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(54) FEED NETWORK AND ANTENNA

EINSPEISUNGSNETZWERK UND ANTENNE

RÉSEAU D'ALIMENTATION ET ANTENNE

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Description

FIELD OF TECHNOLOGY

[0001] The present invention relates to the field of wireless communication, and in particular, to a feed network and an antenna.

BACKGROUND

[0002] In wireless communication systems, as more and more voice and data information need to be transmitted within a fixed bandwidth, passive intermodulation (Passive InterModulation, PIM) becomes an important factor that limits the system capacity. PIM is a frequency interference caused by the non-linear characteristic of passive devices in an emission system. For example, in systems with great power and multiple channels, the non-linearity of the passive devices brings about higher harmonic waves relative to a working frequency. The mixture of the harmonic waves and the working frequency generates a new group of frequencies, which is similar to the generation of stray signals when two or more frequencies in an active device are mixed in a non-linear device. When a stray intermodulation signal falls in a receiving band of a base station, sensitivity of a receiver decreases, thereby decreasing voice quality or a system carrier-to-interface ratio (C/I), and reducing the capacity of a communication system. The PIM is caused by a lot of factors, including poor mechanical contact of a feed network.

US 3 098 983 A discloses a conventional short slot hybrid including an input port, two output ports, and a fourth port. The input port and the fourth port, and the two output ports, are respectively separated by metal interlayers.

US 5 534 877 A discloses a dual polarized printed circuit antenna operating in dual frequency bands. A first array of radiating elements radiates at a first frequency, and a second array of radiating elements radiates at a second, different frequency. Separate power divider arrays are provided for each array of radiating elements, and the overall structure is provided in a stacked configuration.

[0003] A typical communication antenna includes several radiation elements, a feed network and a reflector. The function of the feed network is to allocate signals from a single connector to all dipole antennas. The feed network usually includes controlled impedance transmission lines.

[0004] For feed networks of multiband antennas and smart antennas, a method for separating multiple radio frequency transmission channels in the prior art is shown in FIG. 1. In this method, a thin metal interlayer 2 and a thin metal interlayer 6 are used to separate adjacent radio frequency transmission channel 7 and radio frequency transmission channel 8. The metal interlayers are connected through a screw 11 and a screw 12.

[0005] With rapid development of the mobile communication market, the number of communication networks increases significantly, and operators have an increas-

ingly stronger demand on multiband and multi-system shared antenna, and antenna miniaturization. The structure of the feed network of a multiband antenna and smart antenna is complex, and is critical to the reliability of the entire antenna. Therefore, a stable and reliable feed network with a compact structure is a necessary condition for ensuring multiband and multi-antenna performance.

[0006] However, the complex and excessive metal connections in the feed network in the prior art easily cause the PIM index of the antenna to be unstable and unreliable, and deteriorate the received total wide band power (RTWP, Received Total Wide band Power) or received signal strength indication (RSSI, Received Signal Strength Indication) of the system.

SUMMARY

[0007] Embodiments of the present invention provide a feed network and an antenna, so as to reduce the passive intermodulation interference, and improve the reliability, stability, and mobile communication quality of the antenna.

[0008] An embodiment of the present invention provides a feed network, comprising: at least two separate radio frequency transmission channels, the at least two separate radio frequency transmission channels are separated by a single metal interlayer being on the same plane, one physical surface of the single or metal interlayer faces one of the at least two separate radio frequency transmission channels, and the other physical surface of the single metal interlayer faces another one of the at least two separate radio frequency transmission channels, wherein the radio frequency transmission channels are completely or partially closed except for two ends of a signal transmission direction, wherein the at least two separate radio frequency transmission channels are separated by a single metal interlayer, wherein the single metal interlayer comprises a hole, wherein a metal object is in the hole, one part of the metal object is in one of the at least two separate radio frequency transmission channels, and the other part is in another one of the at least two separate radio frequency transmission channels. An embodiment of the present invention provides an antenna, including a feed network provided in the foregoing embodiment of the present invention.

[0009] In the feed network provided in the embodiment of the present invention, the radio frequency transmission channels are separated by a metal interlayer without using any screw or rivet connection. Therefore, passive intermodulation interference caused by the metal connection is reduced, which increases the reliability and stability of the antenna, enhances the RTWP or RSSI index of the system, and improves the mobile communication quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] To illustrate the technical solutions in the embodiments of the present invention more clearly, the accompanying drawings required for describing the embodiments are briefly described in the following. Apparently, the accompanying drawings in the following description merely show some embodiments of the present invention, and persons of ordinary skill in the art may still derive other drawings from the accompanying drawings without creative efforts.

FIG. 1 is a cross-sectional schematic diagram of a feed network according to the prior art;

FIG. 2 is a three-dimensional schematic diagram of a feed network structure according to Embodiment 1 of the present invention;

FIG. 3 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of the feed network in FIG. 2;

FIG. 4 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to an Example2 of the present invention;

FIG. 5 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 2 of the present invention;

FIG. 6 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 3 of the present invention;

FIG. 7 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 4 of the present invention; and

FIG. 8 is a schematic assembly diagram of a multi-band antenna according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0011] Referring to FIG. 2, FIG. 2 is a three-dimensional schematic diagram of a feed network structure according to Embodiment 1 of the present invention, and FIG. 3 is a schematic diagram of a cross section 27, orthogonal to a signal transmission direction, of the feed network in FIG. 2.

[0012] In the embodiment shown in FIG. 2 or FIG. 3, a feed network includes at least two separate radio frequency transmission channels, which are a radio frequency transmission channel 21 and a radio frequency transmission channel 22. Signal lines, such as a signal line 23, a signal line 24, and a signal line 25, are included in each radio frequency transmission channel. At least one radio frequency transmission channel includes at least two signal lines. For example, the signal line 23 and the signal line 24 are included in the radio frequency

transmission channel 21.

[0013] Unlike the prior art in which two metal interlayers are connected through rivets or screws, in the embodiment of the present invention, the at least two separate radio frequency transmission channels in the feed network are separated by a metal interlayer 26. In the embodiment of the present invention, the metal interlayer 26 has a certain thickness. Therefore, one physical surface of the metal interlayer is exposed to one of the at least two separate radio frequency transmission channels, and the other physical surface of the metal interlayer is exposed to another one of the at least two separate radio frequency transmission channels. For example, one physical surface 261 of the metal interlayer 26 is exposed to the radio frequency transmission channel 21 and the other physical surface 262 is exposed to the radio frequency transmission channel 22.

[0014] The metal interlayer separates the radio frequency transmission channels without using any screw or rivet. Therefore, the feed network provided in the embodiment of the present invention is devoid of unstable PIM index caused by unreliable connection.

[0015] In consideration of information exchange required between two adjacent radio frequency transmission channels or coupling required between two radio frequency transmission channels, the exchange or coupling being either in a wireless manner or a wired manner, an Example of the present invention provides another feed network.

[0016] Referring to FIG. 4, FIG. 4 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to the Example of the present invention. In this Example, a metal interlayer includes several physically continuous metal interlayers, where a gap is between the several physically continuous metal interlayers. For example, in the feed network shown in FIG. 4, the metal interlayer 26 shown in FIG. 2 may be replaced by a metal interlayer 461 and a metal interlayer 462 that are physically continuous. The term "physically continuous" refers to that, although the metal interlayer 26 shown in FIG. 2 may be replaced by the metal interlayer 461 and the metal interlayer 462, the metal interlayer 461 and metal interlayer 462 are on the same plane, and may be regarded as one metal interlayer if a gap between the interlayers is filled. Because there is a gap between the interlayers, a signal line or signal may run through the gap, thereby implementing information exchange between two adjacent radio frequency transmission channels or coupling between two radio frequency transmission channels.

[0017] The feed network shown in FIG. 4 has an alternative solution, which is shown in FIG. 5. In a feed network shown in FIG. 5, a metal interlayer 56 is still one metal interlayer, but different from the metal interlayer 26 shown in FIG. 2, the metal interlayer 56 includes a hole (indicated by the dashed line in FIG. 5), and a signal line or signal may also run through the hole, thereby still implementing information exchange between two adjacent

radio frequency transmission channels or coupling between two radio frequency transmission channels.

[0018] In order to adjust an electrical property of a signal, for example, to adjust a resonance frequency, a metal object such as an aluminum alloy object, a zinc alloy object, or a copper object may be set in the gap (or hole) of the feed network shown in FIG. 4 (or FIG. 5); alternatively, a dielectric part such as FR4 material, microwave sheet material, PS (polystyrene), PTFE (polytetrafluoroethylene), PE (polyethylene), PA66 (polyamide) or POM (polyformaldehyde) is set in the gap (or hole). One part of the metal object or dielectric part is in one of the two separate radio frequency transmission channels, and the other part is in the other one of the two separate radio frequency transmission channels.

[0019] Taking the feed network shown in FIG. 4 as an example, a metal object or dielectric part may be set in the gap, as shown in FIG. 6. In the feed network shown in FIG. 6, one part of a metal object or dielectric part 69 is in the radio frequency transmission channel 21, and the other part is in the radio frequency transmission channel 22. Setting a metal object or dielectric part in the hole of the feed network shown in FIG. 5 is similar to setting a metal object or dielectric part in the gap of the feed network in FIG. 4, which is not described in detail.

[0020] To protect signals in the radio frequency transmission channel from interference or prevent signals in the radio frequency transmission channel from interfering external signals, for example, generating electromagnetic leakage, the feed network shown in FIG. 2 to FIG. 6 may be made into a closed or semi-closed structure. For example, the radio frequency transmission channel, except two ends of the signal transmission direction, is completely closed or partially closed. As shown in FIG. 7, the radio frequency transmission channel 21 is partially closed, and the radio frequency transmission channel 22 is completely closed.

[0021] In the feed network provided in the embodiment of the present invention, the radio frequency transmission channels are separated by the metal interlayer without using any screw or rivet connection, thereby reducing passive intermodulation interference caused by the metal connection, increasing the reliability and stability of the antenna, enhancing the RTWP or RSSI index of the system, and improving the mobile communication quality. Meanwhile, because the metal interlayer is a continuous material layer, no extra size is needed for connection. Therefore, the feed network provided in the present invention has a compact structure, establishes a necessary technical foundation for implementing miniaturization of antennas, especially for miniaturization of multiband and multi-system antennas, reduces the volume and wind load of the antenna, and lowers the requirement on the installation environment of the antenna.

[0022] The present invention also provides a wireless communication system antenna using the foregoing feed network, for example, a multiband antenna, a dual-polarized antenna, a long term evolution (Long Term Evo-

lution, LTE) antenna, or a smart antenna. Referring to FIG. 8, FIG. 8 is an assembly schematic view of a multiband antenna according to an embodiment of the present invention. To facilitate description, only the parts related to the present invention are shown. The antenna includes several radiation/receiving units 801, a feed network 803 provided in the embodiment of the present invention, a calibration network 804 and a dielectric part substrate 805. The radiation/receiving units 801 are configured to radiate wireless signals to the outside or receive external wireless signals. The feed network 803 may be printed on the dielectric part substrate 805 and configured to allocate signals from a single connector to each of the radiation/receiving units 801. The calibration network 804 is configured to perform real-time calibration on an amplitude and a phase of each radiation/receiving unit 801 during operation of the antenna system.

[0023] In the feed network provided in the present invention, the radio frequency transmission channels are separated by a metal interlayer without using any screw or rivet connection, thereby reducing passive intermodulation interference caused by the metal connection, increasing the reliability and stability of the antenna, enhancing the RTWP or RSSI index of the system, and improving the mobile communication quality. Meanwhile, because the metal interlayer is a continuous material layer, no extra size is needed for connection. Therefore, the feed network provided in the present invention has a compact structure, establishes a necessary technical foundation for implementing miniaturization of antennas, especially for miniaturization of multiband and multi-system antennas, reduces the volume and wind load of the antenna, and lowers the requirement on the installation environment of the antenna.

Claims

1. A feed network, comprising: at least two separate radio frequency transmission channels (21, 22), the at least two separate radio frequency transmission channels (21, 22) are separated by a single metal interlayer (26, 56) being on the same plane, one physical surface of the single metal interlayer (26, 56) faces one of the at least two separate radio frequency transmission channels (21, 22), and the other physical surface of the single metal interlayer (26, 56) faces another one of the at least two separate radio frequency transmission channels (21, 22), wherein the radio frequency transmission channels (21, 22) are completely or partially closed except for two ends of a signal transmission direction, wherein the at least two separate radio frequency transmission channels (21, 22) are separated by a single metal interlayer (56), wherein the single metal interlayer (56) comprises a hole; **characterized in that** a metal object is in the hole, one part of the metal object is in one of the at least two separate

radio frequency transmission channels (21, 22), and the other part is in another one of the at least two separate radio frequency transmission channels (21, 22).

2. The feed network according to claim 1, wherein at least one of the radio frequency transmission channels (21, 22) comprises at least two signal lines.
3. The feed network according to claim 1, wherein each radio frequency transmission channels (21, 22) comprises at least one signal line.
4. An antenna, **characterized in that** the antenna comprises the feed network according to any one of claims 1 to 3.

Patentansprüche

1. Speisenetz, das Folgendes umfasst: wenigstens zwei getrennte Funkfrequenzübertragungskanäle (21, 22), wobei die wenigstens zwei getrennten Funkfrequenzübertragungskanäle (21, 22) durch eine einzige Metallzwischenschicht (26, 56), die sich auf der gleichen Ebene befindet, getrennt sind, eine physische Oberfläche der einzigen Metallzwischenschicht (26, 56) einem der wenigstens zwei getrennten Funkfrequenzübertragungskanäle (21, 22) zugewandt ist und die andere physische Oberfläche der einzigen Metallzwischenschicht (26, 56) einem anderen der wenigstens zwei getrennten Funkfrequenzübertragungskanäle (21, 22) zugewandt ist, wobei die Funkfrequenzübertragungskanäle (21, 22) außer zwei Enden einer Signalübertragungsrichtung vollständig oder teilweise abgeschlossen sind, wobei die wenigstens zwei getrennten Funkfrequenzübertragungskanäle (21, 22) durch eine einzige Metallzwischenschicht (56) getrennt sind, wobei die einzige Metallzwischenschicht (56) ein Loch umfasst;
dadurch gekennzeichnet, dass sich ein Metallobjekt in dem Loch befindet, sich ein Teil des Metallobjekts in einem der wenigstens zwei getrennten Funkfrequenzübertragungskanäle (21, 22) befindet und sich der andere Teil in einem anderen der wenigstens zwei getrennten Funkfrequenzübertragungskanäle (21, 22) befindet.
2. Speisenetz nach Anspruch 1, wobei wenigstens einer der Funkfrequenzübertragungskanäle (21, 22) wenigstens zwei Signalleitungen umfasst.
3. Speisenetz nach Anspruch 1, wobei jeder Funkfrequenzübertragungskanal (21, 22) wenigstens eine Signalleitung umfasst.

4. Antenne, **dadurch gekennzeichnet, dass** die Antenne das Speisenetz nach einem der Ansprüche 1 bis 3 umfasst.

Revendications

1. Réseau d'alimentation, comprenant : au moins deux canaux de transmission radiofréquence séparés (21, 22), les au moins deux canaux de transmission radiofréquence séparés (21, 22) sont séparés par une unique intercouche métallique (26, 56) qui est sur le même plan, une surface physique de l'unique intercouche métallique (26, 56) fait face à l'un des au moins deux canaux de transmission radiofréquence séparés (21, 22), et l'autre surface physique de l'unique intercouche métallique (26, 56) fait face à un autre des au moins deux canaux de transmission radiofréquence séparés (21, 22), dans lequel les canaux de transmission radiofréquence (21, 22) sont complètement ou partiellement fermés à l'exception de deux extrémités d'une direction de transmission de signal, dans lequel les au moins deux canaux de transmission radiofréquence séparés (21, 22) sont séparés par une unique intercouche métallique (56), dans lequel l'unique intercouche métallique (56) comprend un trou ;
caractérisé en ce que un objet métallique est dans le trou, une partie de l'objet métallique est dans l'un des au moins deux canaux de transmission radiofréquence séparés (21, 22), et l'autre partie est dans un autre des au moins deux canaux de transmission radiofréquence séparés (21, 22).
2. Réseau d'alimentation selon la revendication 1, dans lequel au moins l'un des canaux de transmission radiofréquence (21, 22) comprend au moins deux lignes de signal.
3. Réseau d'alimentation selon la revendication 1, dans lequel chaque canal de transmission de radiofréquence (21, 22) comprend au moins une ligne de signal.
4. Antenne, **caractérisée en ce que** l'antenne comprend le réseau d'alimentation selon l'une quelconque des revendications 1 à 3.

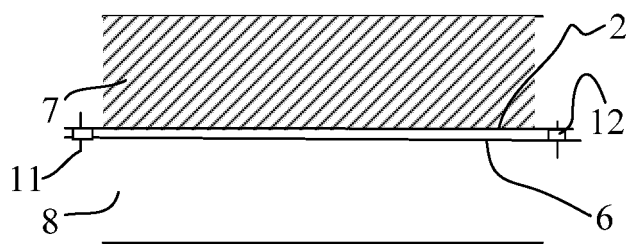


FIG. 1

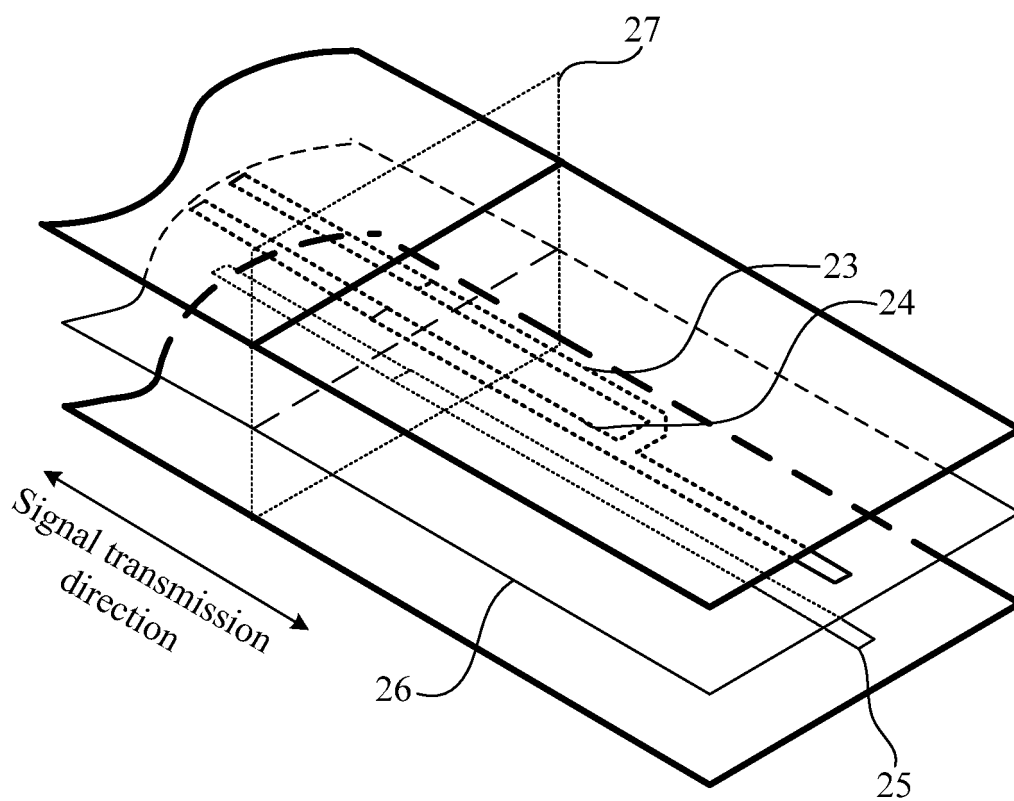


FIG. 2

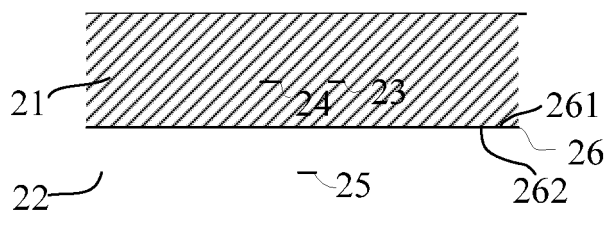


FIG. 3

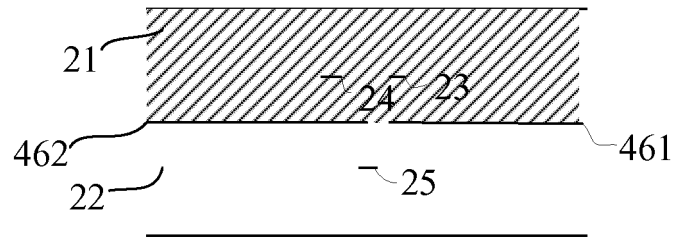


FIG. 4

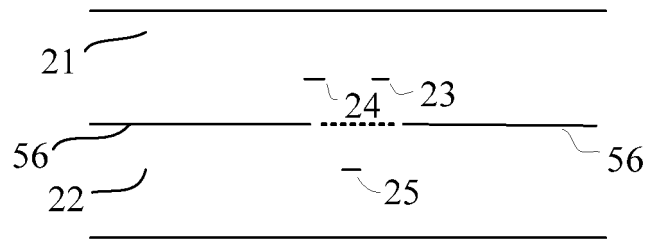


FIG. 5

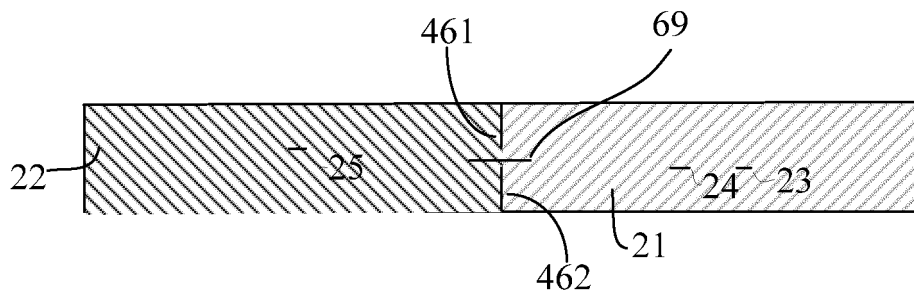


FIG. 6

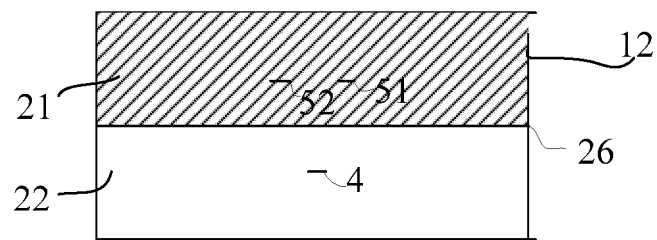


FIG. 7

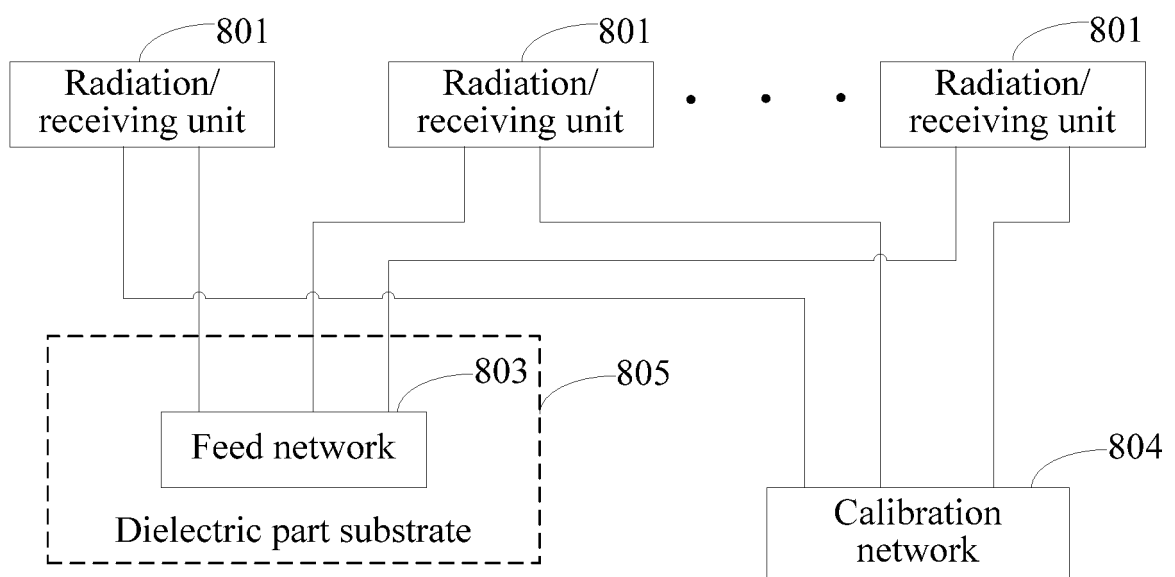


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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