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(54) ANTENNA

(57) An antenna 10 comprises a first antenna element 1 forming a helical antenna, and a second antenna element 2 forming a whip antenna, placed in a linear arrangement. The antenna 10 is rotatable by means of a rotating axle 3 and one or other of the antenna elements is connected to a signal source 7 inside a casing, when the antenna element is set in position. A first contact terminal 5 for the first antenna element and second contact terminal 6 for the second antenna element, which connect with a contact terminal on the casing side, are provided for this purpose. Matching circuits 4, 9 for matching antenna elements assumed to be LLL/2 in electrical length, may be provided inside the antenna 10. By this means, the antenna can be reduced in size and impedance matching can be performed readily.

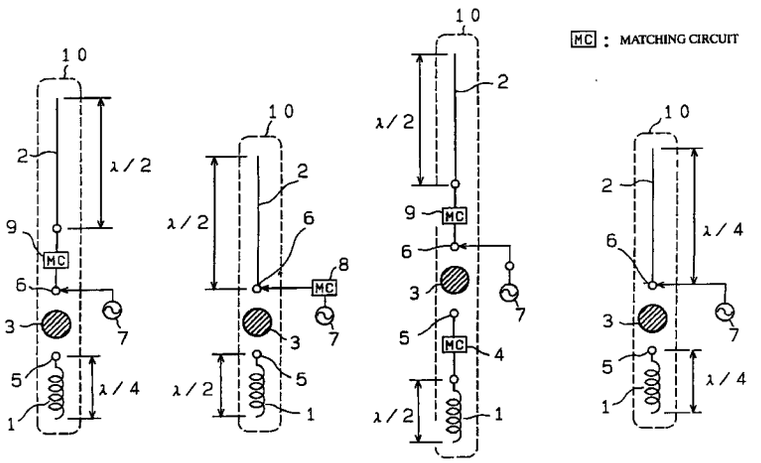


FIG.1 (a) FIG.1 (b) FIG.1 (c) FIG.1 (d)

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Description

TECHNICAL FIELD

The present invention relates to an antenna whereby one or other of two different types of antenna element can be used, and in particular, to an antenna which is suitable for application to a portable radio telephone.

BACKGROUND ART

Conventionally known antennas of this type include: a type A antenna as shown in Fig. 12(a) and disclosed in Japanese Unexamined Patent 3-245603, a type B antenna as shown in Fig. 12(b) and disclosed in Japanese Unexamined Patent 6-216630 and a type C antenna as shown in Fig. 12(c) and disclosed in Japanese Unexamined Patent 2-271701.

The type A antenna comprises a retractable whip antenna element 103 which slides into a casing 100, and a helical antenna element 104 formed at the end of the whip antenna element 103 via an insulating section 106. When the type A antenna is drawn out from the casing 100, a signal source 102 contacts the whip antenna element 103 via a matching circuit (MC) 101, whereby the whip antenna element 103 assumes an operational state. Furthermore, when the type A antenna is retracted inside the casing 100, the helical antenna element 103 projects from the casing 100 and connects with the matching circuit 101, whereby the helical antenna element 103 assumes an operational state.

The insulating section 106 is formed such that the whip antenna element 103 and the helical antenna element 104 do not affect each other.

Furthermore, the type B antenna comprises a helical antenna element 104 housed in a projecting portion of a casing 100 and a retractable whip antenna element 103 which slides into the casing 100. When the type B antenna is drawn out of the casing 100, the whip antenna element 103 connects with a signal source 102 via a matching circuit (MC) 101, whereby the whip antenna element 103 assumes an operational state. When the type A antenna is retracted inside the casing 100, only the helical antenna element 104 connects with the signal source 102 via the matching circuit 101, whereby the helical antenna element 103 assumes an operational state.

The insulating section 106 is formed such that the whip antenna element 103 and the helical antenna element 104 do not affect each other.

The type C antenna comprises a helical antenna element 104 housed in a projecting section of a casing 100 and a retractable whip antenna element 103 formed in a helical shape, which slides into the casing 100. When the type C antenna is drawn out of the casing 100, the whip antenna element 103 assumes an operational state by means of capacitive coupling between the helical antenna element 104, which is connected to a signal source 102 via a matching circuit (MC) 101, and the whip antenna element 103. Furthermore, when the type A antenna is retracted inside the casing 100, the capacitive coupling between the helical antenna element 104 and the whip antenna element 103 is broken and only the helical antenna element 104 assumes an operational state.

The insulating section 106 is formed such that the whip antenna element 103 and the helical antenna element 104 do not affect each other.

In conventional antennas of this type, when the antenna is extended, there is an unnecessary helical antenna element section and/or an insulating section corresponding to the length of the helical antenna element located at the end of the whip antenna element section, and therefore, the overall length of the antenna is increased and a large space for housing the antenna is required. When a helical antenna element section is formed at the end thereof, the end of the antenna becomes enlarged in size.

In this way, there are obstacles to reducing the size of telephones equipped with conventional antennas of this type.

Furthermore, in conventional antennas, impedance matching for the whip antenna element when the antenna is extended and the helical antenna element when the antenna is retracted is conducted by a single matching circuit, but there are various combinations of whip antenna element length and helical antenna element length, so the circuit cannot readily achieve impedance matching for both antennas, there will be a disparity in impedance matching between the two antennas, as shown in Fig. 10, and the SWR will deteriorate.

There is also a problem in that when manufacturing the helical antenna element section, it is difficult the maintain and control characteristics from the coil winding process up to the resin moulding process, and there will be variation in the sliding force of the whip antenna element.

Therefore, it is an object of the present invention to provide an antenna which is simple to manufacture, whereby size reduction is possible, and impedance matching can be performed readily.

DISCLOSURE OF THE INVENTION

In order to achieve the aforementioned objects, the antenna according to the present invention comprises a first antenna element and a second antenna element of mutually different shapes provided in a linear arrangement, and further comprises a through hole provided between the first antenna element and second antenna element, the first antenna element and second antenna element being held rotatably in a main section by means of a rotating axle supported by the through hole, such that power supply means can be connected to either of the antenna elements set to a prescribed position by rotating the antenna.

A further antenna according to the present invention which achieves the aforementioned objects comprises a first antenna element and a second antenna element of mutually different shapes provided in a linear arrangement, the antenna being formed as an integrated unit by means of the ends of the first antenna element and second antenna element being fixed to a rotating axle, and the first antenna element and the second antenna element are located respectively on either side of a casing by means of the rotating axle passing through the casing and being supported thereby, and the integrated antenna is held rotatably in the casing by means of the rotating axle being supported by the casing, such that power supply means can be connected to the first antenna element or second antenna element set to a prescribed position by rotating the antenna.

Furthermore, in both antennas according to the present invention described above, the first antenna element and second antenna element are of different lengths, and a switching mechanism for connecting the power supply means to the first antenna element or second antenna element set to a prescribed position by rotating the antenna is provided on the rotating axle;

and moreover, a matching circuit may be provided to one or both power supply points of the first antenna element and second antenna element;
the first antenna element and second antenna element may be formed on plate-shaped inductive bodies; and
the first antenna element may be taken as a whip antenna element and the second antenna element may be taken as a helical antenna element.

According to the antenna of the present invention, since an antenna comprising two antenna elements is rotatable such that power supply means can be connected to an antenna element in a prescribed position, it is possible to reduce the size of the main unit containing the antenna.

Furthermore, since internal matching circuits can be provided inside the antenna, impedance matching can be performed readily for each antenna element independently.

Furthermore, the antenna can be retracted by being rotated, and if the antenna elements are formed on inductive plates, then manufacturing steps such as precision processing, coil winding, and the like, become unnecessary, and the antenna manufacturing process is simplified.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1(a) shows an overview of a first embodiment of an antenna according to the present invention; Fig. 1(b) shows an overview of a second embodiment of an antenna according to the present invention; Fig. 1(c) shows an overview of a third embodiment of an antenna according to the present invention; and Fig. 1(d) shows an overview of a fourth embodiment of an antenna according to the present invention;

Fig. 2(a) shows a mode where a first antenna element of an antenna according to the present invention is in use; and Fig. 2(b) shows a mode where a second antenna element of an antenna according to the present invention is in use;

Fig. 3(a) is a front view showing the detailed composition of the fourth embodiment of an antenna according to the present invention; and Fig. 3(b) is a side view showing the detailed composition of the fourth embodiment of an antenna according to the present invention;

Fig. 4(a) is a front view showing the detailed composition of the third embodiment of an antenna according to the present invention; and Fig. 4(b) is a side view showing the detailed composition of the third embodiment of an antenna according to the present invention;

Fig. 5(a) is a front view showing the detailed composition of the second embodiment of an antenna according to the present invention; and Fig. 5(b) is a side view showing the detailed composition of the second embodiment of an antenna according to the present invention;

Fig. 6(a) is a front view showing the detailed composition of the first embodiment of an antenna according to the present invention; and Fig. 6(b) is a side view showing the detailed composition of the first embodiment of an antenna according to the present invention;

Fig. 7(a) shows the composition of a switching mechanism provided in a rotating axle in an antenna according to the present invention;

Fig. 8(a) is an oblique view showing the composition of the front and sides of a casing comprising a modification of a fifth embodiment of an antenna according to the present invention; and Fig. 8(b) is an oblique view showing the composition of the rear and sides of a casing comprising a modification of a fifth embodiment of an antenna according to the present invention;

Fig. 9(a) is a sectional view showing the composition of a modification of a fifth embodiment of an antenna according to the present invention; Fig. 9(b) is a sectional view showing the composition of an antenna case housing a second antenna in a modification of a fifth embodiment of an antenna according to the present invention; and Fig. 9(c) is a sectional view showing the composition of an antenna case housing a first antenna in a modification of a fifth embodiment of an antenna according to the present invention;

Fig. 10 shows impedance characteristics for an antenna according to the present invention;

Fig. 11 shows impedance characteristics for a conventional antenna; and

Fig. 12(a) shows the approximate composition of a

type A conventional antenna; Fig. 12(b) shows the approximate composition of a type B conventional antenna; and Fig. 12(c) shows the approximate composition of a type C conventional antenna.

BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 shows the approximate composition of an antenna according to the present invention. Fig. 1(a) shows the composition of a first embodiment of an antenna according to the present invention; Fig. 1(b) shows the composition of a second embodiment of an antenna according to the present invention; Fig. 1(c) shows the composition of a third embodiment of an antenna according to the present invention; and Fig. 1(d) shows the composition of a fourth embodiment of an antenna according to the present invention.

In the antenna 10 according to the first embodiment shown in Fig. 1(a), a second antenna element 2 forming a whip antenna and a first antenna element 1 forming a helical antenna are placed in a linear arrangement, and a rotating axle 3 is provided between the first antenna element 1 and the second antenna element 2. A through hole formed in the antenna 10 engages with this rotating axle 3 and the antenna is held rotatably by the rotating axle 3. The rotating axle 3 is provided in the casing of a portable radio telephone, or the like, which is omitted from the drawing.

Since the electric length of the second antenna 2 is set at approximately 1/2 wavelength (LLL/2) and the antenna impedance is high, a matching circuit (MC) 9 is provided inside the antenna 10 to achieve impedance matching between the antenna and the casing. This matching circuit 9 is provided between the second antenna element 2 and a second contact terminal 6.

When a signal source 7 provided inside the casing is connected to the second contact terminal 6 via a contact terminal on the casing side, as shown in the diagram, the first antenna element 1 assumes an operational state. The first contact terminal 5 for the first antenna element 1 and the second contact terminal 6 for the second antenna element 2 are provided in the antenna 10 for this purpose.

The electrical length of the first antenna element 1 is set to approximately LLL/4.

The antenna according to the first embodiment is composed in this way and the rotating axle 3 is provided with a switching mechanism (described later) whereby a signal source 7 connects with whichever of the antenna elements is set in the uppermost position when the antenna 10 is rotated.

In the antenna 10 according to the second embodiment shown in Fig. 1(b), a second antenna element 2 forming a whip antenna and a first antenna element 1 forming a helical antenna are placed in a linear arrangement, and a rotating axle 3 is provided between the first antenna element 1 and the second antenna element 2. The rotating axle 3 engages with a through hole formed in the antenna 10 and the antenna is held rotatably by the rotating axle 3. The rotating axle 3 is provided in the casing of a portable radio telephone, or the like, which is omitted from the drawing.

Since the electrical length of the first antenna element 1 and second antenna element 2 are set to approximately 1/2 wavelength (LLL/2) and the antenna impedance is high, a matching circuit (MC) 8 is provided inside the casing 10 to achieve impedance matching between the antenna and the casing. This matching circuit 8 is provided between the signal source and means on the casing side for contacting the antenna 10.

When the signal source 7 provided in the casing is connected to the second contact terminal 6 via the matching circuit 8 and a casing side contact terminal, as shown in the diagram, the signal from the signal source 7 is supplied to the second antenna element 2 and assumes an operational state, and if the antenna 10 is rotated such that the first antenna element 1 is set in the uppermost position, the signal source 7 connects with the first contact terminal 5 via the casing side contact terminal and the first antenna element 1 assumes an operational state. The first contact terminal 5 for the first antenna element 1 and the second contact terminal 6 for the second antenna element 2 are provided in the antenna 10 for this purpose.

In this way, compared to the first mode of implementation, in the second embodiment, the electrical length of the first antenna element 1 and second antenna element 2 is taken as approximately LLL/2 in both cases.

In the antenna 10 according to the third embodiment shown in Fig. 1(c), a second antenna element 2 forming a whip antenna and a first antenna element 1 forming a helical antenna are placed in a linear arrangement, and a rotating axle 3 is provided between the first antenna element 1 and the second antenna element 2. This rotating axle 3 engages with a through hole formed in the antenna 10 and the antenna is held rotatably by the rotating axle 3. The rotating axle 3 is provided in the casing of a portable radio telephone, or the like, which is omitted from the drawing.

Since the electrical length of the first antenna element 1 and second antenna element 2 is set to approximately 1/2 wavelength (LLL/2) and the antenna impedance is high, matching circuits (MC) 4, 9 are provided inside the casing 10 to achieve impedance matching between the antenna and the casing. The matching circuit 9 is provided between the second antenna element 2 and the second contact terminal 6, and the matching circuit 4 is provided between the first antenna element 1 and the first contact terminal 5.

When a signal source 7 provided in the casing is connected to the second contact terminal 6 via a casing side contact terminal, as shown in the diagram, the signal from the signal source 7 is supplied to the second antenna element 2, which assumes an operational state, and if the antenna 10 is rotated such that the first antenna element 1 is set in the uppermost position, the signal source 7 connects with the first contact terminal 5

via the casing side contact terminal and the first antenna element 1 assumes an operational state. The first contact terminal 5 for the first antenna element 1 and the second contact terminal 6 for the second antenna element 2 are formed on the antenna 10 for this purpose.

The third embodiment is composed in this way and only differs from the second embodiment described above in the manner in which matching circuits are provided.

In the antenna 10 according to the fourth embodiment shown in Fig. 1(d), a second antenna element 2 forming a whip antenna and a first antenna element 1 forming a helical antenna are placed in a linear arrangement, and a rotating axle 3 is provided between the first antenna element 1 and the second antenna element 2. This rotating axle 3 engages with a through hole formed in the antenna 10 and the antenna is held rotatably by the rotating axle 3. The rotating axle 3 is provided in the casing of a portable radio telephone, or the like, which is omitted from the drawing.

Furthermore, since the electrical length of the first antenna element 1 and second antenna element 2 is taken as approximately 1/4 wavelength (LLL/4), impedance matching with the casing can be achieved without any need for a matching circuit.

When a signal source 7 provided in the casing is connected to the second contact terminal 6 via a casing side contact terminal, as shown in the diagram, the signal from the signal source 7 is supplied to the second antenna element 2, which assumes an operational state, and if the antenna 10 is rotated such that the first antenna element 1 is set to the uppermost position, the signal source 7 connects with the first contact terminal 5 via the casing side contact terminal and the first antenna element 1 assumes an operational state. The first contact terminal 5 for the first antenna element 1 and the second contact terminal 6 for the second antenna element 2 are formed on the antenna 10 for this purpose.

In this way, in the fourth embodiment, the electrical length of the first antenna element 1 and second antenna element 2 is taken as approximately LLL/4.

Fig. 2 shows one example of the composition of a casing for a portable radio telephone, or the like, provided with an antenna according to any one of the embodiments of the present invention.

As shown in this drawing, an antenna 10 formed in the shape of a thin plate is attached rotatably to a casing 11 by means of a rotating axle 3, and a recess 12 is provided in the side of the casing 11 on which the antenna 10 is installed, whereby the antenna 10 can be housed in an upright position and a first antenna element 1 can be rotated.

Fig. 2(a) shows the antenna 10 in an erect state when the side of the casing 11 is in contact with the first antenna element 1, the antenna 10 being set such that the first antenna element 1 is projecting from the casing 11. Here, the second antenna element 2 is housed in the recess 12 such that it does not project from the surface of the casing 11.

From this state, if the antenna 10 is rotated and set such that the second antenna element 2 is projecting from the casing 11, as shown in Fig. 2(b), then the side of the casing 11 assumes contact with the second antenna element 2. Here, the first antenna element 1 is separated from the casing 11.

By rotating and setting the antenna 10 in this manner, it is possible to switch between the first antenna element 1 and second antenna element 2.

Fig. 3 shows the detailed composition of a fourth embodiment of an antenna according to the present invention, as shown in Fig. 1(d). Fig. 3(a) is a front view and Fig. 3(b) is a side view.

As shown in these drawings, an antenna 10 is constituted by means of a first antenna element 1 formed in a coil shape and acting as a helical antenna, and a second antenna element 2 formed in a linear shape and acting as a whip antenna, which are housed in an approximately linear arrangement inside a rectangular-shaped antenna case 20 made of resin.

The electrical length of the first antenna element 1 and the second antenna element 2 is approximately LLL/4, in both cases.

This antenna 10 is attached rotatably to one side of a casing 11 by means of a rotating axle 3, and a first contact terminal 5 connected to the first antenna element 1 and a second contact terminal 6 connected to the second antenna element 2 are provided on the antenna case 20. This first contact terminal 5 and second contact terminal 6 are located in positions corresponding to a casing side contact terminal 13 provided on the casing 11, and when the antenna 10 is rotated and set, the contact terminal for whichever of the antenna elements is projecting from the casing 11 assumes contact with the casing side contact terminal 13.

As shown in the diagram, when the first antenna element 1 is set such that it projects from the casing 11, the first contact terminal 5 assumes contact with the casing side contact terminal 13, and the first antenna element 1 connects with a circuit 14 inside the casing. If the antenna 10 is rotated through 180° such that the second antenna element 2 is set projecting from the casing 11, the second contact terminal 6 assumes contact with the casing side contact terminal 13, and the second antenna element 2 connects with the circuit 14 inside the casing.

Fig. 4 shows the detailed composition of a third embodiment of an antenna according to the present invention, as shown in Fig. 1(c). Fig. 4(a) is a front view, and Fig. 4(b) is a side view.

The antenna in the third embodiment shown in this diagram differs from the antenna in the fourth embodiment shown in Fig. 3 in that the electrical length of the first antenna element 1 and second antenna element 2 is approximately LLL/2, and therefore only the aspects of the composition relating to this difference are

described below.

A first antenna element matching circuit 4 is formed between a first antenna element 1 acting as a helical antenna, and a section contacting a rotating axle 3, which is connected to the earth of a casing 1, and a second antenna element matching circuit 9 is formed between a second antenna element 2 acting as a whip antenna and a section contacting the rotating axle 3, which is connected to the earth of the casing 1, thereby constituting an antenna 10 which is housed in an antenna case 20.

This antenna 10 is attached rotatably to one side of a casing 10 by means of a rotating axle 3, and a first contact terminal 5 connected to the first antenna element matching circuit 4 and a second contact terminal 6 connected to the second antenna element matching circuit 9 is provided in the antenna case 20. This first contact terminal 5 and second contact terminal 6 are located in positions corresponding to a casing side contact terminal 13, and when the antenna 10 is rotated and set in position, the contact terminal 5, 6 on whichever of the antenna elements is set projecting from the casing 11 assumes contact with the casing side contact terminal 13.

The first antenna element matching circuit 4 and the second antenna element matching circuit 9 are provided on printed circuit boards.

When the first antenna element 1 is set such that it projects from the casing 11, the first contact terminal 5 assumes contact with the casing side contact terminal 13, and the first antenna element 1 connects with a circuit 14 in the casing via the first antenna element matching circuit 4. If the antenna 10 is rotated through 180° and the second antenna element 2 is set such that it projects from the casing 11, then the second contact terminal 6 assumes contact with the casing side contact terminal 13, and the second antenna element 2 connects with the circuit 14 inside the casing via the second antenna element matching circuit 9.

Fig. 5 shows the detailed composition of a second embodiment of an antenna according to the present invention, as shown in Fig. 1(b). Fig. 5(a) is a front view and Fig. 5(b) is a side view.

According to the second & embodiment shown in this diagram, an antenna 10 is constituted by means of a first antenna element 1 acting as a helical antenna and a second antenna element 2 acting as a sleeve antenna, which are housed in an antenna case 20 made from resin. The rotating axle is a coaxial rotating axle 21, and an outer conducting element on this coaxial rotating axle 21 is connected to an earth on the side of the casing 11, and a central conducting element is connected to a matching circuit 8 provided inside the casing 11.

The sleeve of the second antenna element 2 acting as a sleeve antenna connects with the outer conducting element of this coaxial rotating axle 21, and a switching mechanism is formed using the central conducting element of the coaxial rotating axle 21.

The detailed composition of this switching mechanism is shown in Fig. 7, and the end portion of a cylindrical casing side power supply terminal 13 forming a central conducting element in the coaxial rotating axle 21 is cut and formed into a semi-cylindrical shape. A first arc-shaped contact terminal 5 connected to the first antenna element 1 contacts this semi-cylindrical casing side power supply terminal 13, and a signal source 7 in the casing 1 is connected to the first antenna element 1.

This antenna 10 is installed rotatably on one side of a casing 11 by means of a rotating axle 3, and when it is rotated through 180° and set such that the second antenna element 2 projects from the casing 11, then a second arc-shaped contact terminal 6 assumes contact with the casing side power supply terminal 13, and the second antenna element 2 connects with the signal source 7 via the second antenna element matching circuit 9.

In this way a switching mechanism is provided in the coaxial rotating axle 21, whereby it is possible to switch automatically between the first antenna element 1 and the second antenna element 2 for connection to the circuit inside the casing 11, by rotating the antenna 10.

In the example shown in Fig. 5, a matching circuit 8 is provided between the casing side power supply terminal 13 and the circuit 14 inside the casing.

A fifth embodiment of an antenna according to the present invention is shown in Fig. 6.

The antenna according to the fifth embodiment shown in this diagram is constituted by means of a first antenna element 1 formed in a zig-zag shape on an inductive plate 22, and a second antenna element 2 formed in a linear shape on an inductive plate 22, which are housed in a long and thin planar antenna case 20 made from resin.

The electrical length of the first antenna element 1 and the second antenna element 2 is approximately LLL/2 in both cases, and a thin, plate-shaped flexible antenna may be used for the antenna 10.

This antenna 10 is attached rotatably on one side of a casing 11 by means of a rotating axle 3, and a first contact terminal 5 connected to the first antenna element 1, and a second contact terminal 6 connected to the second antenna element 2, are provided on the antenna case 20. This first contact terminal 5 and second contact terminal 6 are located in positions corresponding to an arc-shaped casing side contact terminal provided on the casing 11, and when the antenna 10 is rotated and set in position, the contact terminal for whichever of the antenna elements is projecting from the casing 11 assumes contact with the casing side contact terminal 13.

A spring 15 is provided between this casing side contact terminal 13 and a terminal 16, and the casing side contact terminal 13 is held in stable contact with the contact terminals 5, 6 provided on the antenna case 20 under the pressure of this spring 15.

As shown in the diagram, when the first antenna

element 1 is set such that it from the casing 11, the first contact terminal 5 assumes contact with the casing side contact terminal 13, and the first antenna element 1 connects with a circuit 14 inside the casing. When the antenna 10 is rotated through 180° and the second antenna element 2 is set such that it projects from the casing 11, the second contact terminal 6 assumes contact with the casing side contact terminal 13 and the second antenna element 2 connects with the circuit 14 inside the casing.

The signal from the antenna 10 connected to the casing 11 is supplied via a matching circuit 8 to the circuit 14 inside the casing.

A modification of a fifth embodiment according to the present invention is shown in Fig. 8 and Fig. 9.

In the antenna according to the modification of the fifth embodiment shown in this diagram, as shown in Fig. 8, a first antenna element 1 is located on one side of a casing 11 and a second antenna element 2 is located on the other side of the casing 11. Specifically, the first antenna element 1 and the second antenna element 2 are placed on either side of the casing 11 and the first antenna element 1 and second antenna element 2 form an integrated unit by being fixed to a rotating axle 3.

Furthermore, although not shown in the diagram, a fan-shaped recess which enables the first antenna element 1 to rotate, like that illustrated in Fig. 2, is formed on the side of the casing 11 on which the first antenna element 1 is located, and a recess 12 for housing the second antenna element 2 is provided on the side of the casing 11 on which the second antenna element 2 is located.

If the first antenna element 1, which is projecting above the casing 11 and is in an operational state in Fig. 8(a), is rotated, the second antenna element 2 coupled to the rotating axle 3 also rotates, and when it has rotated through 180°, the second antenna element 2 will project from the casing 11, as shown in Fig. 8(b), and the second antenna element 2 will operate in place of the first antenna element 1.

Fig. 9 shows the detailed composition of an antenna of this type, which is constituted such that a first antenna element 1 formed in a zig-zag shape on an inductive plate 22 is housed inside a long and thin planar antenna case 20 made from resin, and a second antenna element 2 formed in linear shape on an inductive plate 22' is housed inside a long and thin planar antenna case 20'.

The electrical length of the first antenna element 1 and the second antenna element 2 is approximately LLL/2, in both cases, and the antenna 10 may be a thin plate-shaped flexible antenna.

In this antenna 10, as shown in Fig. 8, the first antenna element 1 is located on one side of the casing 11 and the second antenna element 2 is located on the other side thereof, the first antenna element 1 and second antenna element 2 being formed into an integrated unit by being fixed to a rotating axle 3. This rotating axle 3 passes from the front of the casing 11 through to the rear thereof, and it is held rotatably in the casing 11.

Furthermore, a first contact terminal 5 connected to the first antenna element 1 is provided in antenna case 20, as shown in Fig. 9(a), and a second contact terminal 6 connected to the second antenna element 2 is provided in the antenna case 20', as shown in Fig. 9(b).

This first contact terminal 5 is located at a position corresponding to an arc-shaped casing side contact terminal 13 provided in the casing 11, and when the antenna 10 is rotated and set in position, the contact terminal 5 for the first antenna element 1 assumes contact with the casing side contact terminal 13. The second contact terminal 6 is located at a position corresponding to an arc-shaped casing side contact terminal 13' provided in the casing 11, and when the antenna 10 is rotated and set in position, the contact terminal 6 for the second antenna element 2 assumes contact with the casing side contact terminal 13'.

These casing side contact terminals 13, 13' are respectively held in reliable contact with the contact terminals 5, 6 provided on the antenna cases 20, 20' under the pressure of springs 15, 15' acting in an outward direction.

Since this antenna 10 is composed in the manner described above, when the first antenna element 1 is set such that it projects from the casing 11, the first contact terminal 5 assumes contact with casing side contact terminal 13 and the first antenna element 1 connects with a circuit 14 inside the casing via a matching circuit 8.

When the antenna 10 is rotated through 180° and the second antenna element 2 is set such that it projects from the casing 11, the second contact terminal 6 assumes contact with the casing side contact terminal 13', and the second antenna element 2 connects with the circuit 14 inside the casing via a matching circuit 8. In this case, since the first antenna element 1 also rotates, the contact between the first contact terminal 5 and casing side contact terminal 13 is broken, and the first antenna element 1 is housed inside the recess.

The antenna 10 according to this modification was described as a modification of the fifth embodiment, but this respective positioning of the antenna elements on either side of the casing 11 is not limited to the antenna according to the fifth embodiment, but may also be applied to the antennas according to the first to fourth embodiments.

The antenna 10 according to the first to fifth embodiments of the present invention described above comprises a first antenna element 1 and a second antenna element 2, but since independent matching circuits or a common matching circuit are provided inside the antenna 10 or inside the casing 11 depending on the electrical length of each antenna element, it is possible to achieve satisfactory control of impedance matching between the different antenna elements and the circuit in the casing.

The impedance characteristics for each antenna

element in an antenna 10 according to the present invention are shown in Fig. 11, and at the operating frequencies marked by the ▽, the SWR of each antenna element is approximately 1, indicating good antenna characteristics. In conventional antennas, since the impedance is not adjusted for each antenna element, there is deterioration of the SWR for each antenna element at the operating frequencies marked by ▽ shown in Fig. 10.

As described above, the antenna according to the present invention is not simply an antenna which can be retracted by being rotated, but rather it is based on the premise that one or other of two antenna elements is in an operational state at all times.

Moreover, the composition of the power supply means connecting the antenna 10 with the side of the casing 11, as shown in Fig. 5 (Fig. 7) and Fig. 6, is not limited to the embodiments illustrated in the drawings, but may naturally be applied to other embodiments also.

In each of the embodiments, a variety of differently shaped antenna elements may be used for either antenna element.

INDUSTRIAL APPLICABILITY

As described above, in the present invention, since an antenna comprising two antenna elements is rotatable and power supply means can be connected to an antenna element when it is set in a prescribed position, it is possible to reduce the size of the unit comprising the antenna, without needing to provide an insulating section in the antenna. Therefore, the antenna is suitable for application in portable devices, especially, portable radio telephones.

Moreover, since matching circuits can be provided inside the antenna, impedance matching can be performed readily for each antenna element, allowing good antenna characteristics to be achieved for both antenna elements.

Furthermore, the antenna can be retracted by being rotated, and if the antenna elements are formed on inductive bodies, then plate-shaped flexible antennas can be obtained, and further size reduction is possible. Moreover, since manufacturing steps such as precision processing, coil winding, and the like, are unnecessary, such antennas can be manufactured readily.

Claims

1. In an antenna comprising a first antenna element and a second antenna element of mutually different shapes provided in a linear arrangement, and further comprising a through hole provided between said first antenna element and said second antenna element,

   an antenna characterized in that said first antenna element and said second antenna element are held rotatably in a casing by means of a rotating axle supported by said through hole, power supply means being connected to whichever of said antenna elements is rotated and set to a prescribed position.

2. An antenna according to claim 1 characterized in that said first antenna element and said second antenna element have different lengths, and a switching mechanism is provided at said rotating axle for connecting power supply means to said first antenna element or said second antenna element set to a prescribed position by rotating said antenna.

3. An antenna according to claim 1 characterized in that a matching circuit is provided at one or both of the power supply points for said first antenna element and said second antenna element.

4. An antenna according to claim 1 characterized in that said first antenna element and second antenna element are formed onto plate-shaped inductive bodies.

5. An antenna according to claim 1 characterized in that said first antenna element is a whip antenna and said second antenna element is a helical antenna.

6. In an antenna comprising a first antenna element and a second antenna element of mutually different shapes provided in a linear arrangement, wherein the ends of said first antenna element and said second antenna element are fixed to a rotating axle, thereby forming an integrated unit,

   an antenna characterized in that said first antenna element and said second antenna element are positioned respectively on either side of a casing by means of said rotating axle passing through said casing and being supported thereby, and
   said integrated antenna is held rotatably in said casing by means of a rotating axle supported by said casing, power supply means being connected to either said first antenna element or said second antenna element rotated and set to a prescribed position.

7. An antenna according to claim 6 characterized in that said first antenna element and said second antenna element have different lengths, and a switching mechanism is provided at said rotating axle for connecting power supply means to said first antenna element or said second antenna element set to a prescribed position by means of rotating said antenna.

8. An antenna according to claim 6 characterized in that a matching circuit is provided at one or both of the power supply points for said first antenna element and said second antenna element.

9. An antenna according to claim 6 characterized in that said first antenna element and second antenna element are formed onto plate-shaped inductive bodies.

10. An antenna according to claim 6 characterized in that said first antenna element is a whip antenna and said second antenna element is a helical antenna.

Amended claims under Art. 19.1 PCT

1. In an antenna comprising a first antenna element and a second antenna element of mutually different shapes provided in a linear arrangement, and further comprising a through hole provided between said first antenna element and said second antenna element,

an antenna characterized in that said first antenna element and said second antenna element are held rotatably in a casing by means of a rotating axle supported by said through hole, power supply means being connected to whichever of said antenna elements is rotated and set to a prescribed position.

2. An antenna according to claim 1 characterized in that the length of said first antenna element and the length of said second antenna element are mutually different, and a switching mechanism is provided at said rotating axle for connecting power supply means to said first antenna element or said second antenna element set to a prescribed position by rotating said antenna.

3. An antenna according to claim 1 characterized in that a matching circuit is provided at either one or both of the power supply point for said first antenna element and the power supply point for said second antenna element.

4. An antenna according to claim 1 characterized in that said first antenna element and second antenna element are formed onto plate-shaped inductive bodies.

5. An antenna according to claim 1 characterized in that said first antenna element is a whip antenna and said second antenna element is a helical antenna.

6. In an antenna comprising a first antenna element and a second antenna element of mutually different shapes provided in a linear arrangement, wherein the ends of said first antenna element and said second antenna element are fixed to a rotating axle, thereby forming an integrated unit,

an antenna characterized in that said first antenna element and said second antenna element are positioned respectively on either side of a casing by means of said rotating axle passing through said casing and being supported thereby, and

said integrated antenna is held rotatably in said casing by means of a rotating axle supported by said casing, power supply means being connected to either said first antenna element or said second antenna element rotated and set to a prescribed position.

7. An antenna according to claim 6 characterized in that the length of said first antenna element and the length of said second antenna element are mutually different, and a switching mechanism is provided at said rotating axle for connecting power supply means to said first antenna element or said second antenna element set to a prescribed position by means of rotating said antenna.

8. An antenna according to claim 6 characterized in that a matching circuit is provided at either one or both of the power supply point for said first antenna element and the power supply point for said second antenna element.

9. An antenna according to claim 6 characterized in that said first antenna element and second antenna element are formed onto plate-shaped inductive bodies.

10. An antenna according to claim 6 characterized in that said first antenna element is a whip antenna and said second antenna element is a helical antenna.

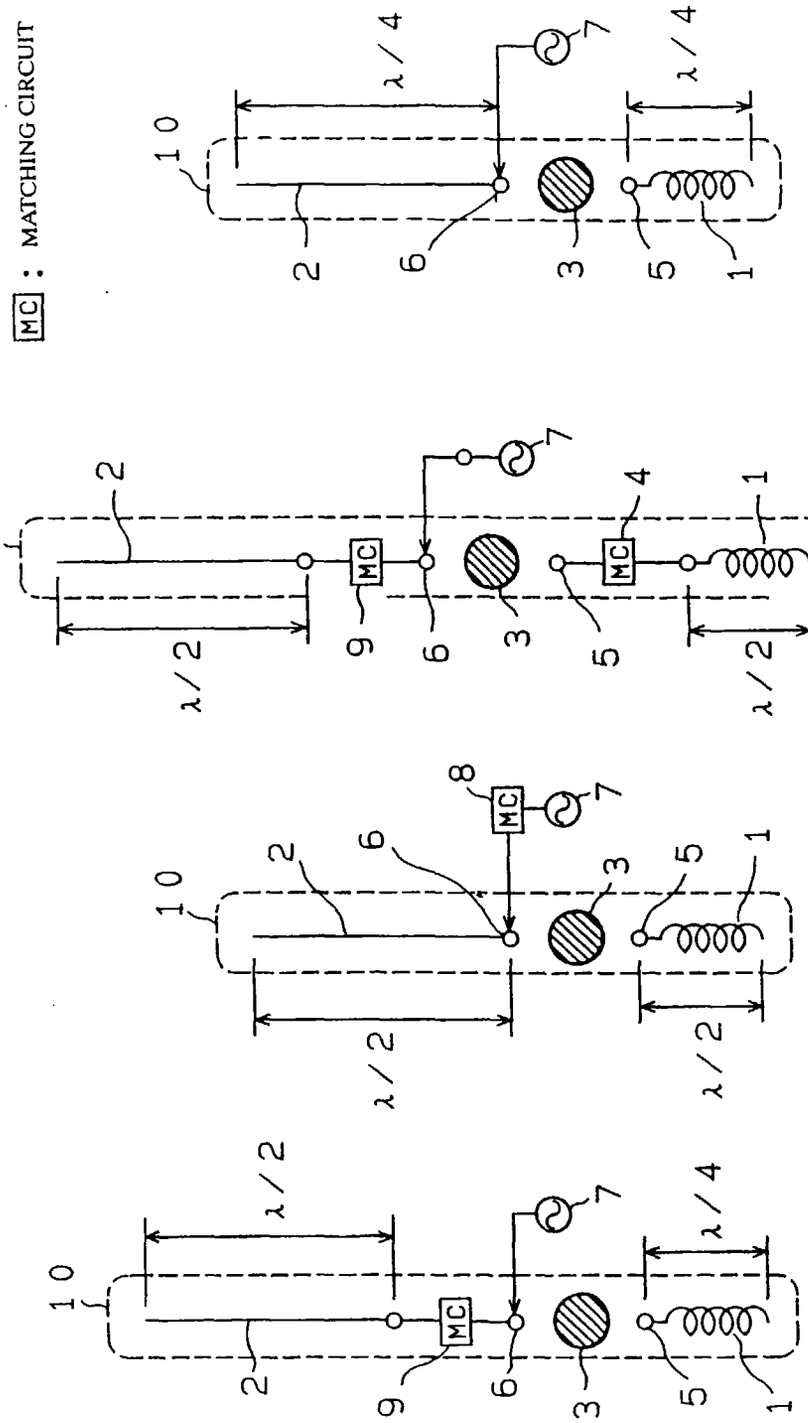


FIG.1 (a)

FIG.1 (b)

FIG.1 (c)

FIG.1 (d)

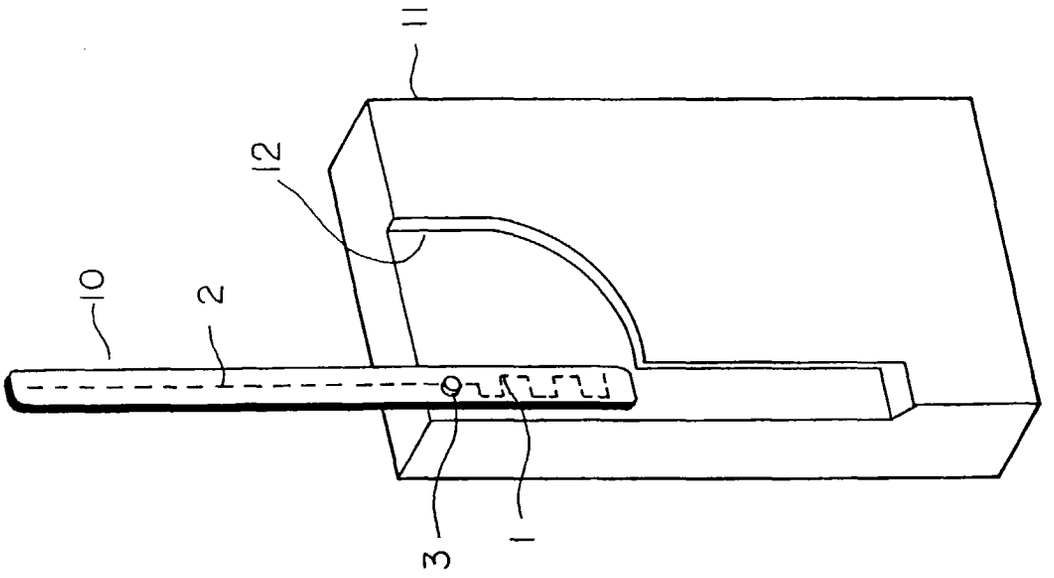


FIG.2 (b)

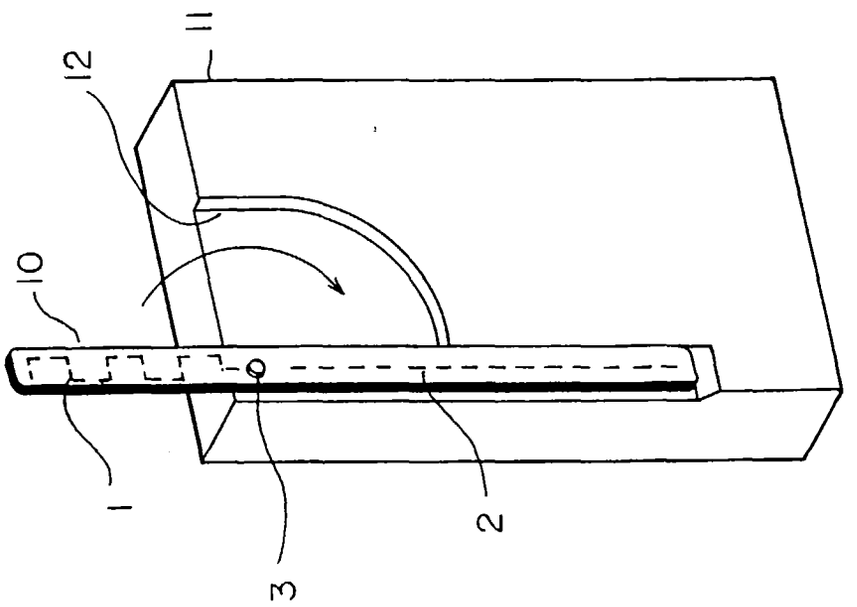


FIG.2 (a)

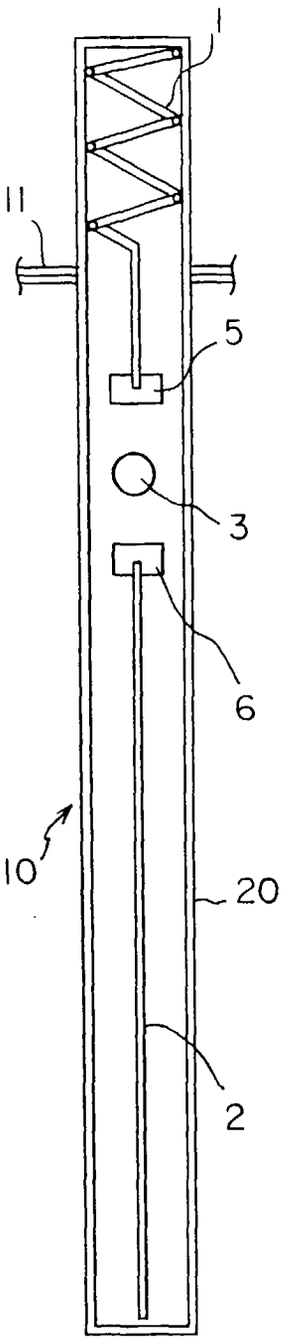


FIG.3 (a)

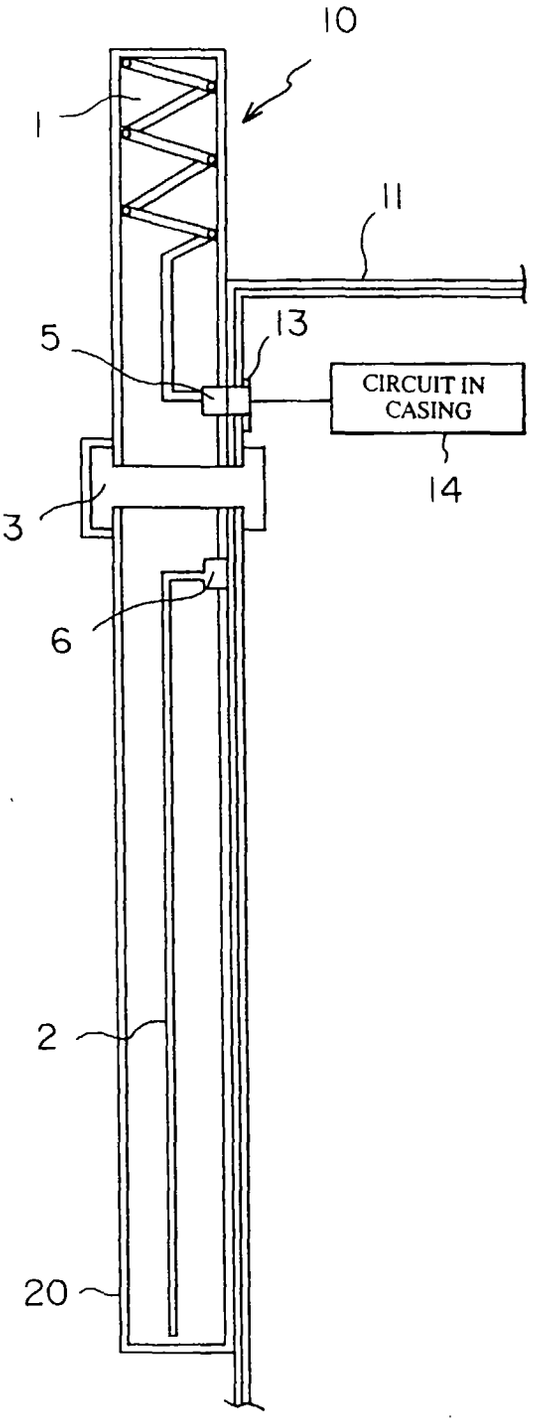


FIG.3 (b)

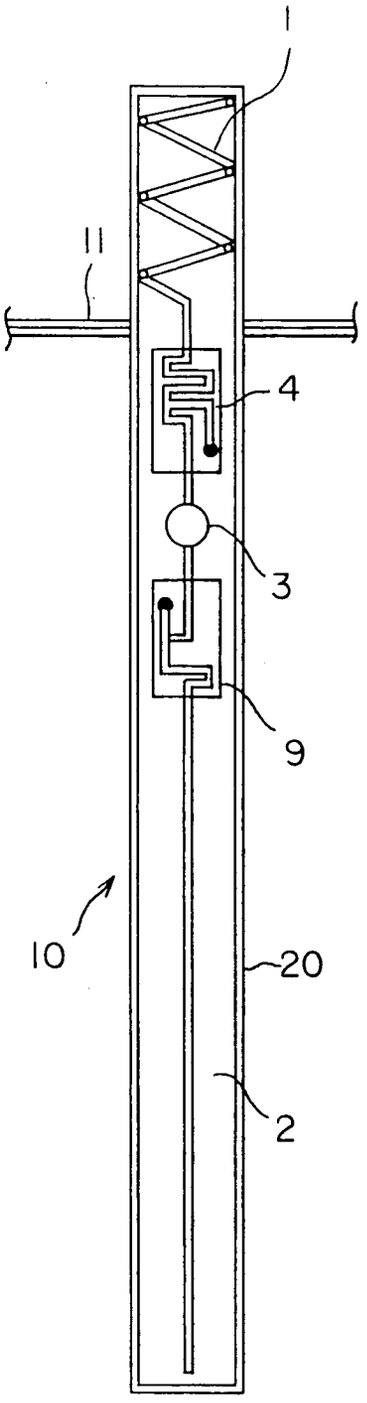


FIG.4 (a)

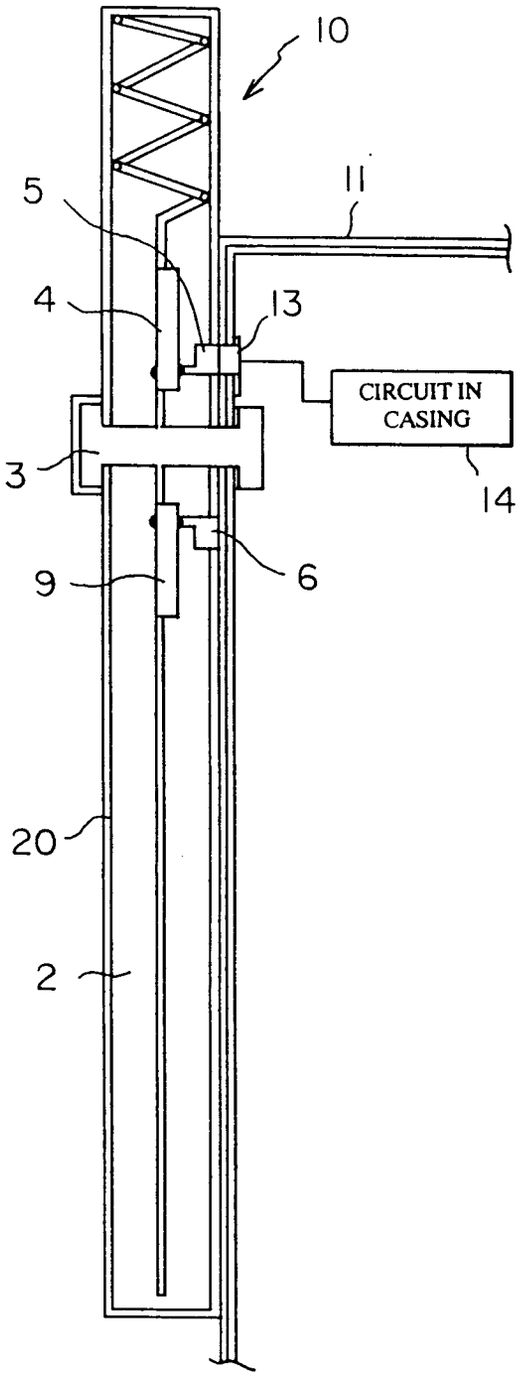


FIG.4 (b)

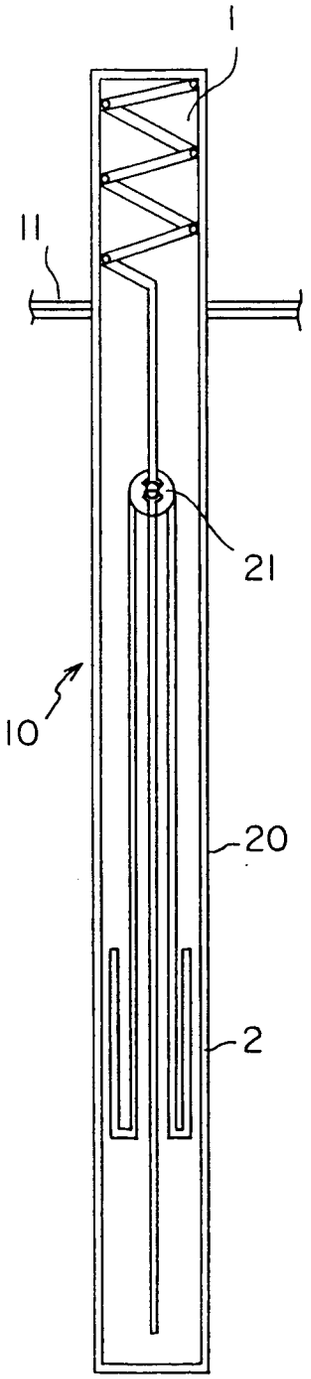


FIG.5 (a)

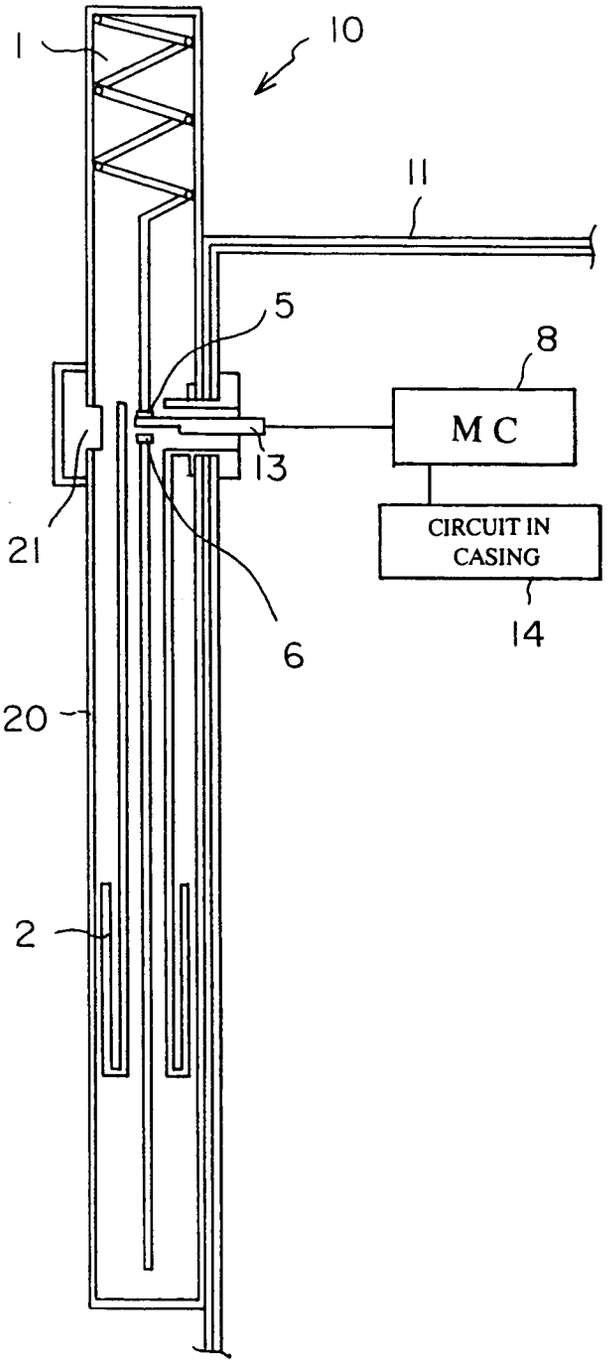


FIG.5 (b)

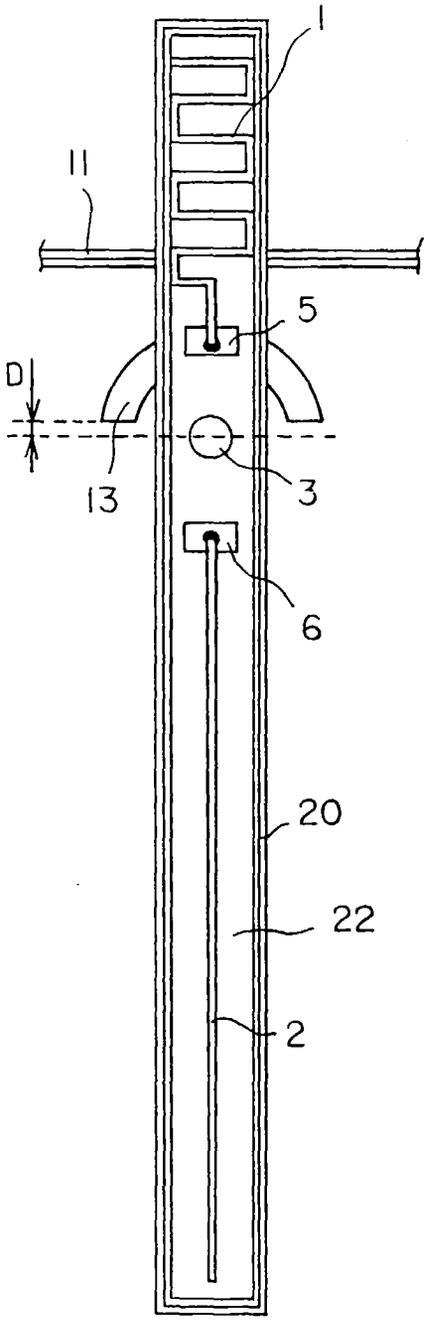

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FIG.6 (a)

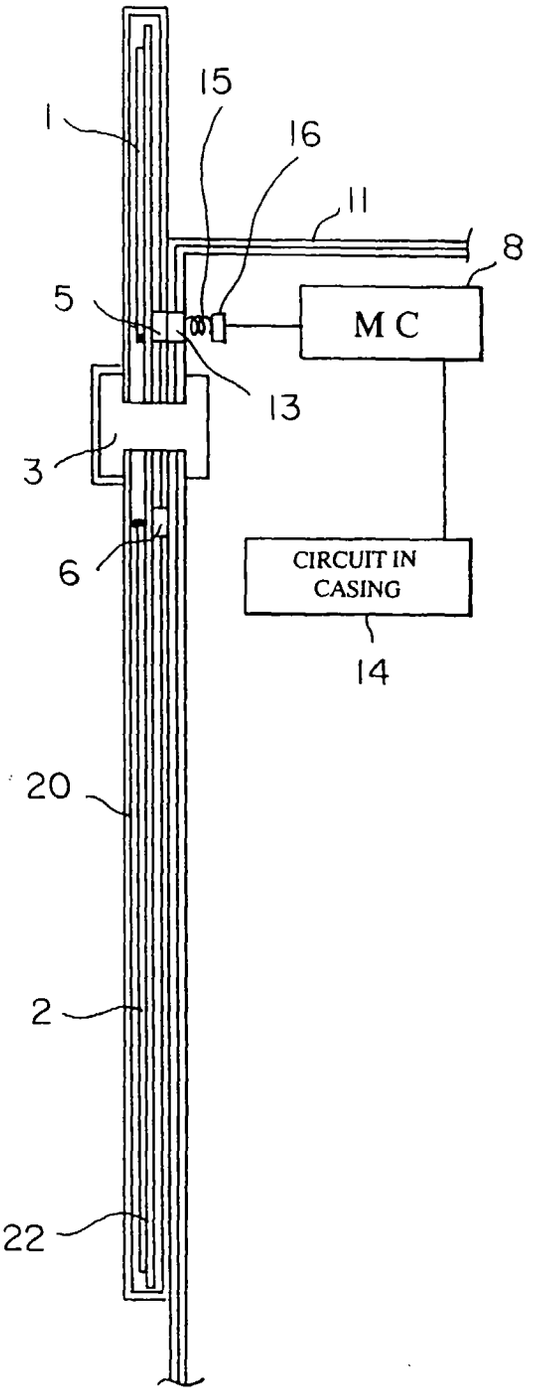

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CIRCUIT IN CASING
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FIG.6 (b)

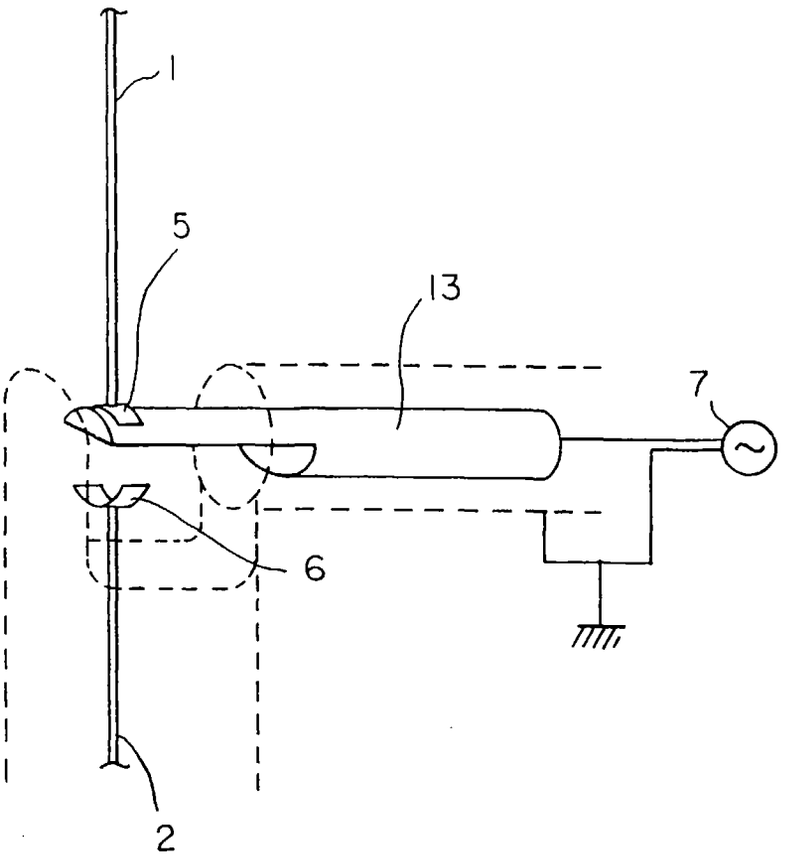


FIG.7

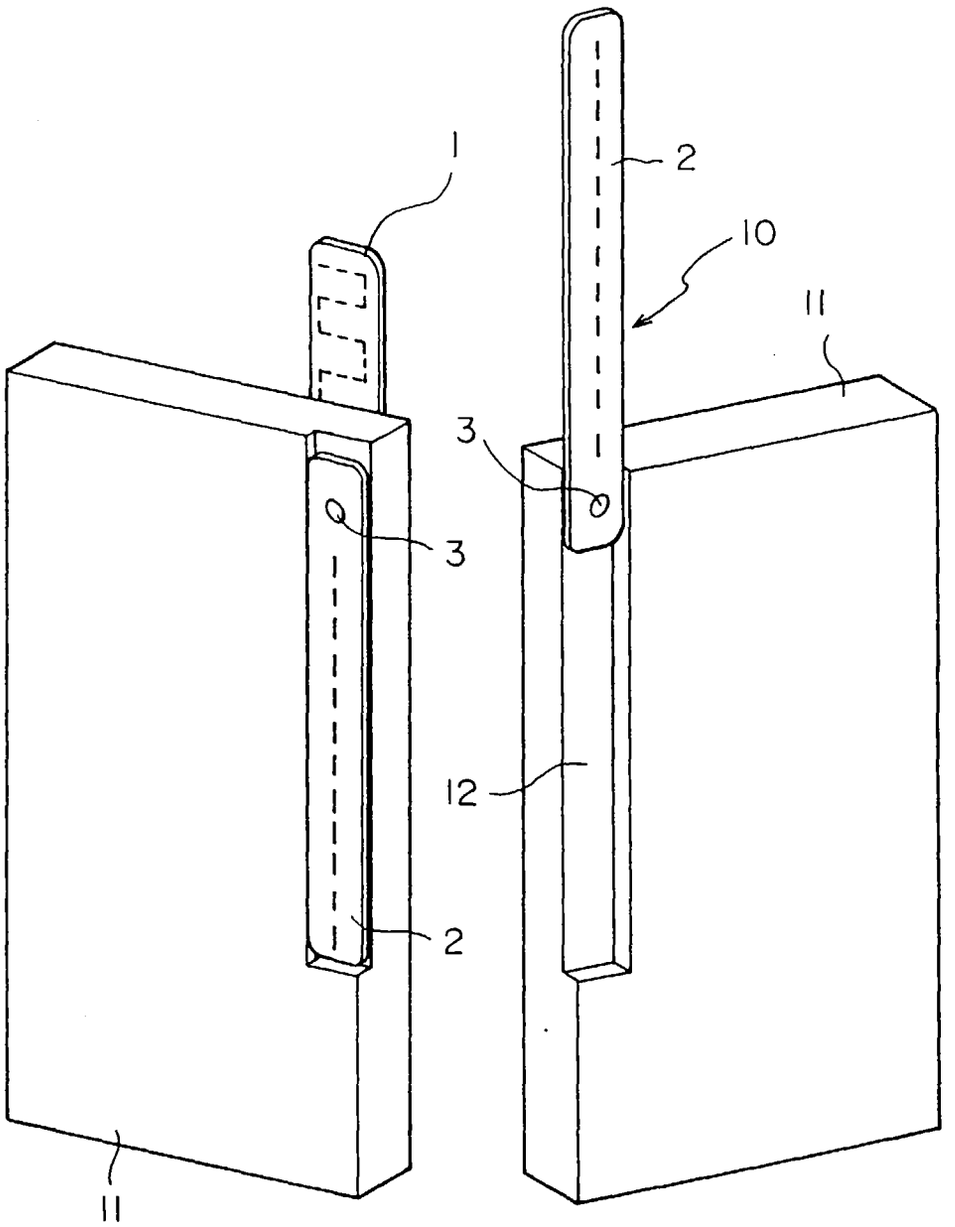


FIG.8 (a)

FIG.8 (b)

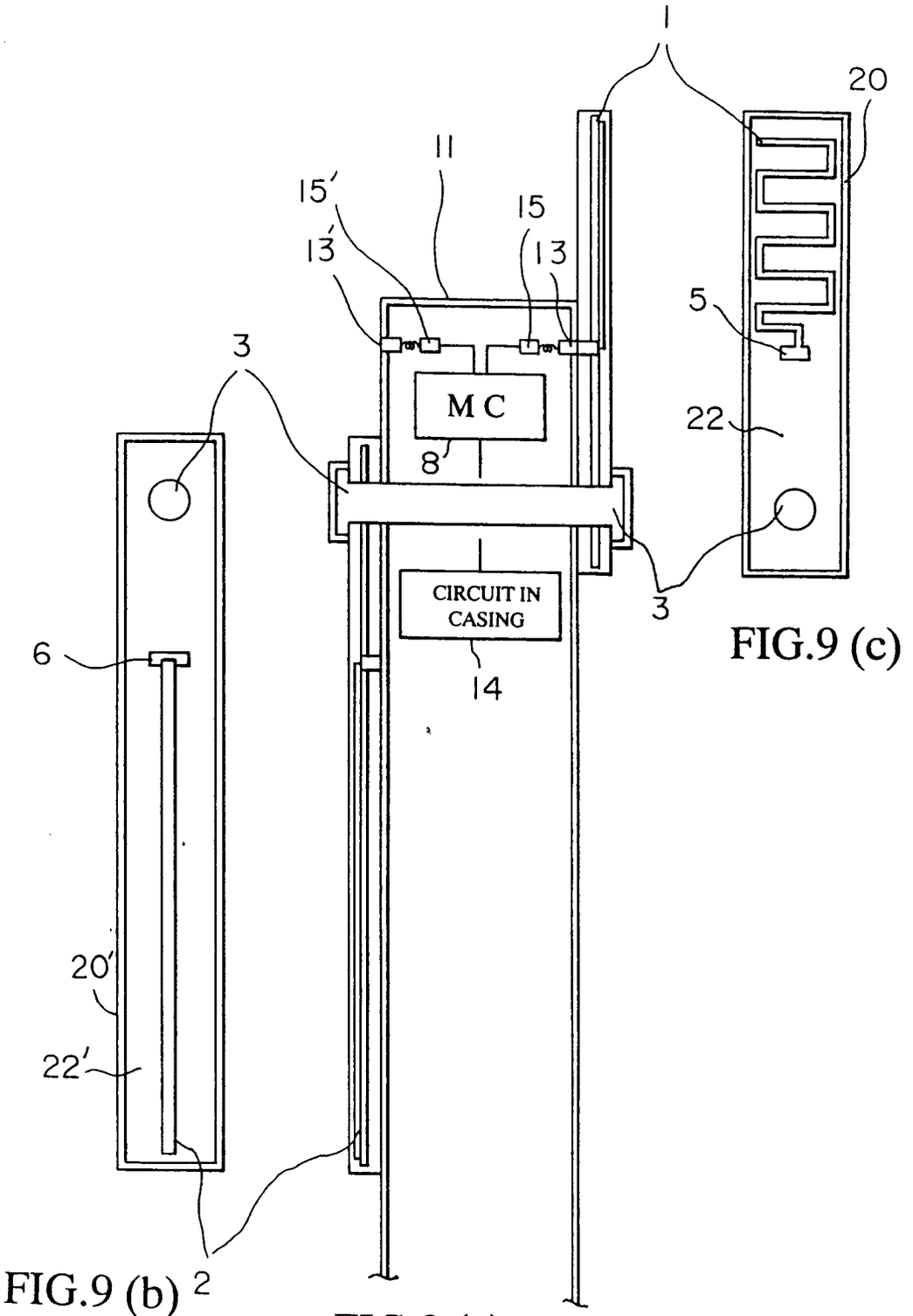


FIG.9 (c)

FIG.9 (b)

FIG.9 (a)

FIG.10

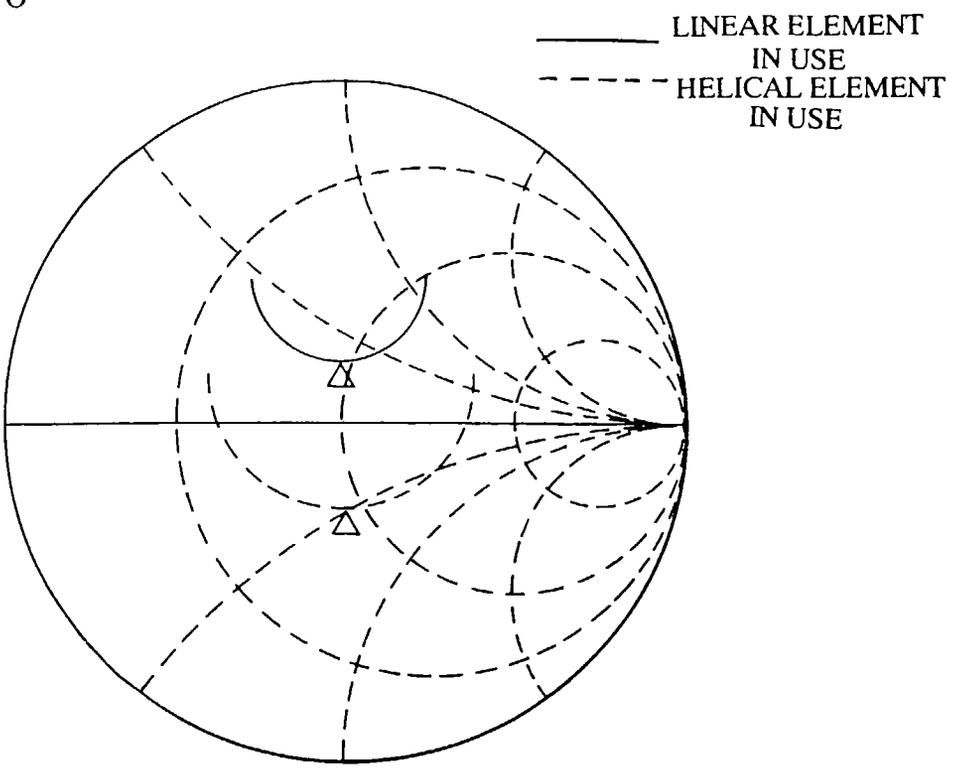
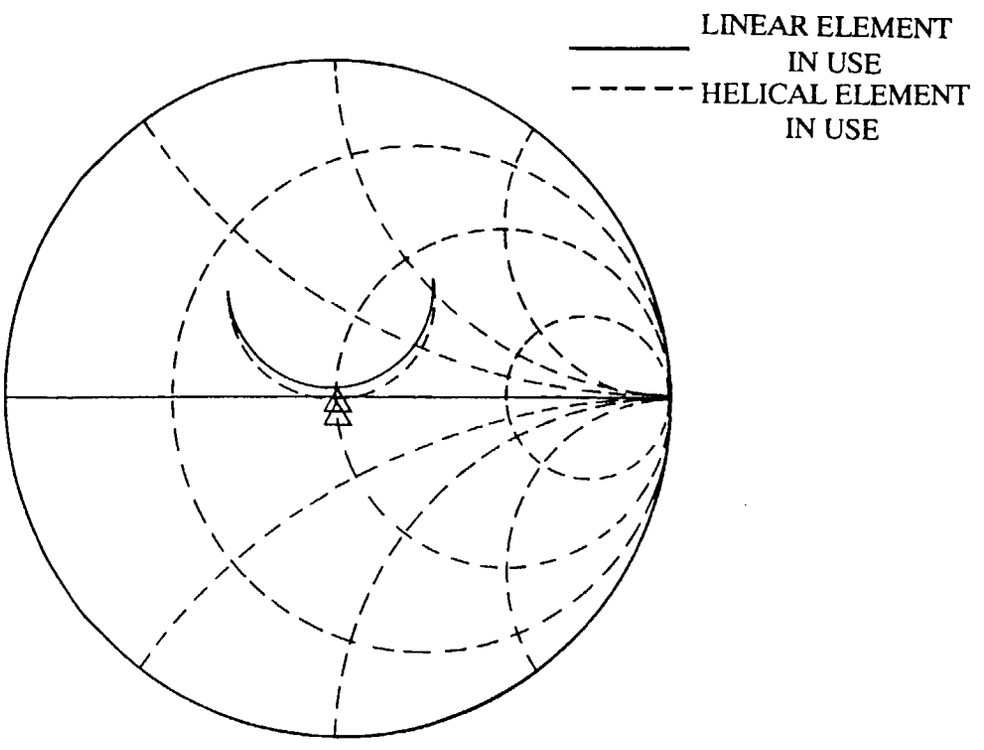

LINEAR ELEMENT
IN USE
HELICAL ELEMENT
IN USE

FIG.11


LINEAR ELEMENT
IN USE
HELICAL ELEMENT
IN USE

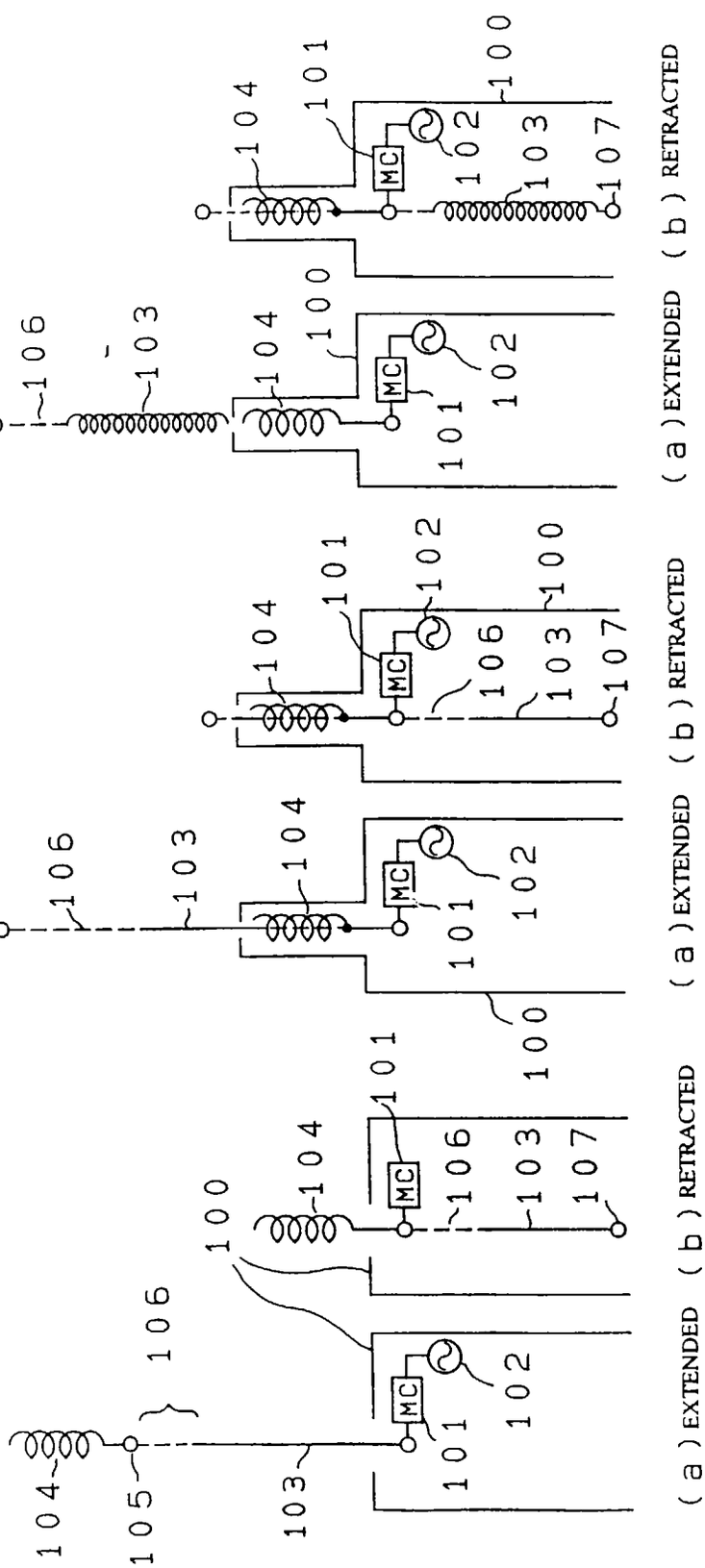


FIG.12 (a)
PRIOR ART

FIG.12 (b)
PRIOR ART

FIG.12 (c)
PRIOR ART

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/03060

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.
A,P A	JP, A, 8-503830 (Saldell, Ulf), April 23, 1996 (23. 04. 96), Page 7, line 7 to page 8, line 25; Fig. 1 & WO, 94/28593	1 - 10
A	JP, A, 6-216630 (Nippon Antenna Co., Ltd.), August 5, 1994 (05. 08. 94), Paragraphs (0009) to (0016); Fig. 1 (Family: none)	1 - 10
A	JP, A, 5-102717 (Kyocera Corp.), April 23, 1993 (23. 04. 93), Paragraphs (0008) to (0009); Fig. 1 (Family: none)	1 - 10

☐ 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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"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

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/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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