception and thus if signals received via the two different antennas are simply combined, they cannot be separated later. Hence, diversity cannot be achieved. Accordingly, the frequency converter 410 converts an Rx-band signal to an Rxs-band signal. The frequency converter 410 can be so configured as to convert a GHz-band (Rx) received signal to a signal in a neighboring GHz band (Rxs). It can also be so configured as to converter the GHz-band (Rx) received signal to a MHz- or KHz-band (Rxs) signal.

Referring to FIG. 3 again, the base station front-end sharer 42 separates a combined reception signal received via the antenna cable 22 and provides the separated reception signals to the first FEU 100 at the rear end. The base station front-end sharer 42 includes a filter 422-4 for filtering the converted Rxs-band signal, and a frequency conversion portion 420 with a frequency converter 426-2 for converting the signal filtered by the filter 422-4 to the original Rx-band signal. It further includes a plurality of filters 422-1 and 422-2 for filtering signals received via the antenna cable 20 in the Tx1 and Rx bands of the main transmit/receive antenna 311, and a filter 424-2 for filtering the Rx-band signal received from the frequency converter 426. Filters 422-3 and 424-1 can be provided in the base station front-end sharer 42, for filtering the Tx2 band of the receive diversity antenna 312.

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In the base station front-end sharer 42 having the above configuration, an Rx-band reception signal received from the main transmit/receive antenna 311 and a converted Rxs-band signal received from the receive diversity antenna 312 commonly via the antenna cable 22 can be separated from each other and the separated Rxs-band reception signal is recovered to the original Rx-band signal. The two reception signals are then provided to an FEUm and an FEUd at the rear end, respectively.

While the filters 414-1 and 414-2 for filtering a signal to be transmitted and a signal received through the receive diversity antenna 312 are separately implemented in FIG. 3 for notational simplicity and better understanding of the principle of the present invention, it is preferable to implement these filters as a typical duplexer. Also, the filters 412-1 to 412-4 and 422-1 to 422-4 are separately implemented at the front end of the antenna cable 22. Yet, these filters are preferably implemented as a typical multiplexer. Transmission and reception paths are practically combined or separated in the multiplexer or duplexer.

While the antenna cable sharing apparatus is shown, by way of example, for sharing the two transmit and receive antennas 311 and 312 used for one sector in the base station, needless to say, it is applicable to each of the two transmit/receive antennas. Furthermore, an antenna cable sharing apparatus can also be configured to share one antenna cable among all transmit/receive antennas of the sectors of one base station, relying on the principle of the antenna sharing apparatus of the present invention. It can be further contemplated that an antenna cable is provided in each transmission path and one antenna cable is shared among reception paths by use of the antenna cable sharing apparatus of the present invention, taking into account transmit power in a plurality of transmit/receive antennas. This will be described in great detail with reference to FIG. 5.

FIG. 5 is a circuit block diagram of a base station antenna cable sharing apparatus according to another embodiment of the present invention. In FIG. 5, an apparatus for sharing an antenna cable among receive antennas 341 to 346 is shown for a base station which operates six sectors and has six transmit antennas (not shown) and the six receive antennas 341 to 346. Compared to the antenna

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cable sharing apparatus illustrated in FIG. 3 for application to transmit/receive antennas, the antenna cable sharing apparatus illustrated in FIG. 5 is configured to be applicable to a plurality of receive only antennas (only reception paths are considered). In FIG. 5, although the reception frequency bands of the receive antennas 341 to 346 are identical, Rx, signals received through the receive antennas 341 to 346 are denoted by Rx1, Rx2, Rx3, Rx4, Rx5 and Rx6, respectively to distinguish the antennas from one another in FIG. 5.

Referring to FIG. 5, the antenna cable sharing apparatus according to the second embodiment of the present invention includes an antenna front-end sharer 51 installed at the front end of the receive antennas 341 to 346, for separably combining signals Rx1 to Rx6 received through the receive antennas 341 to 346 and providing the combined signal through the single antenna cable 22, and a base station front-end sharer 52 installed at the front end of the base station body, for separating the combined signal received through the antenna cable 22 and providing the separated signals to the base station body at the rear end.

The antenna front-end sharer 51 is provided with a plurality of filters 514-2 to 514-6 for filtering the signals Rx2 to Rx6 according to the Rx band and a plurality of frequency converters 516-2 to 516-6 for converting the filtered signals Rx2 to Rx6 to signals Rx2' to Rx6' in a predetermined frequency band so that the signals can be separated later. The antenna front-end sharer 51 further includes a plurality of filters 512-2 to 512-6 for filtering the signals Rx2' to Rx6' received from the frequency converters 516-2 to 516-6 according to their frequency bands. Also, filters 514-1 and 512-1 can be provided to filter the frequency band of the signal Rx1.

The base station front-end sharer 52 is provided with a plurality of filters 522-1 to 522-6 filtering the combined signals Rx1 and Rx2' to Rx6' received through the antenna cable according to their respective frequency bands and a plurality of frequency converters 526-2 to 526-6 for recovering the signals Rx2' to Rx6' to the original Rx band signals. The base station front-end sharer 52 may further include filters 524-2 to 524-6 for filtering the original Rx-band signals Rx2 to Rx6 in the Rx band.

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In the antenna cable sharing apparatus having the above configuration according to the second embodiment of the present invention, the signals Rx1 to Rx6 received through the receive antennas 341 to 346 are converted to signals in appropriate frequency bands such that the signals can be separated later in the antenna front-end sharer 51, and then sent through the single antenna cable 22. The base band front-end sharer 52 separates the signals received through the antenna cable, recover them to signals in the original frequency band, and provide the recovered signals to the base station body at the rear end.

While it is shown in FIG. 5 that the filters 512-1 to 512-6 and the filters 522-1 to 522-6 are implemented separately, they are preferably configured as a typical multiplexer. Practically this multiplexer combines or separates transmission and reception paths.

The base station antenna cable sharing apparatus can be configured and operated according to the embodiment of the present invention as described above. While the invention has been shown and described with reference to certain preferred embodiments thereof, many modifications can be made within the scope of the present invention. For example, while a signal received through the receive diversity antenna is subject to frequency conversion in the first embodiment of the present invention, a signal received through the main transmit/receive antenna or signals received through both the main transmit/receive antenna and the receive diversity antenna can be frequency-converted. While the signal Rx1 received through the first receive antenna 341 is not frequency-converted in the second embodiment of the present invention illustrated in FIG. 5, the antenna cable sharing apparatus can be so configured as to convert the frequency of the signal Rx1. In addition, various transmission and reception processing circuits including amplification circuits for amplifying transmission and received signals can be added to the antenna front-end sharer in the antenna cable sharing apparatus of the present invention.

As described above, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

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Industrial Usability

As described above, the base station antenna cable sharing apparatus of the present invention saves the installation space of an antenna cable, facilitates installation, and reduces repair and maintenance cost.

What Is Claimed Is

1. An apparatus for sharing an antenna cable in a base station having at least two antennas, comprising:

5 an antenna front-end sharer provided at the front end of the antennas, for separating a transmission signal, providing the separated transmission signals to corresponding antennas, combining signals received through the antennas to be separable, and transmitting the combined signal through the antenna cable; and

10 a base station front-end sharer provided at the front end of a base station body, for separating the combined reception signal received through the antenna cable, providing the separated reception signals to the base station body at a rear end, combining transmission signals received from the base station body and providing the combined transmission signal through the antenna cable.

15 2. The apparatus of claim 1, wherein the antenna front-end sharer includes at least one filter for filtering the signals received through the antennas according to a reception frequency band, at least one frequency converter for converting the frequency of a predetermined signal among the filtered signals to a predetermined frequency band, and a filtering portion for filtering the received
20 signals and the converted signal and combining the filtered signals, and

wherein the base station front-end sharer includes a filtering portion for separating the combined reception signal received through the antenna cable by filtering and at least one frequency converter for converting the frequencies of the signals filtered by the at least one filter to an original frequency band.

25 3. The apparatus of claim 2, wherein each of the filtering portions in the antenna front-end sharer and the base station front-end sharer is one of a duplexer and a multiplexer.

30 4. An apparatus for sharing an antenna cable in a base station having a main transmit/receive antenna and a receive diversity antenna, comprising:

35 an antenna front-end sharer provided at the front end of the main transmit/receive antenna and the receive diversity antenna, for separating a transmission signal, providing the separated transmission signals to the main

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transmit/receive antenna, combining signals received through the main transmit/receive antenna and the receive diversity antenna to be separable, and transmitting the combined signal through the antenna cable; and

a base station front-end sharer provided at the front end of a base station body, for separating the combined reception signal received through the antenna cable, providing the separated reception signals to the base station body at a rear end, combining transmission signals received from the base station body and providing the combined transmission signal through the antenna cable.

5. The apparatus of claim 4, wherein the antenna front-end sharer includes a filter for filtering a signal received through the receive diversity antenna according to a reception frequency band, a frequency converter for converting the frequency of the filtered signal to a predetermined frequency band, and a filtering portion for filtering a signal received in the transmission and reception frequency bands of the main transmit/receive antenna and the converted signal and combining the filtered signals, and

wherein the base station front-end sharer includes a filtering portion for separating the combined reception signal received through the antenna cable by filtering, a frequency converter for converting the frequency of the signal filtered by the filter to an original frequency band, a filter for filtering the signal of the transmission and reception frequency bands of the main transmit/receive antenna, and a filter for filtering the reception signal converted by the frequency converter.

6. An apparatus for sharing an antenna cable in a base station having a plurality of receive antennas, comprising:

an antenna front-end sharer provided at the front end of the receive antennas, for combining signals received through the receive antennas to be separable and transmitting the combined reception signal through the antenna cable; and

a base station front-end sharer provided at the front end of a base station body, for separating the combined reception signal received through the antenna cable and providing the separated reception signals to the base station body at a rear end.

7. The apparatus of claim 6, wherein the antenna front-end sharer

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includes a plurality of filters for filtering the signals received through the receive antennas according to a reception frequency band, a plurality of frequency converters for converting the frequency of the filtered signals to predetermined frequency bands, and a filtering portion for filtering the converted signals according to corresponding frequency bands, and

5 wherein the base station front-end sharer includes a filtering portion for separating the combined reception signal received through the antenna cable by filtering and a plurality of frequency converters for converting the frequencies of the signals filtered by the filters to an original frequency band.

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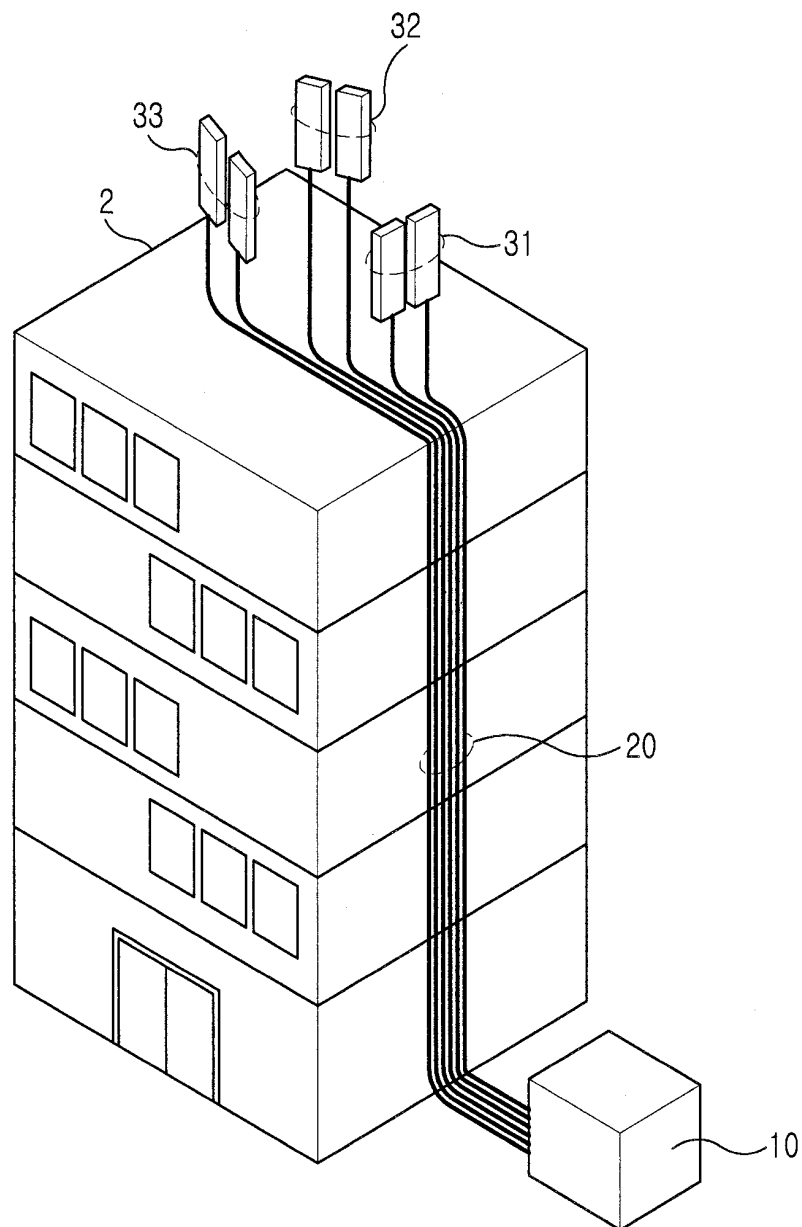


FIG.1

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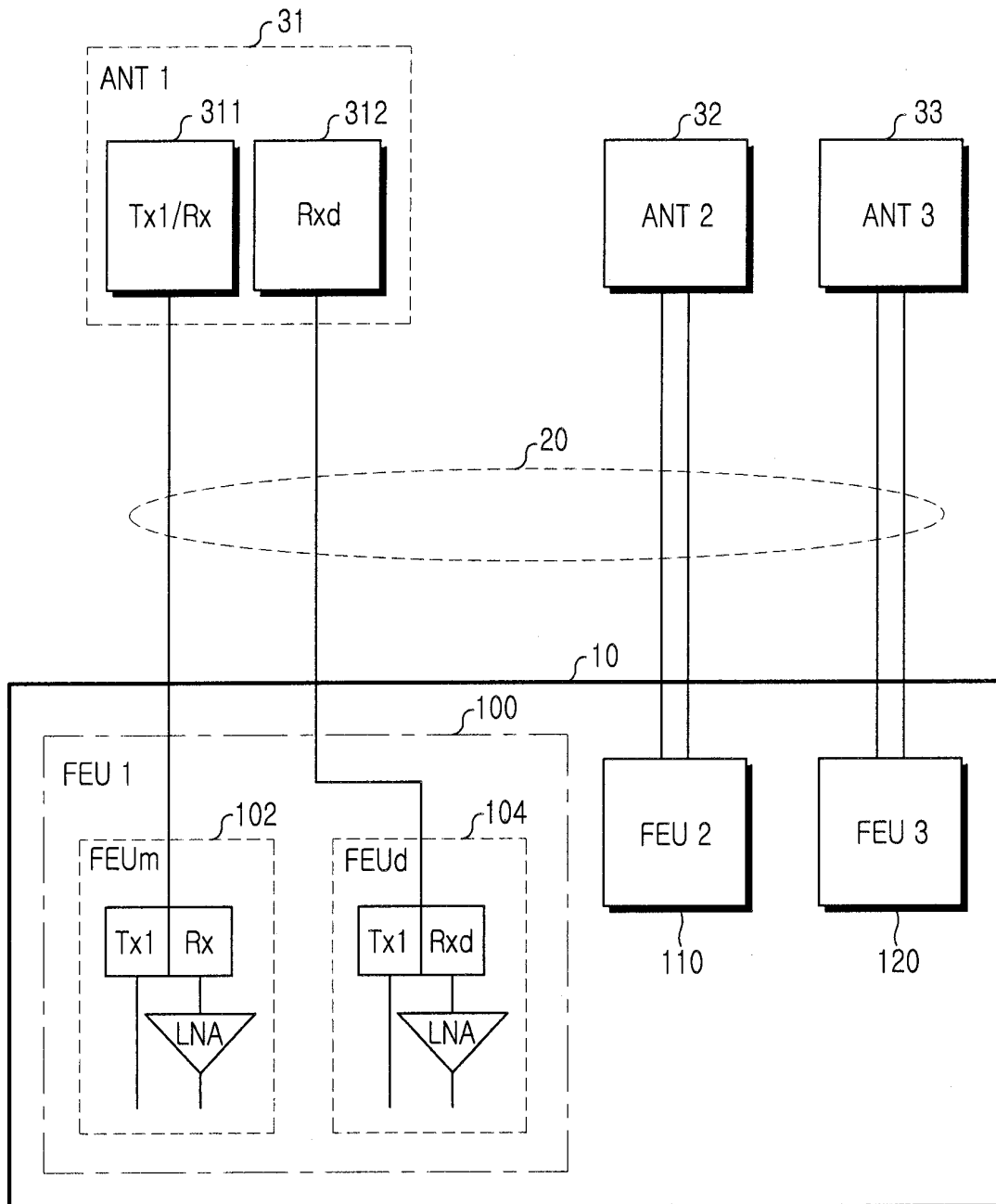


FIG.2

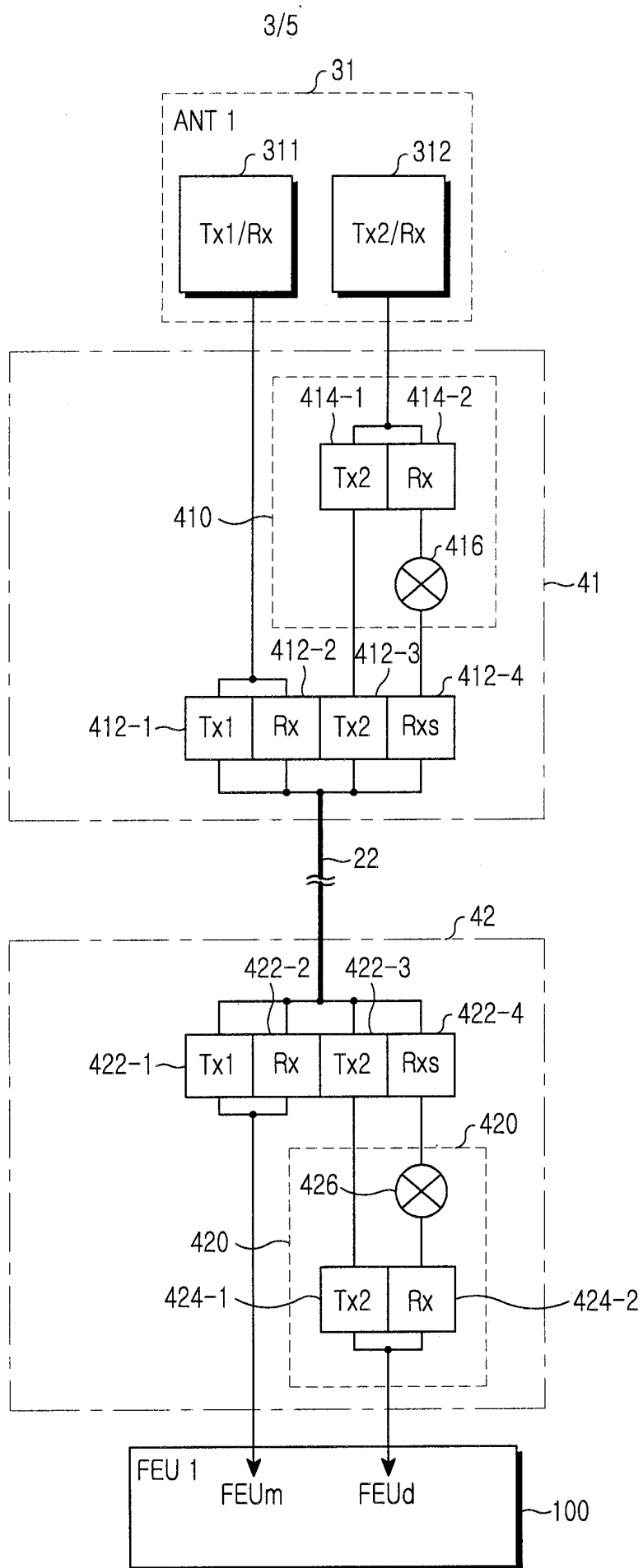


FIG. 3

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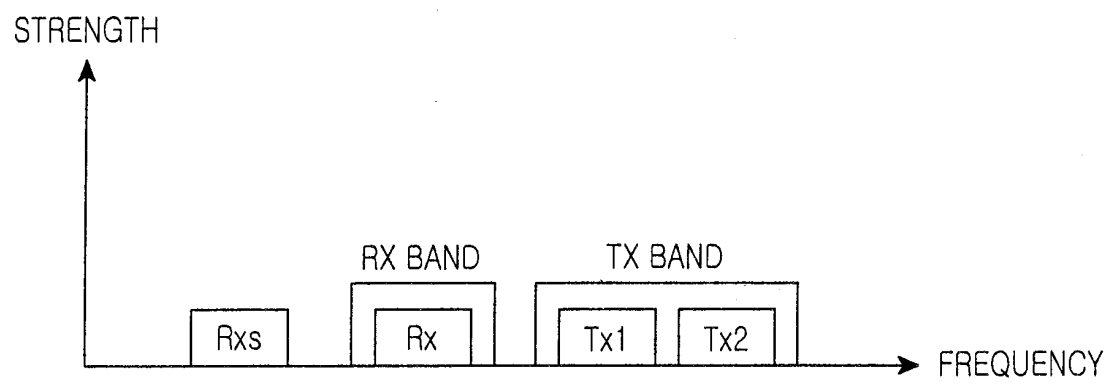


FIG.4

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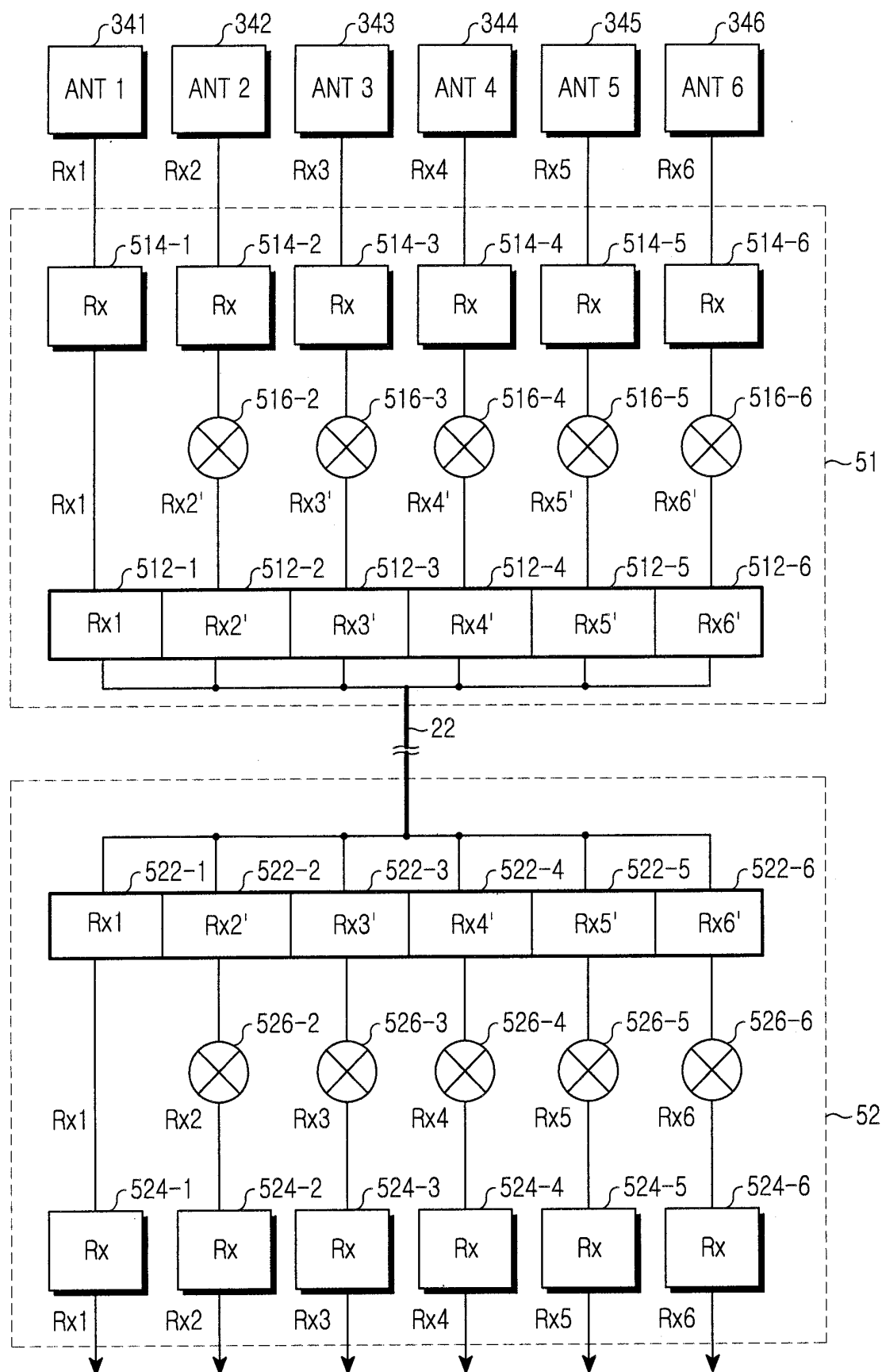


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2005/004071**A. CLASSIFICATION OF SUBJECT MATTER****H04B 7/155(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)

H04B 7/155

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 2003-0004533 A (CYLUX TECHNOLOGIES CO., LTD.) 15 January 2003	1, 4, 6
A	See the whole documents	2-3, 5, 7
Y	KR 2004-0038257 A (UTSTARCOM KOREA LIMITED) 08 May 2004	1, 4, 6
A	See the whole documents	2-3, 5, 7

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

10 MARCH 2006 (10.03.2006)

Date of mailing of the international search report

10 MARCH 2006 (10.03.2006)

Name and mailing address of the ISA/KR

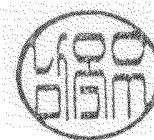
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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