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

(11) EP 0 805 506 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
05.11.1997 Bulletin 1997/45

(21) Application number: **96937561.7**

(22) Date of filing: **12.11.1996**

(51) Int. Cl.^{6}: **H01Q 1/24**, H01Q 21/30

(86) International application number:
PCT/JP96/03315

(87) International publication number:
WO 97/19488 (29.05.1997 Gazette 1997/23)

(84) Designated Contracting States:
DE FI FR GB

(30) Priority: **22.11.1995 JP 326249/95**

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(54) ANTENNA

(57) When the antenna element of an antenna is expanded, a helical element (4) acts as a parasitic element, and a high-frequency current flows through an element conductor (3), causing the element (4) to act as a parasitic element which is excited in a high frequency wave way. When the antenna element is housed, electrical energy is fed to the upper end of the element (4) from the upper end of an upper conductor section (6), and the overlapping parts of the element (4) and section (6) form an L-C parallel resonance circuit. Therefore, the antenna makes two-resonance operation.

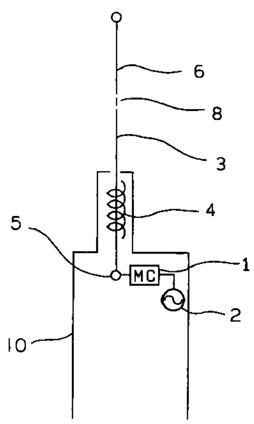

FIG.1(a)

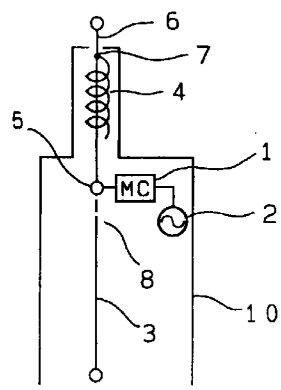

FIG.1(b)

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Description

TECHNICAL FIELD

The present invention relates to an antenna provided slidably in a casing, and more particularly, to an antenna which is suitable for use in a portable radio telephone.

BACKGROUND ART

Figs. 5(A) and (B) show general views of a conventional antenna of this type. The type A antenna shown in Fig. 5(A) comprises an antenna element provided with an insulating section 106 on the upper portion of an element conductor 103, and a helical element 104, as disclosed in Japanese Unexamined Patent No.6-216630. The antenna element can be retracted inside the casing 100 and the retracted antenna element can be extended from the casing 100, by sliding it through the helical element 104. The helical element 104 is fixed in a projecting section in the upper portion of the casing 100.

Figure (a) in Fig. 5(A) shows the antenna element in an antenna of this type in a state where it is extended by sliding the antenna element. In this case, a signal from a signal source 102 inside the casing 100 is supplied to a power supply section 105 via a matching circuit (MC) 101. The power supply section 105 is electrically connected to the lower end of the element conductor 103 and the lower end of the helical element 104, and the element conductor 103 and helical element 104 assume an operational state.

Figure (b) in Fig. 5(A) shows the antenna element in a state where it is retracted inside the casing 100 by sliding the antenna element. In this case, the signal from the signal source 102 inside the casing 100 is supplied to the power supply section 105 via the matching circuit (MC) 101, but the power supply section 105 is electrically connected only to the lower end of the helical element 104, and only the helical element 104 assumes an operational state.

In this case, the insulating section 106 formed on the upper portion of the antenna element assumes a position inside the helical element 104, such that the antenna element has no effect on the helical element 104.

Fig. 5(B) shows a general view of a type B conventional antenna having a different composition to the aforementioned antenna. This antenna comprises an antenna element, wherein an insulating section 106 is provided at the upper portion and lower portion of a coil-shaped element conductor 103, and a helical element 104, as disclosed in Japanese Unexamined Patent No.2-271701. The antenna element can be retracted inside helical element 104 and the retracted antenna element can be extended from the casing 100, by sliding it through the helical element 104.

The helical element 104 is fixed in a projecting section in the upper portion of the casing.

Figure (a) in Fig. 5(B) shows the antenna element of an antenna of this type in a state where it is extended by sliding the antenna element. In this case, a signal from a signal source 102 inside the casing 100 is supplied to a power supply section 105 via a matching circuit (MC) 101. The power supply section 105 is electrically connected to the lower end of the helical element 104 and the helical element is driven. Due to inductive coupling between the helical element 104 and the coil-shaped element conductor 103, the element conductor 103 is also driven by means of the helical element 104 being driven.

Therefore, the antenna element and the helical element 104 assume an operational state. Here, the insulating section 106 formed at the lower portion of the antenna element assumes a position inside the helical element 104.

Figure (b) in Fig. 5(B) shows the antenna element in a state where it is retracted inside the casing 100 by sliding the antenna element. In this case, the signal from the signal source 102 inside the casing 100 is supplied to a power supply section 105 via a matching circuit (MC) 101, and the helical element 104 connected to the power supply section 105 assumes an operational state. The coil-shaped element conductor 103 is retracted inside the casing 100 and assumes an non-operational state.

In this case, the insulating section 106 formed on the upper portion of the antenna element assumes a position inside the helical element 104.

Next, to describe the operation of the antenna, when the antenna element is extended in a type A conventional antenna as described above, the element conductor 103 and the helical element 104 are connected in parallel. Here, the helical element 104 has the action of increasing the equivalent thickness of the element conductor 103, with the result that frequency-to-impedance characteristics show a broader bandwidth than in an independent element conductor 103. Fig. 3(a) shows characteristics for voltage standing wave ratio (VSWR) against frequency in a type A antenna, and since the helical element 104 and the element conductor 103 are set to the same resonant frequency, simple resonance characteristics are obtained.

When the antenna element is retracted in a type A conventional antenna as described above, only the helical element 104 assumes an operational state, and it forms an L - C series resonance antenna. Therefore, the frequency-to-VSWR characteristics in this case show simple resonance for both type A and type B antennas, as illustrated in Fig. 3(b).

When the antenna element is extended in a conventional type B antenna as described above, the helical element 104 connects with the power supply section. In this case, the helical element 104 is coupled by induction to the element conductor 103, which forms a passive element, and the element conductor 103 is driven at high frequency. Fig. 3(a) shows frequency-to-voltage standing wave ratio (VSWR) characteristics for a type B antenna, and since the resonant frequency of the helical element 104 and element conductor 103 are set to the sane frequency, simple resonance characteristics are obtained.

When the antenna element in a type B conventional antenna is retracted, only the helical element 104 operates, thereby forming an L - C series resonance antenna. Accordingly, the frequency-to-VSWR characteristics in this case form a simple resonance curve for both type A and type B antennas, as shown in Fig. 3(b).

In a portable telephone, the transmission band and the reception band at a mobile station are respectively assigned to different frequency bands, as indicated on the frequency axis shown in Fig. 3. It is therefore necessary for the antenna of a portable telephone to have characteristics covering both the transmission band and the reception band.

However, as shown in Fig. 3, type A and type B conventional antennas produce a simple resonance curve, both when they are extended and when they are retracted, and therefore it is not possible to obtain suitable characteristics covering both the transmission band and the reception band.

It is an object of the present invention to provide an antenna capable of covering a transmission band and reception band respectively assigned to different frequency bands, both when the antenna is extended and when it is retracted.

DISCLOSURE OF THE INVENTION

In order to achieve the aforementioned object, in an antenna comprising an antenna element provided with an upper conducting section at the upper portion of an element conductor via an insulating section, and a helical element, the antenna according to the present invention is composed such that the antenna element is extendable by sliding it through the helical element, and when the antenna element is in an extended state, the lower end of the antenna element forms a power supply section, and when the antenna element is in a retracted state, the upper end of the helical element makes contact with the upper end of the upper conducting section, and the lower end of the upper conducting section forms a power supply section.

Furthermore, in the antenna described above, the antenna element can slide freely inside a holder conductor connected to a circuit inside the casing: when the antenna element is in an extended state, the lower end of the antenna element connects with the holder conductor; and when the antenna element is in a retracted state, the lower portion of the upper conducting section connects with the holder conductor.

When the antenna element is extended or when it is retracted, the antenna element and helical element operate as a dual resonance antenna.

According to the antenna of the present invention, since an antenna comprising an antenna element and a helical element is composed such that it operates as a dual resonance antenna, it is possible to obtain antenna characteristics covering a transmission band and a reception band which are respectively assigned to different frequency bands, both when the antenna is extended and when it is retracted.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1(a) shows a general view of the composition of a mode for implementing the antenna according to the present invention, when the antenna is extended; and Fig. 1(b) shows a general view of the composition of a mode for implementing the antenna according to the present invention, when the antenna is retracted;

Fig. 2(a) shows a detailed compositional example of a mode for implementing the antenna according to the present invention, when the antenna is extended; and Fig. 2(b) shows a detailed compositional example of a mode for implementing the antenna according to the present invention, when the antenna is retracted;

Fig. 3(a) shows frequency-to-VSWR characteristics for an antenna according to the present invention and conventional antennas, when the antenna is extended; and Fig. 3(b) shows frequency-to-VSWR characteristics for an antenna according to the present invention and conventional antennas, when the antenna is retracted;

Fig. 4 shows a further detailed compositional example of a mode for implementing an antenna according to the present invention; and

Fig. 5(A) is a diagram showing a general view of the composition of a type A conventional antenna; and Fig. 5(B) is a diagram showing a general view of the composition of a type B conventional antenna.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention is now described in more detail in accordance with the appended drawings.

Figs. 1(a) and (b) show the general composition of a mode for implementing an antenna according to the present invention; and in these diagrams, an antenna is constituted by an antenna element having an upper conducting section 6 formed at the upper portion of an element conductor 3 via an insulating section 8, and a helical element 4.

In this antenna, the antenna element is composed such that it slides through the helical element 4 and it can be moved in and out of a casing 10: Fig. 1(b) shows the antenna element in a state where it is retracted into the casing 10 and Fig. 1(a) shows the antenna element in a state where it is extended from the casing 10. The helical element 4 is fixed in a projecting section in the upper portion of the casing 10.

When the antenna element of an antenna of this kind is extended, a signal from a signal source 2 inside the casing 10 is supplied via a matching circuit (MC) 1 to a power supply section 5. The power supply section 5 is electrically connected to the lower end of an element conductor 3, which assumes an operational state. In this case, the helical element 4 forms a passive element which is not connected at any point, but it is driven at high frequency due to high-frequency current flowing in the element conductor 3.

When the antenna element is in a state where it is retracted inside the casing 10, as shown in Fig. 1(b), the signal from the signal source 2 inside the casing 10 is supplied to the power supply section 5 via the matching circuit (MC) 1, and the power supply section 5 assumes electrical connection with the lower end of the upper conducting section 6 on the upper portion of the antenna element. The upper end of the helical element 4 assumes electrical connection with the upper end of the upper conducting section 6 at a contact point 7. Thereby, the helical element 4 is driven via the upper conducting section 6.

In this case, the element conductor 3 is insulated from the upper conducting section 6 by means of the insulating section 8 and it assumes a non-operational state.

Next, to describe the operation of an antenna according to the present invention, when the antenna element is extended, the element conductor 3 is connected to the power supply section 5 and the element conductor 3 is driven. In this case, the helical element 4 acts as a parasitic element, driven at a high frequency by the high-frequency current flowing in the element conductor 3, and since, for example, the resonant frequency of the helical element 4 is set to the central frequency of the mobile station reception band, and the resonant frequency of the element conductor 3 is set to the central frequency of the mobile station transmission band, dual resonance characteristics are obtained in the frequency-to-impedance characteristics of the antenna.

Namely, the frequency-to-voltage standing wave ratio (VSWR) characteristics for the antenna when it is extended show dual resonance characteristics covering the assigned mobile station transmission band and mobile station reception band, as shown in Fig. 3(a) relating to the present invention.

In the antenna according to the present invention, when the antenna element is retracted, since the upper conducting section 6 connects with the power supply section 5 and the upper end of the upper conducting section 6 connects with the helical element 4, a distributed capacitance is generated at the overlapping section between the upper conducting section 6 and the helical element 4. Consequently, an L - C parallel resonance circuit is formed, and a different resonant frequency to the intrinsic resonant frequency of the upper conducting section 6 is produced. Thereby, dual resonance characteristics are obtained.

Namely, when the antenna is retracted, the frequency-to-VSWR characteristics for the antenna also show dual resonance characteristics covering the assigned mobile station transmission band and mobile station reception band, as shown in Fig. 3(b) relating to the present invention.

As described above, by composing the antenna according to the present invention such that the element conductor 3 and the helical element 4 have different resonant frequencies, the antenna operates as a dual resonance antenna covering a mobile station transmission band and a mobile station reception band, both when the antenna is extended and when it is retracted. An example of the detailed composition of such an antenna is shown in Figs. 2(a) and (b).

Fig. 2(a) shows the antenna element in a state where it is extended from the casing 10 and Fig. 2(b) shows the antenna in a state where it is retracted inside the casing 10.

The antenna element shown in Figs. 2(a) and (b) is formed with an insulating antenna top 13 at the end thereof, and an upper conducting section 6 is fitted over the circumference of the lower portion of an extended section with extends downwards from the antenna top 13. The lower end of the extended section of the antenna top 13 projects from the lower end of the upper conducting section 6 and this projecting extended section and the upper end of an element conductor 3 are formed into a single integrated unit by moulding.

An insulating tube 9 is fitted over the outer circumference of this element conductor 3, and a stopper conductor 11 is fitted to the lower end of the element conductor 3 over the insulating tube 9, such that the element conductor 3 and the stopper conductor 11 are electrically connected.

This antenna element is inserted through a helical element 4 which is housed in a projecting section on the outer side of a casing 10, and it passes slidably through a holder conductor 12 fixed to the casing 10. This holder conductor 12 is electrically connected to a matching circuit 1, and the matching circuit 1 is connected to a signal source 2.

When the antenna is transmitting, this signal source 2 corresponds to the final stage of a transmission section provided in the casing 10, and when the antenna is receiving, the signal source 2 corresponds to the reception signal supplied to a reception section provided in the casing 10.

When the antenna element is extended, as shown in Fig. 2(a), the stopper conductor 11 fitted to the lower end of the element conductor 3 engages with the holder conductor 12, assuming electrical connection therewith, whereby the signal source 2 is connected, via the matching circuit 1 and the holder conductor 12 and stopper conductor 11, to the element conductor 3. Thereupon, the helical element 4, which forms a passive element and is not connected at any point, is coupled at high frequency with the element conductor 3 due to high-frequency current flowing in the element conductor 3, and the helical element 4 thereby operates as a parasitic element.

The upper conducting section 6 does not function as an antenna due to the insulating section 8.

When the antenna element is retracted inside the casing 10, as shown in Fig. 2(b), the antenna top 13 abuts the projecting section on the outer side of the casing 10, the upper conducting section 6 is inserted through the helical element 4, and the lower portion thereof engages with the holder conductor 12 and assumes electrical connection therewith. Therefore, the signal source 2 connected via the matching circuit 1 is supplied via the holder conductor 12 to the lower portion of the upper conducting section 6. Furthermore, in this case, the upper end of the upper conducting section 6 connects with the upper end of the helical element 4 and a high-frequency current flows through the upper conducting section 6 and the helical element 4.

The element conductor 3 assumes a non-operational state due to the action of the insulating section 8. Meanwhile, the overlapping section between the upper conducting section 6 and the helical element 4 forms an L - C parallel resonance circuit.

Next, a further example of the detailed composition of an antenna according to the present invention is shown in Fig. 4. The antenna shown in this diagram differs from the composition of the antenna shown in Figs. 2(a) and (b) in that it is formed as an independent unit, rather than being integrated in a casing 10. The operation of this antenna is the same as the operation of the antenna shown in Figs. 2 (a) and (b), and therefore it is not described in detail here, and the description will relate to the aforementioned point of difference.

Fig. 4 shows an antenna element in an extended state; a stopper 11 electrically connected to the lower end of an element conductor 3 which is fitted inside an insulating tube 9 abuts the lower end of a holder conductor 12. In this state, the holder conductor 12 and the element conductor 3 connect with each other, and the element conductor 3 connects with a matching circuit 1, and the like, provided inside a casing 10.

A helical element 4, which forms a passive element and is coupled at high frequency to the element conductor 3 by means of high-frequency current flowing in the element conductor 3, is located inside a helical element cover 14 made from resin, or the like. This helical element cover 14 is fixed to the upper portion of the holder conductor 12.

When an antenna composed in this way is fitted to a casing 10, it should be fitted using installation screw section 12-1 formed on the lower portion of the holder conductor 12.

In the antenna according to the present invention described above, since the element conductor 3 is made from an elastic material, the element conductor 3 covered by the insulating tube 9 is flexible, and therefore it is possible to prevent the antenna element from breaking even when the extended antenna element hits an obstacle, or the like.

Furthermore, the antenna operating mode can be set to a desired measurement from about 1/4 wavelength to about 1/2 wavelength. In this case, if the conditions are near 1/4 wavelength, then the matching circuit 1 can be omitted.

INDUSTRIAL APPLICABILITY

Since the antenna according to the present invention is composed such that the resonant frequency of the element conductor and the resonant frequency of the helical element are different, if the helical element forms a passive component, then it will operate as a parasitic element, producing dual resonance characteristics, and if power is supplied to the helical element, then the overlapping section between the upper conducting section and the helical element will form an L - C parallel resonance circuit, producing dual resonance characteristics.

Therefore, the antenna according to the present invention is capable of functioning as a dual resonance antenna covering the transmission band and reception band of a mobile station, both when it is extended and when it is retracted, and it is suitable for application to portable devices, and in particular, portable radio telephones.

Claims

1. An antenna comprising an antenna element provided with an upper conducting section (6) at the upper portion of an element conductor (3) via an insulating section (8), characterized in that said antenna element is extendable by sliding it through an helical element (4), and when said antenna element is in an extended state, the lower end of said antenna element forms a power supply section (5), and said helical element (4), which forms a passive element, is driven at high frequency by said antenna element, and when said antenna element is in a retracted state, the upper end of said helical element (4) connects with the upper end of said upper conducting section (6), the lower end of which forms the power supply section (5), and a parallel resonance circuit is formed by the overpalling section between said upper conducting section (6) and said helical element (4), whereby said antenna element and said helical element operate as a dual resonance antenna, both when the antenna element is extended and when it is retracted.

2. Antenna according to claim 1 characterized in that said antenna element can slide freely inside a holder conductor (12) connected to a circuit (1) inside a casing, and when said antenna element is in an extended state, the lower end of said antenna

element connects with said holder conductor (12); and when said antenna element is in a retracted state, the lower portion of said upper conducting section (6) connects with said holder conductor (12).

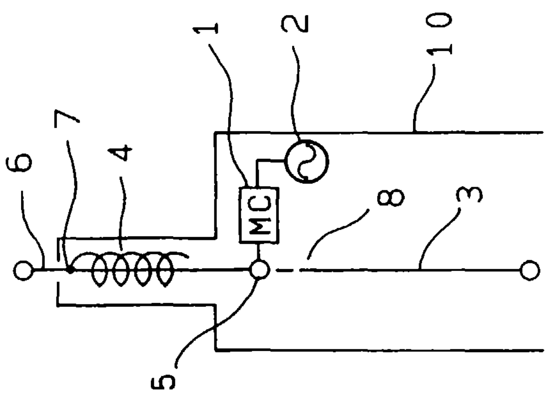


FIG.1(b)

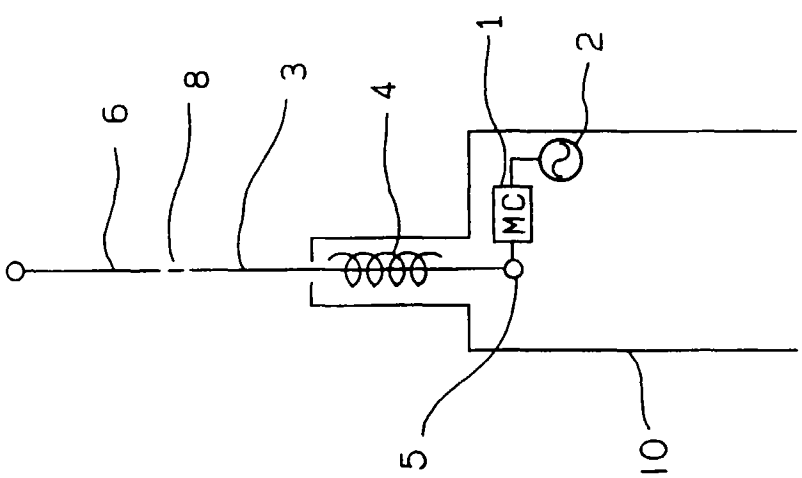


FIG.1(a)

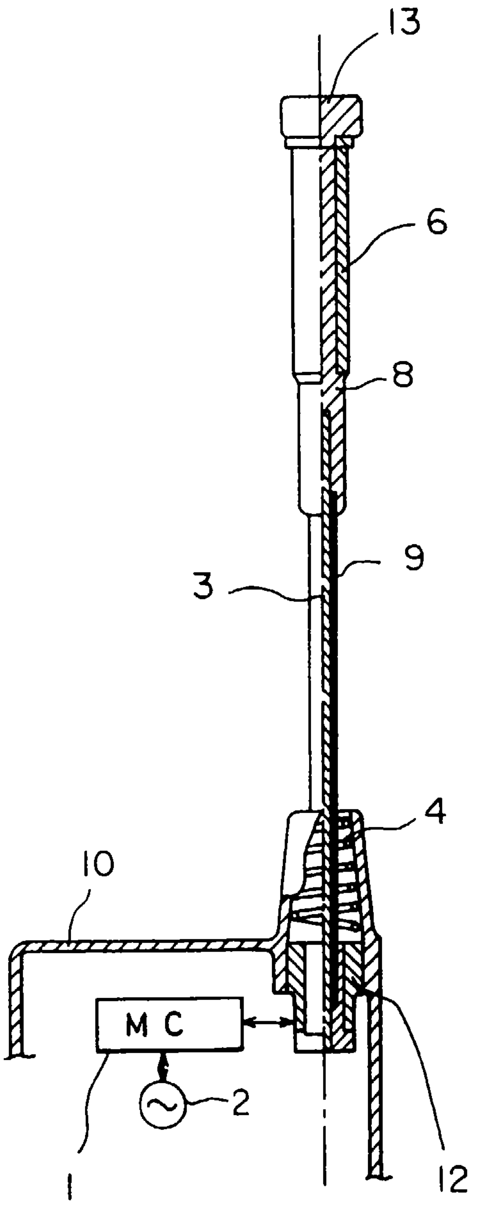


FIG.2(a)

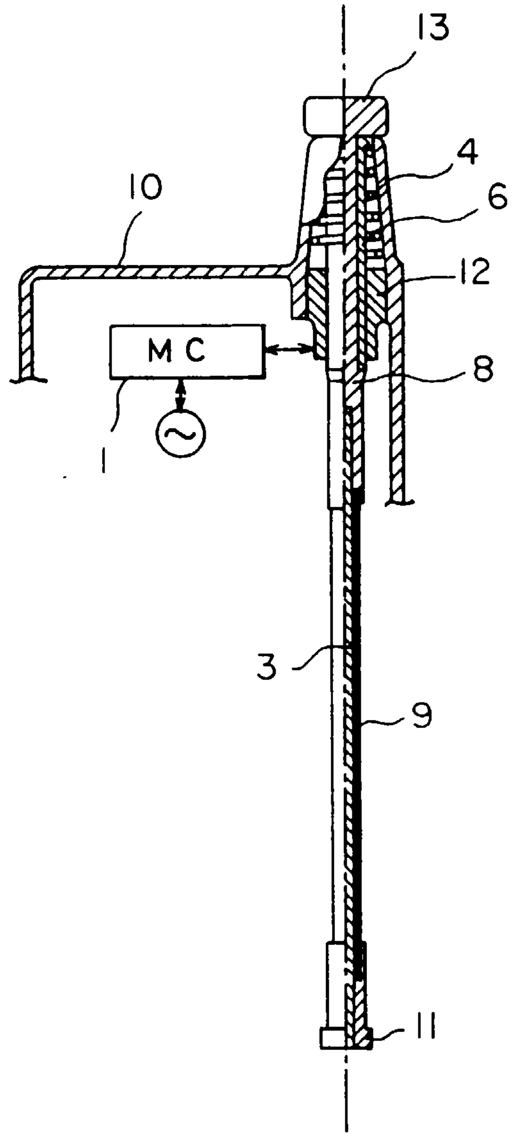


FIG.2(b)

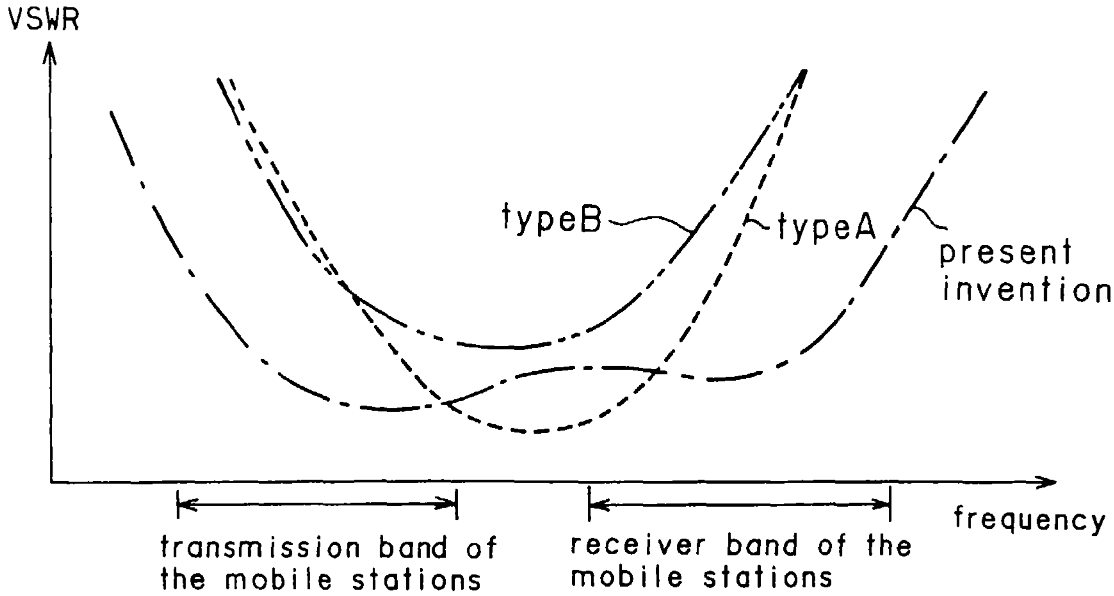
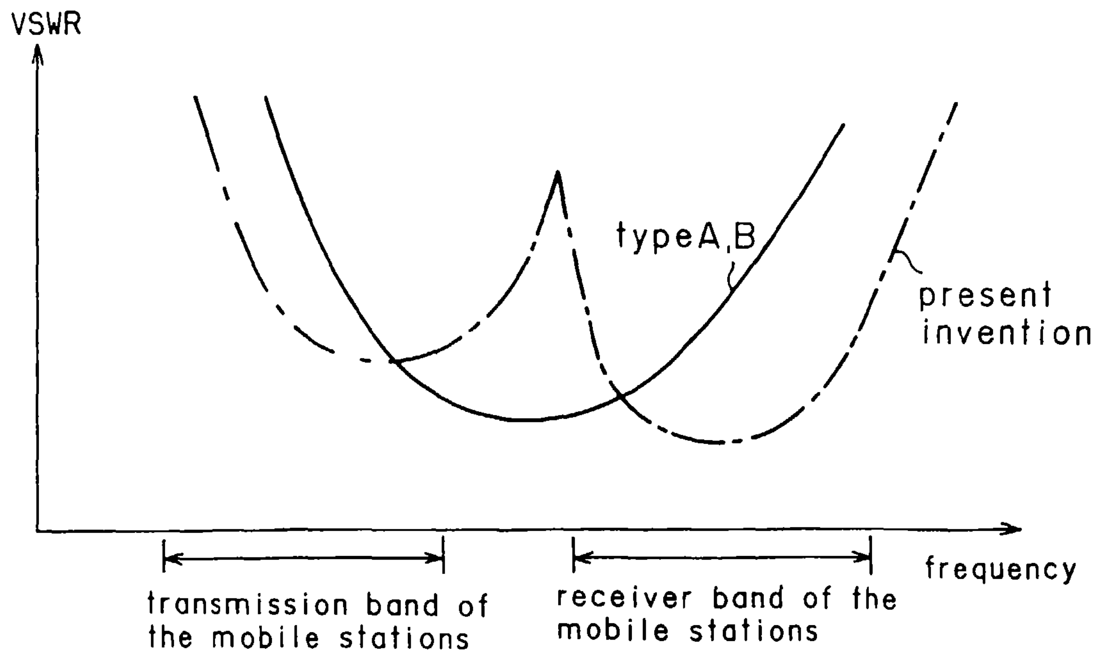

VSWR
typeB
typeA
present invention
frequency
transmission band of the mobile stations
receiver band of the mobile stations

FIG.3(a)


VSWR
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present invention
frequency
transmission band of the mobile stations
receiver band of the mobile stations

FIG.3(b)

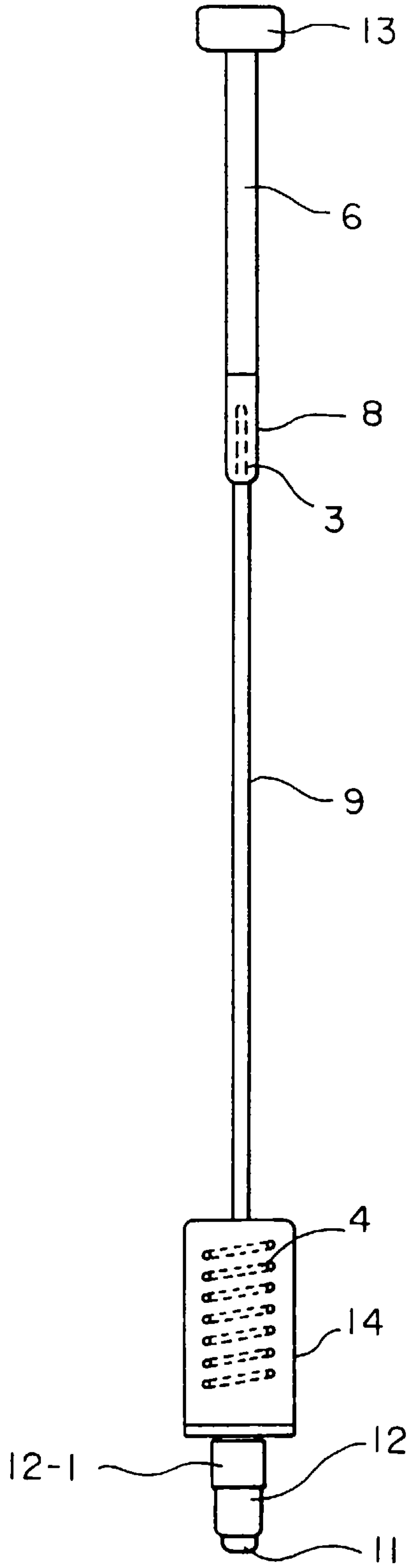

FIG.4

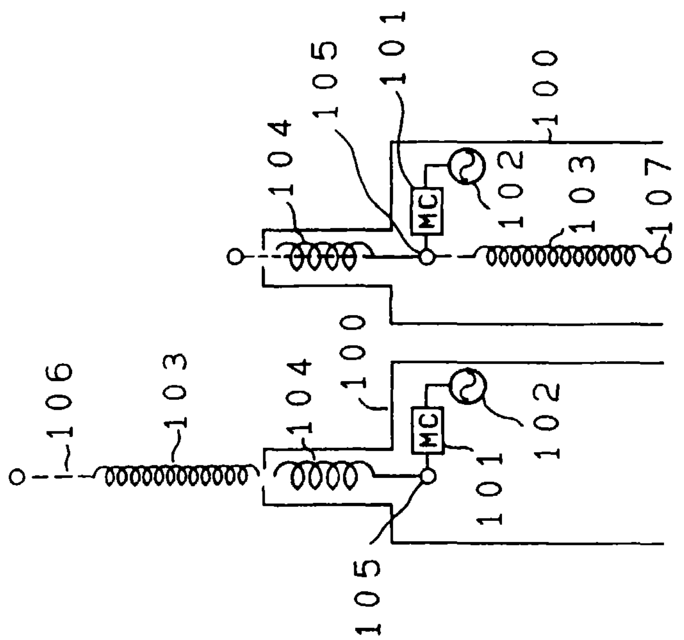

FIG.5B(a) FIG.5B(b)

typeB

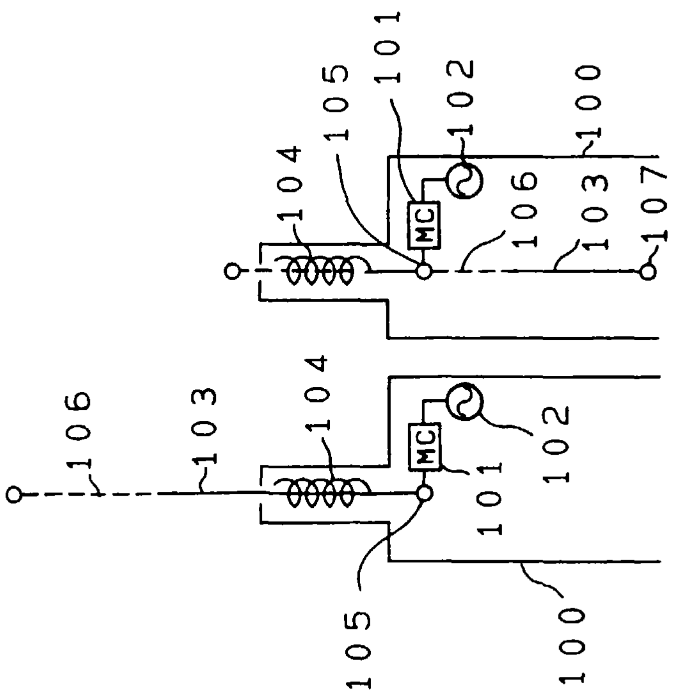

FIG.5A(a) FIG.5A(b)

typeA

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/03315

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 H01Q1/24, H01Q21/30

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)

Int. Cl^6 H01Q1/12-1/26, H04B1/38-1/58, H01Q5/00-5/02, H01Q9/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1996
Kokai Jitsuyo Shinan Koho	1971 - 1996
Toroku Jitsuyo Shinan Koho	1994 - 1996

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.
X,P	JP, A, 8-503830 (Saldell, Ulf), April 23, 1996 (23. 04. 96), Page 7, line 7 to page 8, line 25; Fig. 1	1 - 3
X	& WO, 94/28593	
X	JP, A, 6-216630 (Nippon Antenna Co., Ltd.), August 5, 1994 (05. 08. 94), Paragraphs (0009) to (0016); Fig. 1 (Family: none)	1 - 3
X	JP, A, 5-102717 (Kyocera Corp.), April 23, 1993 (23. 04. 93), Paragraphs (0008) to (0009); Fig. 1 (Family: none)	1 - 3

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "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

Date of the actual completion of the international search	Date of mailing of the international search report
January 14, 1997 (14. 01. 97)	January 28, 1997 (28. 01. 97)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)