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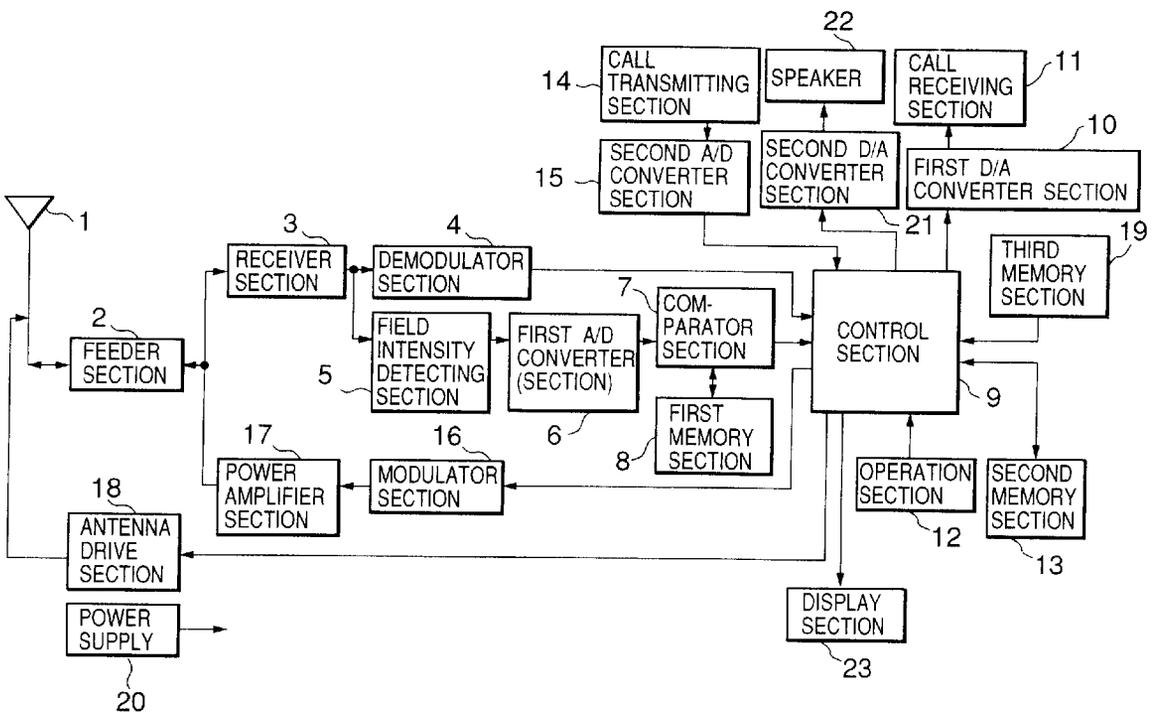
(54) Device for controlling expansion/contraction of an antenna in a radio unit and method therefor

(57) An antenna control device for a radio unit automatically expands an antenna in response to the detection of a call, and automatically contracts the antenna when the call is terminated. Also, the device automatically expands the antenna in response to a call reception.

Fig.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a device for controlling the expansion/contraction of an antenna and a method therefor, and more particularly to a control device for automatically expanding or contracting the antenna of a radio unit and a method therefor.

2. Description of the Related Art

Up to now, the antenna control device of this type has been disclosed, for example, in Japanese Utility Model Unexamined Publication No. Sho 60-64606 (hereinafter referred to as "Document 1").

The control device disclosed in Document 1 automatically expands an antenna when a power supply is turned on by the on-operation of a power supply switch. The control device disclosed in Document 1 also automatically contracts the antenna when the power supply is turned off by the off-operation of the power supply switch.

On the other hand, in Japanese Utility Model Unexamined Publication No. Hei 4-137621 (hereinafter referred to as "Document 2"), there is disclosed an antenna device that automatically expands the antenna by depressing a call start button.

Further, in Japanese Utility Model Unexamined Publication No. Hei 2-92241 (hereinafter referred to as "Document 3"), there is disclosed a cordless telephone that automatically expands the antenna by depressing an off-hook button and automatically contracts the antenna in response to the accommodaticn of the cordless telephone into a master unit upon the completion of call.

However, the antenna control device disclosed in Document 1 automatically expands the antenna even in the case where a user does not call or does not intend to call in a state of waiting for a call reception signal because the antenna is expanded by turning on the power source. This leads to such a problem that the portability of the radio unit is deteriorated because the expanded antenna is obstructive.

The cordless telephone disclosed in Document 2 suffers from such a problem that operation is troublesome because the antenna is contracted manually. Also, because the antenna is automatically expanded by depressing the call start button, the antenna can be automatically expanded when transmitting a call. However, there arises such a problem that the antenna cannot be automatically expanded when receiving a call.

Moreover, in the cordless telephone disclosed in Document 3, because the antenna is automatically expanded by depressing the off-hook button, even though the user does not intend to call, the depression of the off-hook button causes the antenna to be automatically expanded, thereby leading to such a problem that the antenna is obstructive. Also, because the antenna is automatically expanded by depressing the off-hook button, the antenna can be automatically expanded when transmitting a call. However, there arises such a problem that the antenna cannot be automatically expanded when receiving a call. Further, because the antenna is automatically contracted in response to the accommodation of the cordless telephone into the master unit, there arises a problem that it is not applicable to a telephone having no master unit, for example, an automobile telephone or a portable telephone.

The specific structures in which the antenna is expanded and contracted are disclosed in the following three documents.

Referring to "vehicle power antenna" disclosed in Japanese Patent: Unexamined Publication No. Hei 5-283918 (hereinafter referred to as "Document 4"), the antenna includes a changeover switch for changing over the forward rotation or the reverse rotation of a reversible motor, and a motor control unit for controlling the amount of expansion/contraction of an antenna element of a car radio while controlling the amount of rotation of the motor and the changeover operation of the changeover switch, for the purposes of ensuring an excellent receiving state of the AM broadcasting regardless of day or night and facillitating the automatic tuning of a desired broadcasting during the night.

Also, referring to "antenna expanding/contracting device" disclosed in Japanese Patent Unexamined Publication No. Sho 64-29103 (hereinafter referred to as "Document 5"), the device includes a means for contracting a main antenna at the time of a weak electric field in response to an output from an auxiliary antenna for the detection of intensity of an electric field, for the purposes of making the main antenna in an expanded state when the intensity of the electric field is relatively strong in the automobile telephone or the personal radio, thereby being capable of surely conducting the transmission/reception operation, and automatically contracting the main antenna when the intensity of the electric field is weak, to thereby improve the operability.

Further, referring to "fold type portable telephone" disclosed in Japanese Patent Unexamined Publication No. Hei 5-336022 (hereinafter referred to as "Document 6"), the operation of expanding the antenna at the time of starting a call and the operation of accommodating the antenna in a casing at the time of finishing the call are linked to the operation of opening or closing hinges so as to be automatically conducted by a gear drive system.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above circumstances, and therefore an object of at least the preferred embodiments of the present invention is to provide an antenna control device for a radio unit

which solves the above problems and improves in portability and operability.

Another such object is to provide an antenna control device for a radio unit which automatically contracts an antenna in response to the call end operation of the radio unit.

Still another such object is to provide an antenna control device for a radio unit which automatically expands an antenna in response to a call reception of the radio unit.

Yet still another such object is to provide an antenna control device for a radio unit which automatically expands an antenna when the intensity of an electric field of a received signal becomes a predetermined value or less during calling, and automatically contracts the antenna at the time of terminating the call.

Yet still another such object is to provide an antenna control device for a radio unit, which is capable of selecting an automatic contraction mode in which an antenna is automatically contracted and an analog mode in which the antenna is contracted manually by an user.

According to one aspect of the present invention, the termination of a call is detected, and the antenna is automatically contracted in response to the detection of the termination of the call.

According to another aspect of the present invention, the reception of a call is detected, and the antenna is automatically expanded in response to the detection of the reception of the call.

According to yet another aspect of the present invention, it is detected that line is busy, the intensity of the electric field of the received signal is detected while it is detected that line is busy, the detected intensity of the electric field is compared with a predetermined intensity of the electric field, and when the detected intensity of the electric field is the predetermined intensity of the electric field or less, the antenna is automatically expanded.

According to a further aspect of the present invention, in the case of setting the analog mode in which the antenna is manually expanded by the user, the antenna is prohibited from being automatically expanded by means for automatically expanding or contracting the antenna.

In the above-mentioned structure, , because the antenna is automatically contracted with the detection that line is busy, the device is applicable to the automobile telephone or the portable telephone, thereby being capable of simplifying the operation.

Also, because the antenna is automatically expanded with the detection that a call is received, the operability can be simplified.

Further, because the antenna is automatically expanded only in the case where the intensity of the electric field during calling is low, the portability of the radio unit can be more improved.

Still further, because a user selects the automatic contraction mode or the manual mode, the antenna can be expanded or contracted not only automatically but also manually, thereby being capable of widening the operability of the expansion/contraction of the antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the present invention will become more fully apparent from the following detailed description taken with the accompanying drawings in which:

Fig. 1 is a functional block diagram showing a radio unit in accordance with an embodiment of the present invention;

Fig. 2 is a front view showing an operation section shown in Fig. 1;

Fig. 3 is a flowchart for explaining a method of setting an antenna contraction mode;

Fig. 4 is a flowchart for explaining an automatic antenna contraction;

Fig. 5 is a flowchart for explaining an automatic antenna contraction;

Figs. 6A to 6C are diagrams showing the structure of an antenna section in accordance with the present invention, respectively;

Fig. 7 is a functional block diagram showing an electronic circuit section in accordance with the embodiment of the present invention; and

Fig. 8 is a flowchart showing a control flow of the electronic circuit section in Fig. 7.

In the drawings, the same reference numerals denote the same structural elements.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, a description will be given in more detail of preferred embodiments of the present invention with reference to the accompanying drawings.

Fig. 1 is a functional block diagram showing a radio unit in accordance with an embodiment of the present invention.

In Fig. 1, the radio unit includes an antenna 1, a feeder section 2, a receiver section 3, a demodulator section 4, an electric field intensity detecting section 5, a first analog-to-digital (A/D) convertor section 6, and a comparator section 7. Also, the radio unit includes a first memory section 8, a control section 9, a first digital-to-analog (D/A) convertor secticn 10, a call receiving section 11, an operation section 12, and a second memory section 13. Further, the radio unit includes a call transmitting section 14, a second A/D convertor section 15, a modulator section 16, a power amplifier section 17, an antenna drive section 18, a third memory section 19, a power supply 20, a second D/A convertor section 21, a speaker 22, and a display section 23.

The radio unit is preferably a radio unit such as a

portable telephcne, an automobile telephone, a pager, a radio portable terminal, etc.

Subsequently, the operation of the radio unit will be described.

The radio unit is operated by a power supplied from the power supply 20.

A radio signal received by the antenna 1 is inputted through the feeder section 2 and supplied to the receiving section 3. The radio signal is then amplified by the receiving section 3 and outputted to the demodulator section 4 and the electric field intensity detecting section 5. The signal from the receiving section 3 is demodulated by the demodulator section 4 and further converted into a digital signal so that a demodulated signal is outputted to the control section 9.

Upon detecting a call reception signal from the demodulated signal from the demodulator section 4 by the control section 9 while waiting for the call reception signal, a ringer sound received by the antenna 1 is supplied to the control section 9 through the feeder section 2, the receiving section 3, and demodulator section 4, subsequent to the call reception signal. The ringer sound from the control section 9 is analog-converted by the D/A convertor section 21 and outputted to the speaker 22. The speaker 22 announces the ringer sound from the second D/A convertor section 21.

In calling from a subject radio unit for starting a call, the operation section 12 is operated for requesting the control section 9 to call. Upon the request to call, a call signal is outputted to the modulator section 16 by the control section 9, converted into an analog signal to be modulated by the modulator section 16, so that a modulated signal is outputted to the power amplifier section 17. The modulated signal is power-amplified by the power amplifier section 17, and transmitted to another radio unit or other radio unit, preferably a counterpart of communication through the feeder section 2 and the antenna 1.

During calling, the control section 9 outputs the demodulated signal from the demodulator section 4 to the first D/A convertor section 10. The demodulated signal inputted through the control section 9 is converted into an analog signal by the first D/A convertor section 10 and then outputted to the call receiving section 11. The call receiving section 11 outputs the analog signal from the first D/A convertor section 10 as a voice.

Also, a voice from the call transmitting section 14 is outputted to the second A/D convertor section 15. The voice is converted into a digital signal by the second A/D convertor section 15 and outputted to the control section 9. The digital signal inputted through the control section 9 is converted into an analog signal to be modulated by the modulator section 16, so that a modulated signal is outputted to the power amplifier section 17. The modulated signal is power-amplified by the power amplifier section 17 and transmitted to the counterpart of communication through the feeder section 2 and the antenna 1.

When the radio unit performs its functions of, for example, adjusting the volume of sound, storing an abbreviated number, or setting an antenna expanding manner, the operation section 12 is operated so as to request the control section 9 to set them, the control section 9 reads a menu screen from the second memory section 13, and the display section 23 displays, as the menu screen, items for the adjustment of a sound volume, the storage of the abbreviated number or the setting of the antenna expanding manner. Upon selecting the setting of the antenna expanding manner by the operation section 12, the control section 9 reads an antenna expansion/contraction setting screen from the second memory section 13, and allows the display section 23 to display, a plurality of antenna expansion/contraction modes, for example, an antenna expansion setting screen for setting the automatic expansion/contraction or the manual expansion/contraction. Of the antenna expansion/contraction modes on the displayed antenna expansion/contraction screen, a selected mode is stored in the third memory section 19 by the control unit 9.

The automatic expansion/contraction or the manual expansion/contraction of the antenna 1 is conducted by reading the antenna expansion/contraction mode stored in the third memory section 19 so as to drive the antenna drive section 18 to expand the antenna 1.

Also, in the case of setting the electric field intensity interlocking mode in which the antenna 1 is automatically expanded when the intensity of the electric field is weak during calling, the intensity of the electric field of a radio signal is detected by the electric field intensity detecting section 5 on the basis of a signal from the receiving section 3. The intensity of the electric field of the radio signal includes field strength or freqency signal strength. The detected intensity of the electric field is converted into a digital signal by the first A/D convertor section 6. The digital signal is compared with a predetermined intensity of the electric field from the first memory section 8 by the comparator section 7, and it is judged whether or not the intensity of the electric field of the radio signal received by the antenna 1 is equal to or lower than the predetermined intensity of the electric field. In the case where the intensity of the electric field of the radio signal received by the antenna 1 is equal to or lower than the predetermined intensity of the electric field, the comparator section 7 outputs a judgement signal to the control section 9 so that the control section 9 drives the antenna drive section 18 to expand the antenna 1.

Subsequently, the structure of the operation section 12 will be described with reference to Fig. 2.

Fig. 2 is a front view of the operation section 12.

In Fig. 2, the operation section 12 includes ten-keys consisting 0 to 9 so that a dial number of a counterpart of communication is inputted when calling. A function key 121 is a key for shifting the radio unit to a menu mode, and upon depressing the function key 121, a

menu screen is displayed on the display section 23. A send key 122 is a key for requesting a call. The send key 122 is depressed after the dial number of the counterpart of communication is inputted through the ten-keys so that the subject radio unit is connected to the counterpart of communication. It should be noted that the dial number of the cc,unterpart of communication may be inputted by the ten-keys after depression of the send key 122. An off-hook key 123 is a key for shifting the radio unit to an off-hook state or an on-hook state, and in the off-hook state, the radio unit is connected to a base station through a communication line.

Subsequently, the operation of the operation section 12 will be described.

Upon depressing the function key 121, the operation section 12, the operation section 12 outputs a menu screen display request signal to the control section 9 to request that the menu screen is displayed on the display section 12. Upon depressing any one of the ten-keys for selecting a function which is intended to be set by a user among the functions of the radio unit when the menu screen is displayed on the display section 12, the operation section 12 outputs a setting signal to the control section 9 to request that the particulars of the set function are displayed on the display section 12. Similarly, in further selecting a function to be set in the radio unit among the particulars of the set function, the ten-keys are depressed.

Upon depressing the ten-keys and also the send key 122 when the menu screen is not displayed on the display section 12, the operation section 12 outputs to the control section 9 a call request signal which requests that a call is sent to the number inputted by the ten-keys, thus,requesting the connection of a line to the counterpart of communication.

Upon depressing the off-hook key 123 in the on-hook state, the control section 12 outputs an off-hook signal to the control section 9 to request the connection of a communication line to the base station.

Subsequently, the details of the antenna expansion/contraction setting in accordance with the present invention will be described with reference to Fig. 3.

Fig. 3 is a flowchart for explaining the setting of the antenna expansion/contraction.

In Fig. 3, upon depressing the function key 121 (S101), the control section 9 reads a menu screen from the second memory section 13 and displays it on the display section 12 (S102). It should be noted that in the case where no function key 121 is depressed, the processing returns to the process of S101. The display section 12 displays the menu screen, for example, the respective setting items of the adjustment of a sound volume, the storage of an abbreviated number and the antenna expansion/contraction setting manner, and numerals of 1 to 3 are displayed at heads in correspondence with the respective setting items. For example, in the case where the user intends to set the antenna expansion/contraction manner, if a numeral "3" is added to the head of the item for setting the antenna contraction manner, the user depresses the ten-key "3". Therefore, in the operation of setting the antenna expansion/contraction, the control section 9 judges whether the ten-key "3" is depressed or not (S103). If the ten-key "3" is not depressed, the processing returns to the process of S103. Upon depressing the ten-key "3", the control section 9 reads the antenna expansion/contraction setting screen from the second memory section 13 to display it on the display section 12 (S104). The display section 12 displays the antenna expansion/contraction setting screen, that is, an analog mode in which the antenna 1 is manually expanded or contracted, an automatic expansion/contraction mode in which the antenna 1 is automatically expanded or contracted during non-calling, and an electric field intensity interlocking mode in which the antenna 1 is automatically expanded or contracted when the intensity of the electric field during calling is weak. Numerals 1 to 3 are added to the heads of these plural modes, respectively. For example, when a user intends to set the automatic expansion/contraction mode, a numeral added to the head of the automatic expansion/contraction mode, for example, "3" is added, the ten-key "3" is depressed. Therefore, in order to set the antenna expansion manner, the control section 9 judges whether any one of the ten-keys "1", "2" or "3" is depressed or not (S105). If these ten-keys are not depressed, the processing returns to the process of S105. On the other hand, if any of these ten-keys is depressed, the mode set by the control section 9 is stored in the third memory section 19.

Subsequently, a description will be given in more detail of the automatic antenna contraction with reference to Figs. 4 and 5.

Figs. 4 and 5 are flowcharts for explaining the automatic antenna contraction.

In Fig. 4, in order to detect whether the radio unit shifts to the off-hook state or not, it is judged whether the off-hook key 123 is depressed in the on-hook state or not (S201). If it is depressed, the processing advances to the process of S208. On the other hand, in the process of S201, if the off-hook key 123 is not depressed, in order to detect whether a call is requested or not, it is judged whether the send key 122 is depressed or not (S202). If the send key 122 is depressed, the processing advances to the process of S208. On the other hand, if the send key 122 is not depressed, it is judged whether a call reception signal is received or not (S203), and if the call reception signal is not received, the processing then returns to the process of S201.

If the call reception signal is received in the process of S203, it is judged whether a ringer sound sent subsequent to the call reception signal is received or not (S204). Then, the operation of the process S204 is continued until receiving the ringer sound. Upon receiving the ringer sound, an announce sound is announced from the speaker 22 to call out the user (S205). When the speaker 22 announces the announce sound, in or-

der to detect whether the user responds to the announce sound or-not, it is judged whether any key of the operation section 12 is depressed or not (S206). If it is depressed, the processing advances to the process of S208. On the other hand, when the speaker 22 announces the announce sound, if any key of the operation section 12 is not depressed, in order to detect whether the user is still being called out from the counterpart of communication or not, it is judged whether the ringer sound is still being received or not (S207). If the ringer sound is still being received, the processing returns to the process of S205. If the ringer sound has not been received, the process is ended. Those processes of S201 to S206 are conducted to judge whether the radio unit is in a call state or not. Also, as described, the user may depress any key of the operation section 12 in order to respond to the call reception, that is, the announce sound (any one key function). Instead of depressing any key of the operation section 12, the off-hook key 123 may be depressed.

In order to detect to which mode a mode for setting the antenna contracting manner is set in the process of S208, it is first judged whether the antenna contraction setting mode stored in the third memory section 19 is the analog mode or not (S208). If it is the analog mode, the processing is ended, and subsequently the antenna 1 is expanded or contracted manually by the user. On the other hand, if the mode is not set to the analog mode, as shown in Fig. 5, it is judged whether the antenna contraction setting mode stored in the third memory section 19 is the electric field intensity interlocking mode or not (S209). If the mode is not set to the electrical field intensity interlocking mode, the antenna 1 is automatically expanded regardless of the intensity of the electric field (S212), and if the mode is set to the electrical field intensity interlocking mode, it is judged whether or not the intensity of the electric field of the received radio signal is equal to or less than a predetermined value, on the basis of a judgement signal from the comparator section 7 (S210).

In the process of S210, if the intensity of the electric field of the received radio signal is equal to or less than the predetermined value, the processing advances to the process of S212 where the antenna 1 is automatically expanded. If the intensity of the electric field of the received radio signal is not equal to or less than the predetermined value, it is judged whether the off-hook key 123 is depressed or not (S211). When the off-hook key 123 is depressed so that the call is terminated, the processing is ended without expanding the antenna 1. If the call is continued without depressing the off-hook key 123, the processing returns to the process of S210, and the antenna 1 is automatically expanded at the time where the intensity of the electric field of the radio signal is equal to or less than the predetermined value while the call is continued.

If the antenna 1 is automatically expanded in the process of S212, in order to judge whether the call is terminated or nct, it is judged whether the off-hook key 123 is depressed or not (S213). Upon depressing the off-hook key 123 so that the call is terminated, the antenna 1 is automatically contracted (S214), and the processing is ended. On the other hand, if the call is continued without depressing the off-hook key 123, the prccessing returns to the process of S213 to wait for the termination of the call.

In this embodiment, there was described that in the case where the analog mode is set, both of the expansion and contraction of the antenna 1 is manually performed. Instead, it may be constituted such that only the expansion of the antenna 1 is manually performed, and the antenna 1 is automatically contracted at the time of terminating the call.

Also, in this embodiment, in the case where the electric field intensity interlocking mode is set, if the intensity of the electric field is weakened and the antenna 1 is expanded, the antenna 1 is held in the expanded state until the call is terminated. Instead, it may be constituted such that the intensity of the electric field is detected at all times, and the antenna 1 is automatically contracted at the time where the intensity of the electric field is high.

Subsequently, the structure of the antenna in accordance with the present invention will be described with reference to the accompanying drawings.

Fig. 6A is a perspective view showing the interior of a case of a radio unit, in particular, a portable telephone in accordance with an embodiment of the present invention, Fig. 6B is a perspective view showing the structure of the antenna section in Fig. 6A, and Fig. 6C is a partially top view showing the antenna expansion/contraction port of the case in Fig. 6A.

Referring to Fig. 6, the portable telephone of this embodiment includes an antenna control means for automatically expanding and contracting the antenna in response to the above operation, etc.

Also, the antenna control means may expand or contract the antenna in response to the operation of the off-hook button of the operation section.

In other words, the portable telephone is made up of an antenna section having an expandable and contractible antenna 51, a reversible motor 54 that rotates the antenna 51, an electronic circuit section having the function of the above antenna control means, and a case 56 having an antenna section receiving chamber 57 that receives the antenna section and the reversible motor 54, and an electronic circuit section receiving chamber 58 that receives the electronic circuit section.

Then, the antenna section includes an antenna 51 having a spiral groove 52 formed in its outer periphery, and a rotating bar 53 that makes the antenna 51 move rotationally and move vertically along its axial direction.

Also, the case 56 includes an antenna expansion/contraction port 55 having a protrusion 55a which is engaged with the spiral groove 52 of the antenna 51.

It should be noted that the spiral groove 52 defined

in the antenna 51 is formed counterclockwise and upwardly as shown in Fig. 6B.

Fig. 7 shows a part relating particularly to an antenna control in the radio unit shown in Fig. 6.

Fig. 7 is a functional block diagram showing an electronic circuit section in accordance with the embodiment of the present invention. Referring to Fig. 7, the electronic circuit section 61 includes an operation section 64 having operation keys consisting of a start key, an end key such as an off-hook key, etc., a motor control section 65 that controls the rotation of the reversible motor (M) 64, a control section 63 that detects the operating state of the operation key and the expanding/contracting state of the antenna 51 of the antenna section 50 to instruct the rotation control of the motor 54 to the motor control section 65, and a radio section 62 that conducts the transmission/reception of electric waves between the radio unit and a base station (not shown) through the antenna section 50 and the antenna 51.

Now, the operation of expanding and contracting the antenna 51 by the electronic circuit section 61 will be described with reference to Figs. 6 and 7. It should be noted that for simplification of the description, Fig. 7 shows the operation of expanding or contracting the antenna according to the operation from the operation section.

First, the operation of expanding the antenna 51 will be described. Since the rotating bar 53 and the shaft of the motor 54 are coupled to each other, when the motor 54 is rotated counterclockwise by the motor control section 75, the rotating bar 53 also rotates counterclockwise. Since the counterclockwise rotation of the rotation bar 53 makes the antenna 51 rotate counterclockwise, and the protrusion 55a of the antenna expansion/contraction port 55 is engaged with the spiral groove 52, the antenna 51 expands upward while it rotates along the spiral groove 52.

It should be noted that if the length of the rotating bar 53 is set to be longer than that of the antenna 51, there is no case where the rotating bar 53 comes out from the antenna 51.

Then, the operation of contracting the antenna 51 will be described. When the motor control section 65 allows the motor 54 to rotate clockwise, the rotating bar 53 also rotates clockwise. Since the clockwise rotation of the rotating bar 53 makes the antenna 51 rotate clockwise, and the protrusion 55a of the antenna expansion/contraction port 55 is engaged with the spiral groove 52, the antenna 51 contracts downward while it rotates along the spiral groove 52.

It should be noted that the r.p.m. of the motor 54 necessary for completely contracting the antenna 51 to receive it in the antenna section receiving chamber 57 is stored in the motor control section 65 in advance.

Then, the control operation according to this embodiment will be described with reference to Fig. 8. Fig. 8 is a flowchart showing the control flow of an electronic circuit section in Fig. 7.

First, the control section 63 checks whether the start key of the operation section 64 is depressed or not (Step S31).

Then, upon detection that the start key is depressed (Y in S31), the control section 63 checks whether the antenna 51 is in an expanded state or not (S32). If it is Y in S32, that is, the antenna 51 is in the expanded state, the processing is ended.

Also, if it is N in S32, that is, the antenna 51 is not in the expanded state (in a contracted state), the control section 63 instructs the motor control section 65 so that the motor 54 is rotated counterclockwise at a predetermined r.p.m. to expand the antenna 51, thus ending the processing (S33).

On the other hand, if it is N in S31, that is, the depression of the start key is not detected, the control section 63 checks whether the end key of the operation section 64 is depressed or not (S34).

Then, upon the detection that the end key is depressed (Y in S34), the control section 63 checks whether the antenna 51 is in the contracted state or not (S35). If it is Y in S35, that is, the antenna 51 is in the contracted state, the processing is ended.

Also, if it is N in S35, that is, the antenna 51 is not in the contracted state (in the expanded state), the control section 63 instructs the motor control section 65 so that the motor 54 is rot:ated clockwise at a predetermined r.p.m. to contract the antenna 51, thus ending the processing (S36).

Summarizing the above processing operation, when the start key or the end key is depressed, the antenna 51 is automatically expanded or contracted. In other words, if the user depresses the start key at the time of calling or responding to the call reception, the antenna 51 is automatically expanded, and if the end key is depressed at the time of terminating the call, the antenna 51 is automatically contracted.

It should be noted that even though the start key is depressed in the state where the antenna 51 is in the expanded state, or even though the end key is depressed in the state where the antenna 51 is in the contracted state, since the motor control section 65 does not drive the motor 54, the contracted state of the antenna 51 is not changed.

In the above embodiment, although the termination of the call is detected by the key operation, the present invention is not limited to this, and control may be conducted in response to the detection of the call end signal in the radio signals.

As was described above, a'ccording to the present invention, because the antenna is automatically contracted with the detection that the call is terminated, the device is applicable to the automobile telephone or portable telephone, thereby being capable of simplifying the operation.

Also, according to the present invention, because the antenna is automatically expanded with the detection that the call is received, the operability can be sim-

plified.

Further, according to the present invention, because the antenna is automatically expanded only in the case where the intensity of the electric field during calling is low, the portability of the radio unit can be further improved.

Still further, according to the present invention, because the user selects the automatic contraction mode and the analog mode, the antenna can be expanded or contracted not only automatically but also manually, the operability of the expansion/contraction operation of the antenna can be widened.

While the present invention has been described with reference to specific embodiments thereof, this description is by way of example only. It will be appreciated by those skilled in the art that numerous variations, modifications, and embodiments are possible, and accordingly, all such variations, modifications, and embodiments are to be regarded as being with in the scope of the present invention as defined by the claims.

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

The text of the abstract filed herewith is repeated here as part of the specification.

An antenna control device for a radio unit automatically expands an antenna in response to the detection of a call, and automatically contracts the antenna when the call is terminated. Also, the device automatically expands the antenna in response to a call reception.

Claims

1. An antenna control device for a radio unit, comprising:

   first detecting means for detecting the termination of a call; and
   automatic antenna contracting means for automatically contracting an antenna in response to the detection by said first detecting means that the call is terminated.

2. An antenna control device for a radio unit as claimed in claim 1, wherein said first detecting means detects that an off-hock key that requests the shift to an on-hook state is depressed.

3. An antenna control device for a radio unit, comprising:

   first detecting means for detecting a call reception; and
   automatic antenna expanding/contracting means for automatically expanding an antenna in response to the detection of the call reception by said first detecting means.

4. An antenna control device for a radio unit as claimed in claim 2, wherein said first detecting means detects that an arbitrary key in said radio unit is operated at the time of receiving a call for a user of said radio unit.

5. An antenna control device for a radio unit, comprising:

   first detecting means for detecting a calling state with a counter part radio unit;
   electric field intensity detecting means for detecting an intensity of electric field of a received signal when said first detecting means detects the calling state;
   judging means for comparing said detected intensity of electric field with a predetermined intensity of electric field to output a judgement signal when said detected intensity of electric field is equal to or less than said predetermined intensity of electric field; and
   automatic antenna expanding/contracting means for automatically expanding the antenna in response to said judgement signal.

6. An antenna control device for a radio unit as claimed in claim 5, wherein when said judging means stops outputting said judgement signal, said automatic antenna expanding/contracting means automatically contracts the. antenna.

7. An antenna control device for a radio unit, comprising:

   first detecting means for detecting the start of a call;
   automatic antenna expanding/contracting means for automatically expanding an antenna in response to the detection of the start of the call by said first detecting means;
   setting means for setting an analog mode in which the antenna is manually expanded by a user; and
   prohibiting means for prohibiting said antenna from being automatically expanded by said automatically antenna expanding/contracting means when said setting means sets said analog mode.

8. An antenna control device for a radio unit as claimed in claim 7, wherein when said setting means sets said analog mode, said prohibiting means prohibits said antenna from being automatically contracted by said automatic expanding/contracting means.

9. An antenna control device for a radio unit as claimed in claim 1, further comprising:

an antenna section having an expandable and contractible antenna, a reversible motor that rotates said antenna, an electronic circuit section having the function of said antenna ccntrol means, and a case for receiving said antenna, said reversible motor and said electronic circuit section;
wherein said antenna section includes an antenna having a spiral groove formed in its outer periphery and a rotating bar that makes said antenna move rotationally and move vertically along its axial direction; and
wherein said case includes an antenna expansion/contraction port having a protrusion which is engaged with said spiral groove of said antenna.

10. An antenna control device for a radio unit as claimed in claim 9, wherein said electronic circuit section includes an operation section having operation keys including a start key and an end key, a motor control section that controls the rotation of said reversible motor, and a control section that detects the operating state of said operation key and the expanding/contracting state of said antenna of said antenna section to instruct the rotation control of said reversible motor to said motor control section.

11. An antenna control method for a radio unit, comprising the steps of:

detecting the termination of a call; and
automatically contracting an antenna in response to the detection of the termination of the call by said detecting step.

12. An antenna control method for a radio unit as claimed in claim 11, wherein said detecting step detects that an off-hook key that request a shift to an on-hook state is depressed.

13. An antenna control method for a radio unit, comprising the steps of:

detecting a call reception; and
automatically expanding an antenna in response to the detection of said call reception by said detecting step.

14. An antenna control method for a radio unit as claimed in claim 13, wherein said detecting step detects that an arbitrary key in said radio unit is operated when said radio unit calls out an user.

15. An antenna control method for a radio unit, comprising the steps of:

detecting a calling state with a counter part radio unit;
detecting an intensity of electric field of a received signal when said calling state detecting step detects the calling state;
comparing said detected intensity of electric field with a predetermined intensity of electric field to output a judgement signal when said detected intensity of electric field is equal to or less than said predetermined intensity of electric field; and
automatically expanding the antenna in response to said judgement signal.

16. An antenna control method for a radio unit as claimed in claim 15, wherein when the output of said judgement signal is stopped, said antenna is automatically expanded.

17. An antenna control method for a radio unit, comprising the steps of:

detecting the start of a call;
automatically expanding an antenna in response to the detection of the start of the call by said detecting step;
setting an analog mode in which said antenna is manually expanded by a user; and
prohibiting said antenna from being automatically expanded when said setting step sets said analog mode.

18. An antenna control method for a radio unit as claimed in claim 17, wherein when said setting step sets said analog mode, said antenna is prohibited from being automatically contracted.

Fig.1

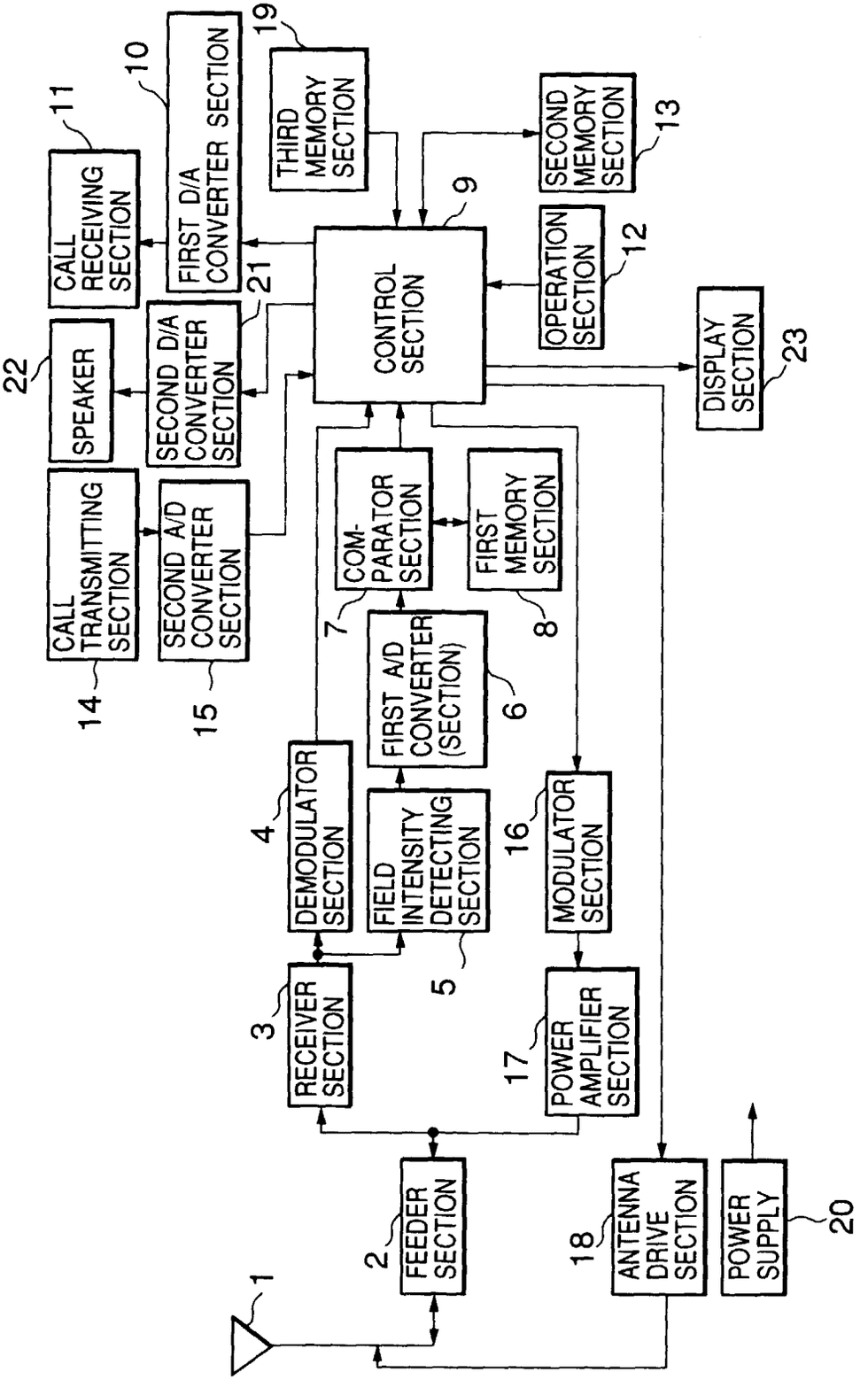

1
2
FEEDER SECTION
3
RECEIVER SECTION
4
DEMODULATOR SECTION
5
FIELD INTENSITY DETECTING SECTION
6
FIRST A/D CONVERTER (SECTION)
7
COM-PARATOR SECTION
8
FIRST MEMORY SECTION
9
CONTROL SECTION
10
FIRST D/A CONVERTER SECTION
11
CALL RECEIVING SECTION
12
OPERATION SECTION
13
SECOND MEMORY SECTION
14
CALL TRANSMITTING SECTION
15
SECOND A/D CONVERTER SECTION
16
MODULATOR SECTION
17
POWER AMPLIFIER SECTION
18
ANTENNA DRIVE SECTION
19
THIRD MEMORY SECTION
20
POWER SUPPLY
21
SECOND D/A CONVERTER SECTION
22
SPEAKER
23
DISPLAY SECTION

Fig.2

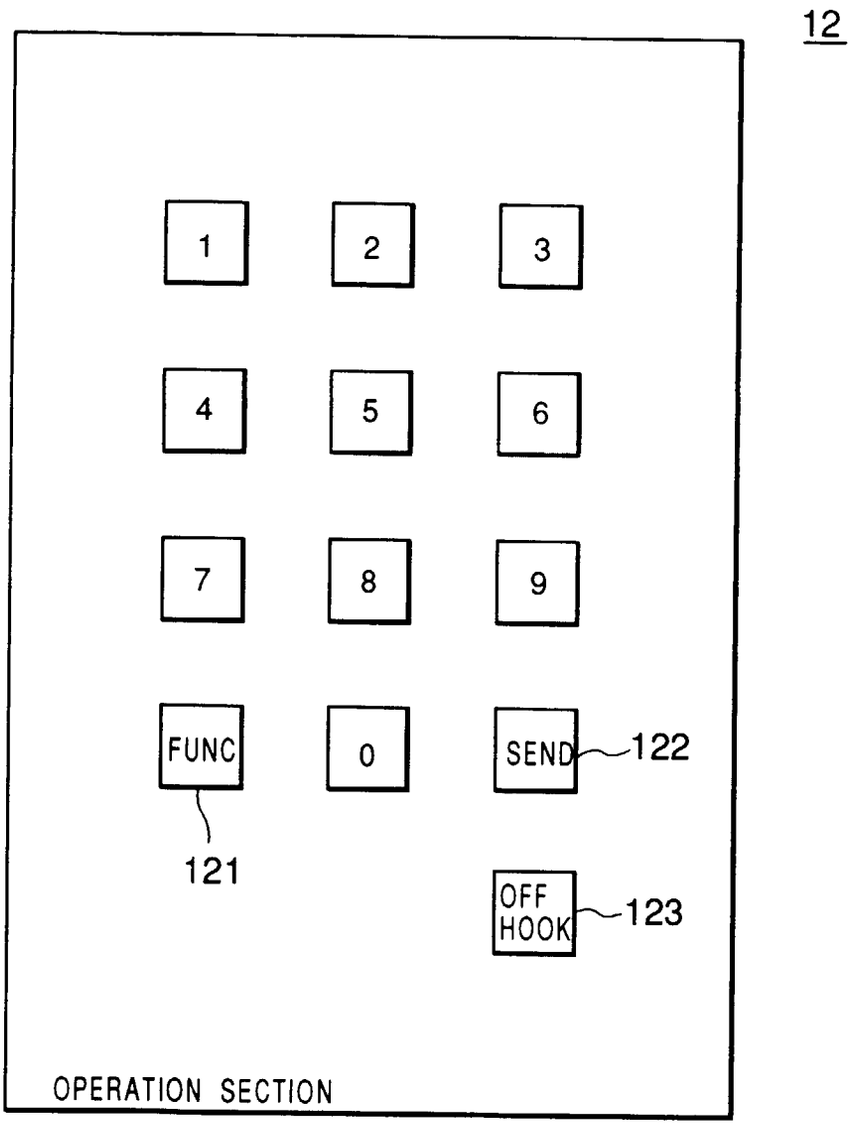

12
1
2
3
4
5
6
7
8
9
FUNC
0
SEND
122
121
OFF HOOK
123
OPERATION SECTION

Fig.3

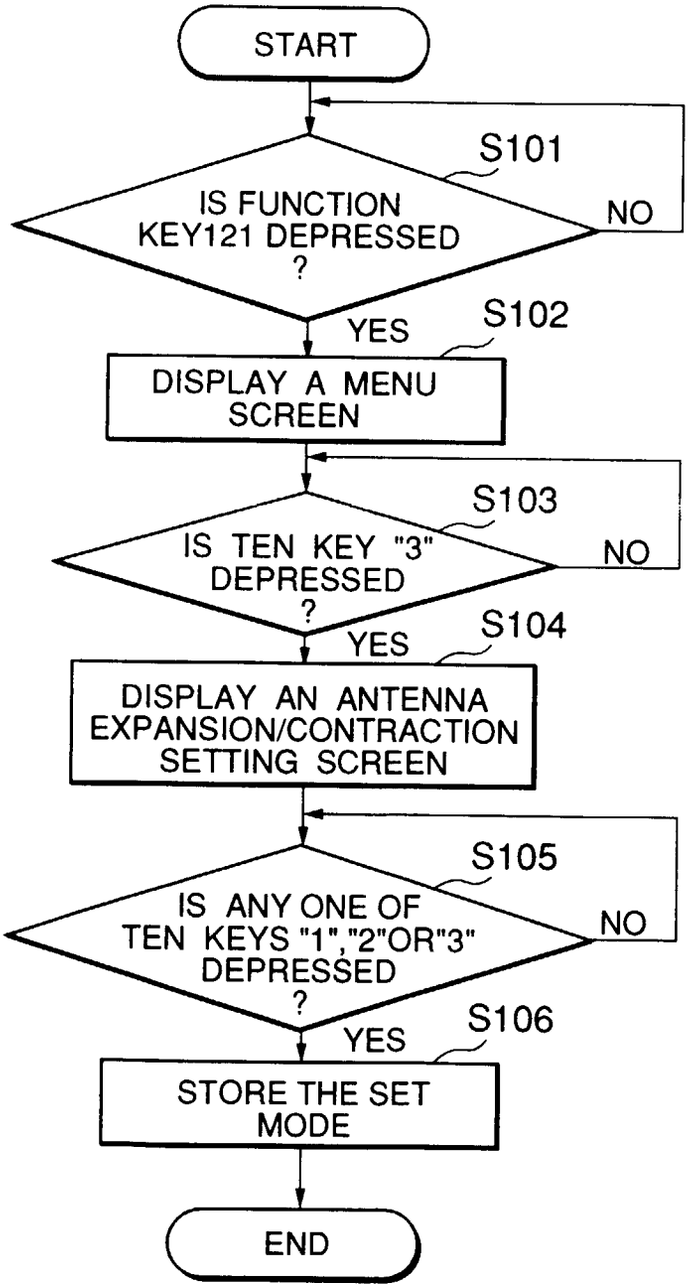

START
S101
IS FUNCTION KEY121 DEPRESSED ?
NO
YES
S102
DISPLAY A MENU SCREEN
S103
IS TEN KEY "3" DEPRESSED ?
NO
YES
S104
DISPLAY AN ANTENNA EXPANSION/CONTRACTION SETTING SCREEN
S105
IS ANY ONE OF TEN KEYS "1","2"OR"3" DEPRESSED ?
NO
YES
S106
STORE THE SET MODE
END

Fig.4

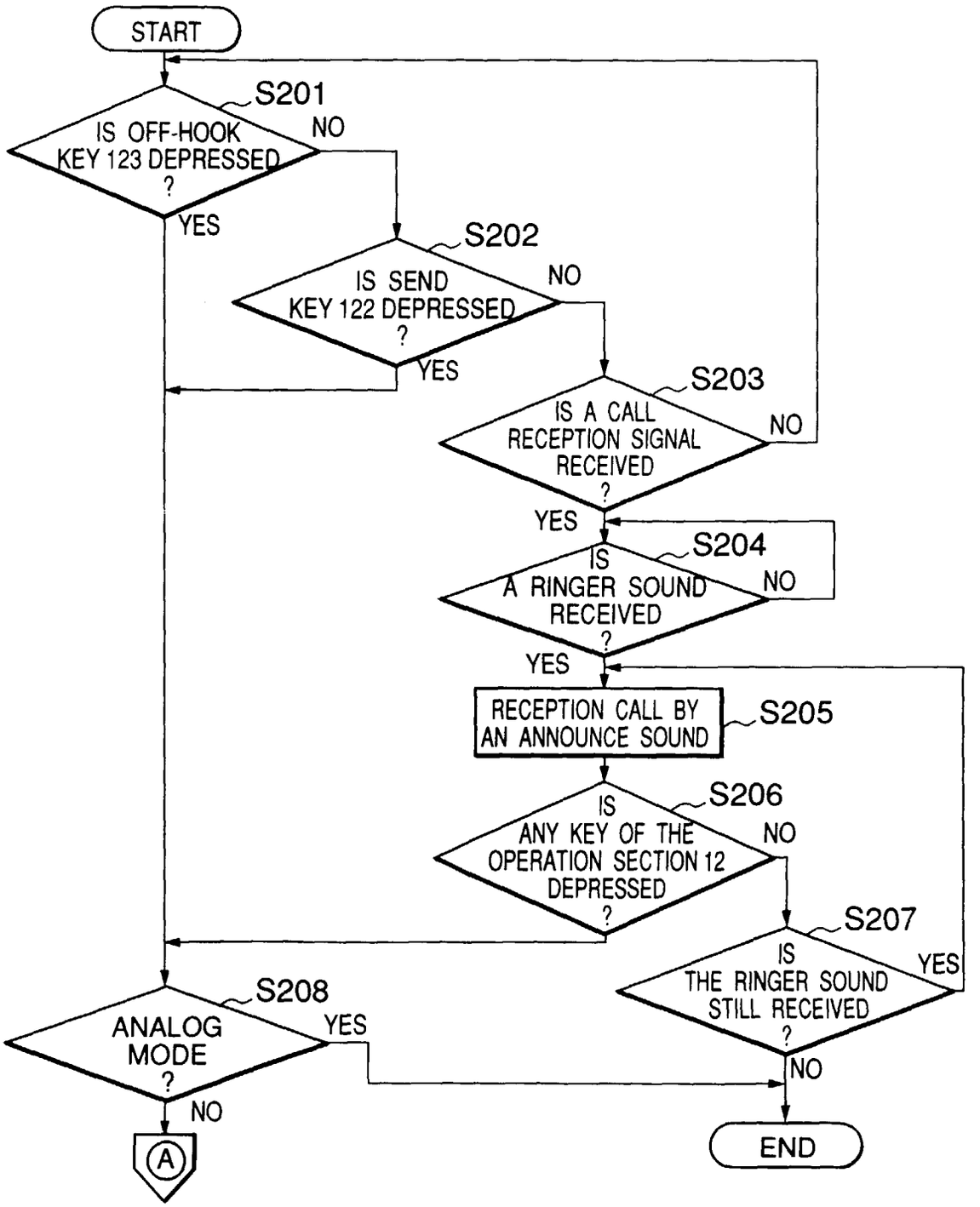

START
S201
IS OFF-HOOK KEY 123 DEPRESSED ?
NO
YES
S202
IS SEND KEY 122 DEPRESSED ?
NO
YES
S203
IS A CALL RECEPTION SIGNAL RECEIVED ?
NO
YES
S204
IS A RINGER SOUND RECEIVED ?
NO
YES
RECEPTION CALL BY AN ANNOUNCE SOUND
S205
S206
IS ANY KEY OF THE OPERATION SECTION 12 DEPRESSED ?
NO
S207
IS THE RINGER SOUND STILL RECEIVED ?
YES
NO
S208
ANALOG MODE ?
YES
NO
A
END

Fig.5

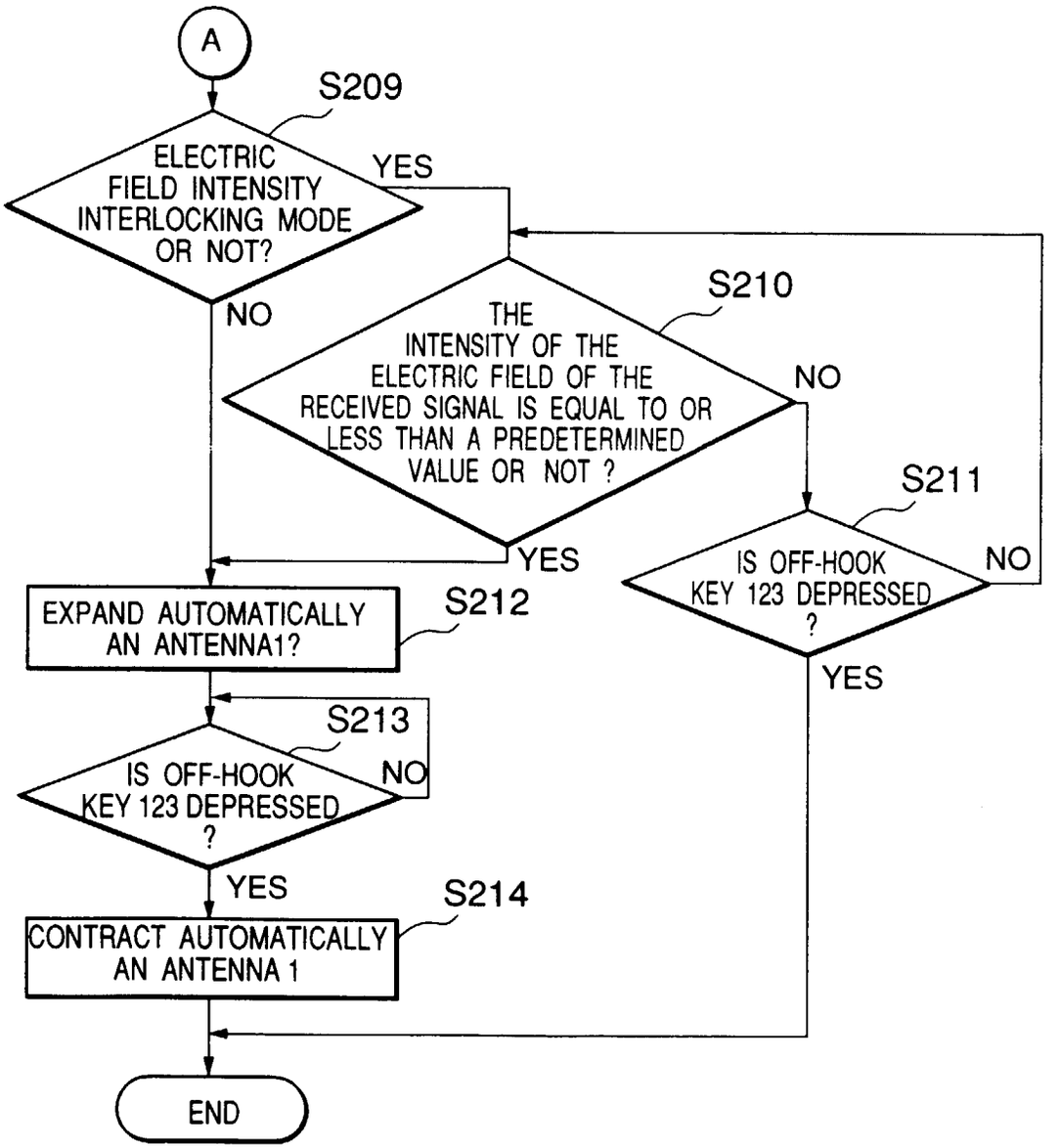

A
S209
ELECTRIC FIELD INTENSITY INTERLOCKING MODE OR NOT?
YES
NO
S210
THE INTENSITY OF THE ELECTRIC FIELD OF THE RECEIVED SIGNAL IS EQUAL TO OR LESS THAN A PREDETERMINED VALUE OR NOT ?
NO
YES
S211
IS OFF-HOOK KEY 123 DEPRESSED ?
NO
YES
EXPAND AUTOMATICALLY AN ANTENNA1?
S212
S213
IS OFF-HOOK KEY 123 DEPRESSED ?
NO
YES
S214
CONTRACT AUTOMATICALLY AN ANTENNA 1
END

Fig.6(c)

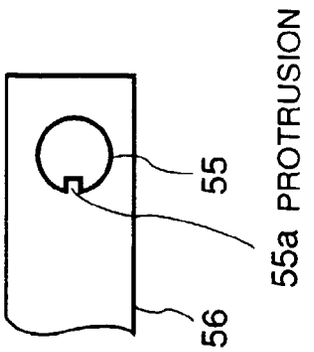


Fig.6(b)

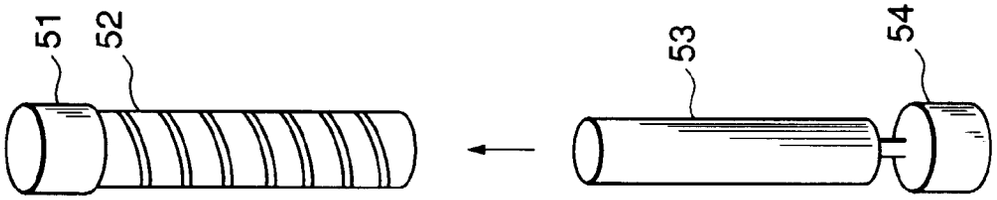


Fig.6(a)

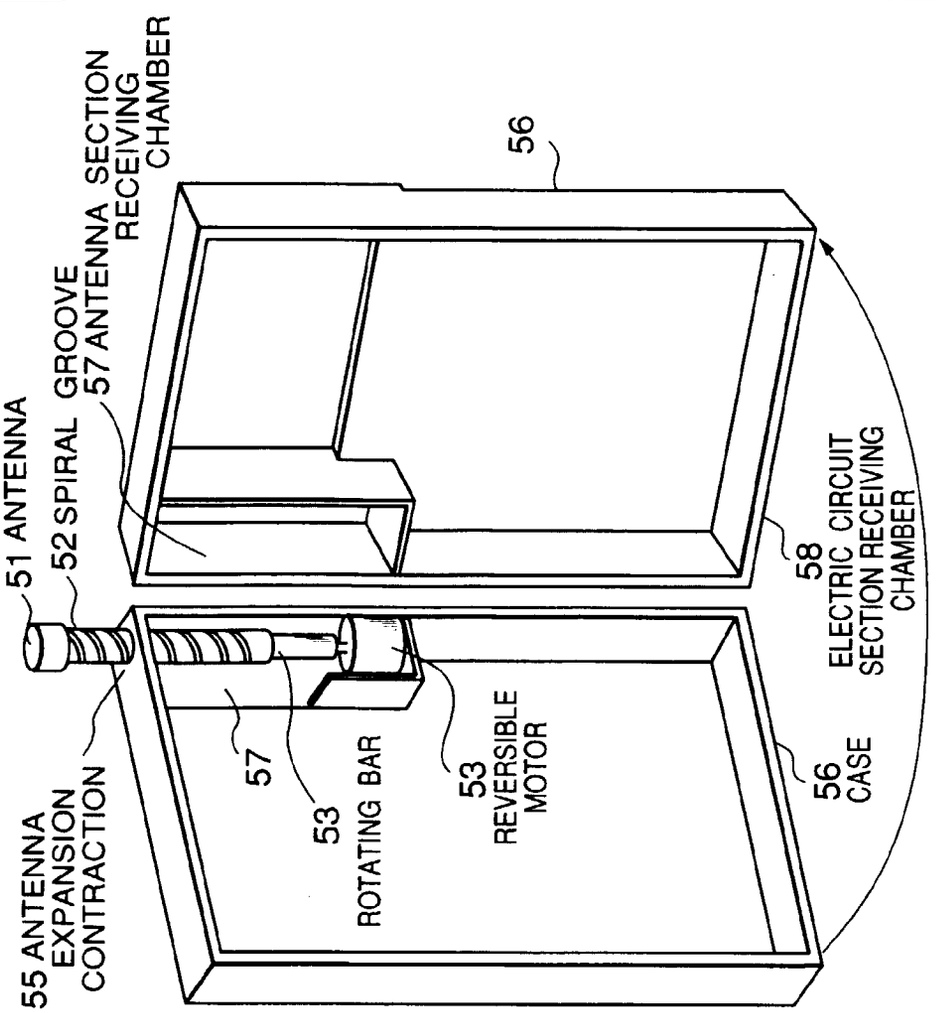


Fig.7

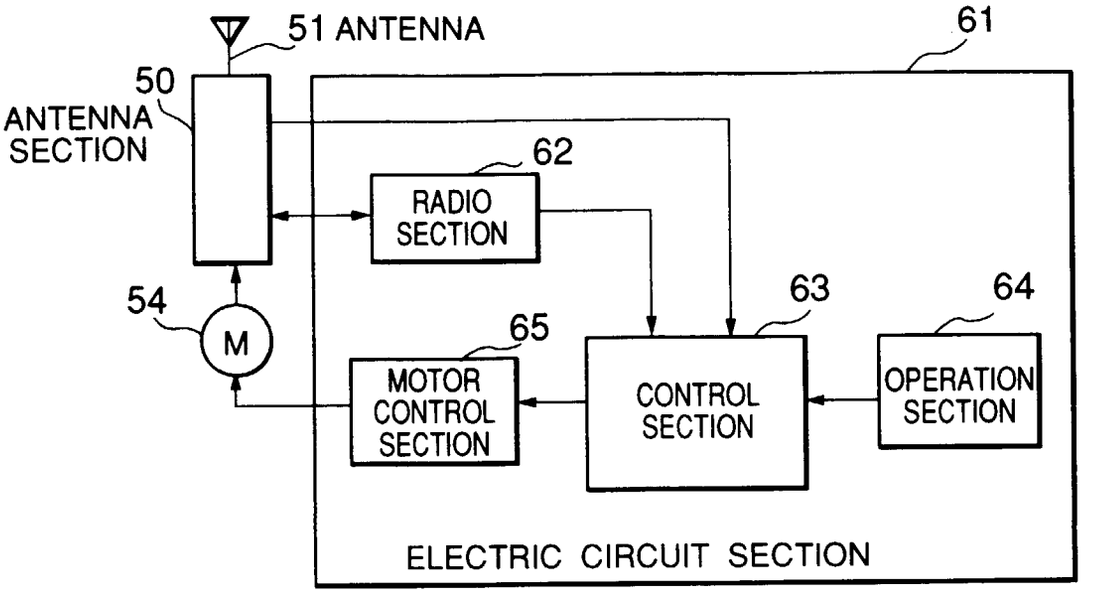
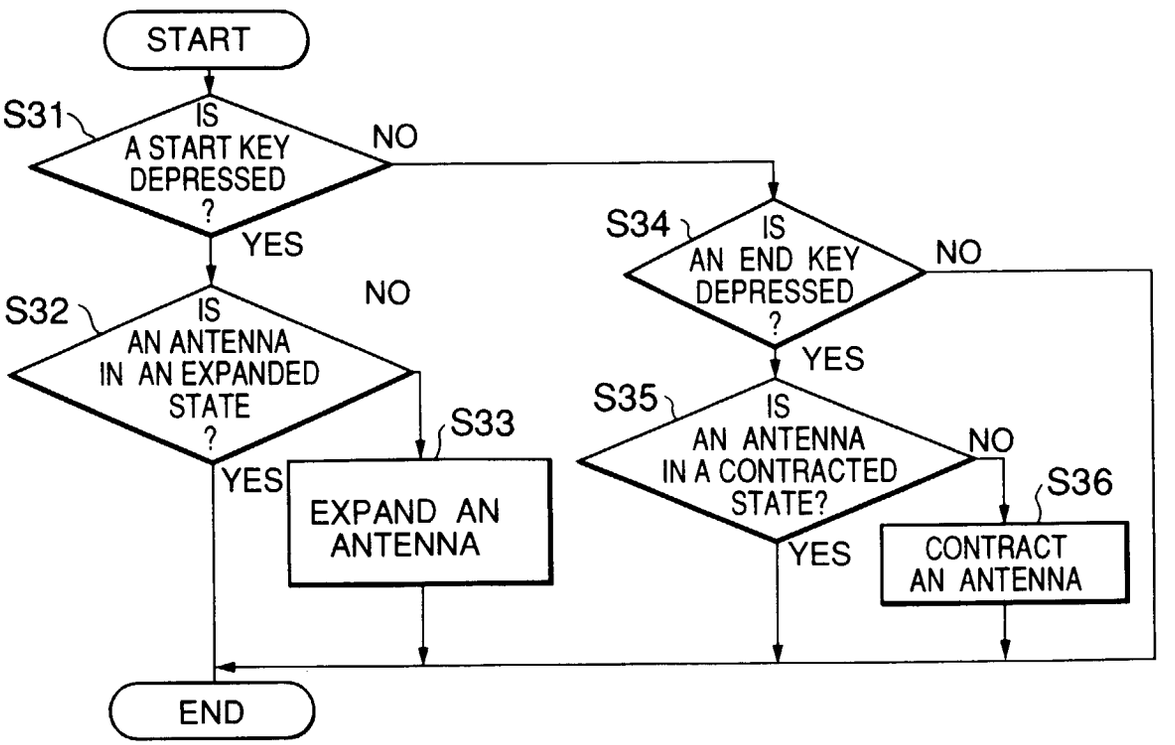

51 ANTENNA
61
50
ANTENNA SECTION
62
RADIO SECTION
54
M
63
64
65
MOTOR CONTROL SECTION
CONTROL SECTION
OPERATION SECTION
ELECTRIC CIRCUIT SECTION

Fig.8


START
S31
IS A START KEY DEPRESSED ?
NO
YES
S32
IS AN ANTENNA IN AN EXPANDED STATE ?
NO
YES
S33
EXPAND AN ANTENNA
S34
IS AN END KEY DEPRESSED ?
NO
YES
S35
IS AN ANTENNA IN A CONTRACTED STATE?
NO
YES
S36
CONTRACT AN ANTENNA
END