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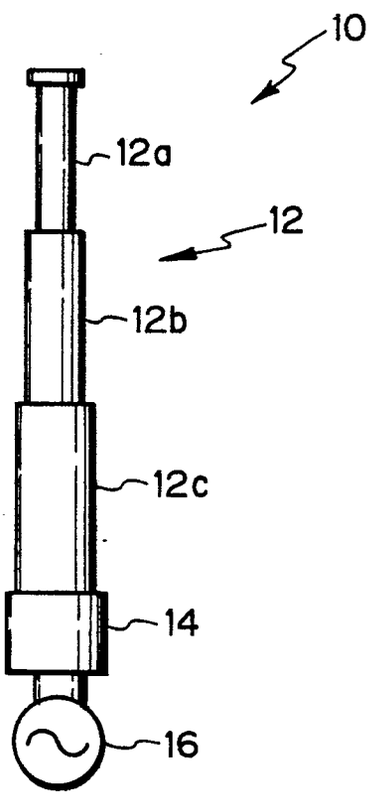
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(54) Antenna for portable radio equipment.

(57) An antenna for portable radio equipment serves as a λ/2 wavelength long antenna when extended or as a less than λ/4 wavelength long antenna such as a λ/8 wavelength long antenna when contracted. Both of such antenna configurations are matched by a single matching circuit with respect to impedance. The antenna radiates power efficiently in the horizontal plane.

Fig. 1A



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The present invention relates to an antenna applicable to various kinds of mobile radio equipment, particularly portable radio equipment.

It is a common practice to provide portable radio equipment with a whip antenna whose wavelength is one half of the wavelength λ of the carrier or center frequency particular to the equipment, i. e., λ/2. Such a λ/2 wavelength long whip antenna insures a relatively high gain of the order of 0 dBd (dipole ratio) in the horizontal plane and causes a minimum of decrease in gain even when the equipment is brought closer to the human body. Such an antenna, however, lacks portability since its element is as long as λ/2 wavelength. To eliminate this problem, portable radio equipment capable of receiving the λ/2 antenna in the casing thereof has been proposed in the past. This, however, brings about another problem that the λ/2 antenna practically fails to play the role of an antenna when received in the casing. In light of this, portable radio equipment may be provided with a built-in antenna in addition to the λ/2 antenna, as also proposed in the past. The built-in antenna will be substituted for the λ/2 antenna when the latter is received in the casing of the equipment. Nevertheless, the problem with this kind of scheme is that not only the equipment is complicated in construction, but also the built-in antenna increases the overall size of the equipment.

It is therefore an object of the present invention to provide an antenna for portable radio equipment which is free from the drawbacks particular to the conventional λ/2 antenna as discussed above.

It is another object of the present invention to provide an antenna for portable radio equipment which has a telescopic body section to selectively serves as either one of a λ/2 wavelength long antenna and a less than λ/4 wavelength long antenna.

It is another object of the present invention to provide an antenna for portable radio equipment which radiates power effectively in the horizontal plane at all times and insures a relatively high gain of the order of 0 dBd.

It is another object of the present invention to provide an antenna for portable radio equipment which has a single matching circuit capable of matching both a λ/2 wavelength long antenna and a less than λ/4 wavelength long antenna with respect to impedance.

In accordance with the present invention, an antenna is λ/2 wavelength long (λ being the wavelength of a carrier frequency used) to serve as a λ/2 wavelength long antenna when a telescopic body section thereof is expanded or is less than λ/4 wavelength long to serve as a less than λ/4 wavelength long antenna when the body section is contracted. The antenna has substantially the same impedance when extended and when contracted.

Also, in accordance with the present invention, an antenna comprises a telescopic body section having a wavelength which is approximately one half of the wavelength of a carrier frequency used when the body section is extended or is less than one-fourth of the wavelength of the carrier frequency when the body section is contracted, and a matching circuit connected to one end of the body section.

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

Figs. 1A and 1B are views showing an antenna embodying the present invention in an extended position and a contracted position, respectively;

Fig. 2 is a perspective view of portable radio equipment implemented with the illustrative embodiment;

Fig. 3 plots return loss characteristics particular to the extended and contracted positions of the embodiment;

Fig. 4 is a circuit diagram showing a specific construction of a matching section included in the embodiment;

Figs. 5A and 5B are charts showing respectively the directivity characteristics in the horizontal plane particular to the extended position and the contracted position of the embodiment; and

Fig. 6 shows a curve representative of a directivity characteristic in the horizontal plane particular to a conventional contracted λ/4 wavelength long helical whip antenna.

Referring to Figs. 1A and 1B of the drawing, an antenna embodying the present invention is shown and generally designated by the reference numeral 10. As shown, the antenna 10 has a telescopic conductive tube assembly 12 which resembles a rod and constitutes a body section. A matching section 14 is connected to one end or base end of the tube assembly 12. The tube assembly 12 is made up of a plurality of (three in the embodiment) telescoped tubes 12a, 12b and 12c each having a particular diameter. The tube 12c having the largest diameter is connected to the matching section 14. A feed section 16 incorporated in the body of portable radio equipment is also connected to the matching section 14. In the extended position shown in Fig. 1A, the antenna 10 has a length which is approximately one half of the wavelength λ of the carrier or center frequency of the equipment, i.e., it serves as a λ/2 antenna. In the contracted position, the length of the antenna 10 is less than 1/4 of the wavelength λ, and therefore the antenna 10 plays the role of, for example, a λ/8 antenna.

When the antenna 10 is extended to serve as a λ/2 antenna, the matching section 14 matches the antenna 10 and the body of the equipment with repect to impedance. When the antenna 10 is contracted to play the role of, for example, a λ/8 antenna, the matching section 14 also matches the impedance of the antenna 10 and that of the equipment body. Stated another way, the λ/2 and λ/8 antennas are implemented by the single matching section 14. Specifically, in the extended or λ/2 position shown in Fig. 1A, the antenna 10 has a high impedance close to infinity (∞). As the telescopic tube assembly 12 is sequentially contracted from the position shown in Fig. 1A to a particular length, substantially the same impedance as that of the λ/2 antenna is obtained. Such a length corresponds to a substantially λ/8 wavelength. The matching section 14, therefore, can set up impedance matching for both of the λ/2 and λ/8 antennas. This allows the power from the feed section 16 to be efficiently radiated via the antenna 10.

Fig. 2 shows portable radio equipment 20 having a casing 22 on which the antenna 10 is mounted. In the illustrative embodiment, the antenna 10 is approximately 0.17 meter long when extended or 0.045 meter long when contracted. Fig. 3 plots return loss characteristics particular to the extended and contracted positions of the antenna 10. In Fig. 3, the abscissa and the ordinate indicate respectively the carrier frequency and the return loss, while the solid curve and the dashed curve indicate respectively the return loss in the extended position and the return loss in the contracted position. As the curves indicate, the return loss change substantially in the same manner in both of the extended and contacted positions with respect to frequency, i.e., impedances are successfully matched in both of the extended and contracted positions.

Referring to Fig. 4, a specific construction of the matching section 14 will be described. As shown, the matching section 14 has a so-called L circuit configuration constituted by a coil L and a capacitor C. Looking into the antenna 10 from a point X, the impedance is extremely high, as stated earlier. In light of this, the impedance matching between the antenna 10 and the feed section 16 is set up by the coil or inductance element L and the capacitor or reactance element C which are interposed between the feed point Y of the feed section 16 and the point X. The characteristic impedance Z_o at the feed point Y is 50 ohms. It is to be noted that the capacitor C is omissible if, looking into the feed point Y from the point X, the impedance is higher than the characteristic impedance Z_o.

Figs. 5A and 5B show directivity characteristics in the horizontal plane particular to the antenna 10 as measured in the extended or λ/2 position and the contracted or λ/8 position, respectively. In these figures, solid curves each is representative of the directivity characteristic of the main polarization. It will be seen that in both of the λ/2 wavelength position shown in Fig. 5A and the λ/8 wavelength position shown in Fig. 5B the antenna 10 has substantially the same directivity characteristic approximate to 0 dBd in the +X and -X directions. Further, the directivity characteristic of the antenna 10 in the contracted position is comparable even with the directivity characteristic particular to a contracted λ/4 helical whip antenna in the +X and -X directions, as shown in Fig. 6.

Regarding the parameters used to determine the directivity characteristics shown in Figs. 5A and 5B, the carrier frequency f_o was 870 megahertz, the telescopic tube assembly 12 was approximately 170 millimeters long when extended or approximately 45 millimeters long when contracted, and the tubes 12c and 12a had diameters of 6 millimeter and 2 millimeter, respectively.

In summary, it will be seen that the present invention provides an antenna for portable radio equipment which serves as a λ/2 wavelength long antenna when extended or as a less than λ/4 wavelength long antenna, e.g., a λ/8 antenna when contracted. Both of such antenna configurations have their impedances matched by a single matching circuit. The antenna radiates power efficiently in the horizontal plane.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof.

Claims

1. An antenna which is λ/2 wavelength long (λ being a wavelength of a carrier frequency used) to serve as a λ/2 wavelength long antenna when a telescopic body section of said antenna is extended or is less than λ/4 wavelength long to serve as a less than λ/4 wavelength long antenna when said body section is contracted, said antenna having substantially the same impedance when extended and when contracted.

2. An antenna as claimed in claim 1, wherein said body section is substantially λ/8 wavelength long when contracted, serving as a λ/8 antenna.

3. An antenna comprising:

a telescopic body section having a wavelength which is approximately one half of the wavelength of a carrier frequency used when said body section extended or is less

than one-fourth of said wavelength of said carrier frequency when said body section is contracted; and

a matching circuit connected to one end of said body section.

4. An antenna as claimed in claim 3, wherein said body section comprises a conductive tube assembly made up of a plurality of telescoped conductive tubes.

5. An antenna as claimed in claim 4, wherein said plurality of conductive tubes each has a particular diameter.

6. An antenna as claimed in claim 4 or 5, wherein said conductive tube assembly is approximately 0.17 meter long when extended or approximately 0.045 meter long when contracted.

7. An antenna as claimed in any of claims 3 to 6, wherein said body section is approximately $\lambda/8$ wavelength long when contracted.

8. An antenna as claimed in claim 7, wherein said body section has substantially the same impedance when extended and when contracted.

Fig. 1A

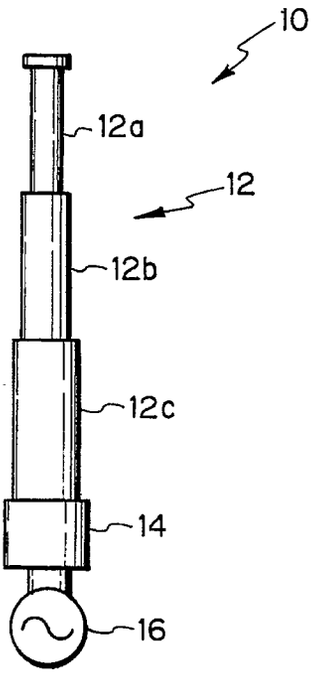


Fig. 1B

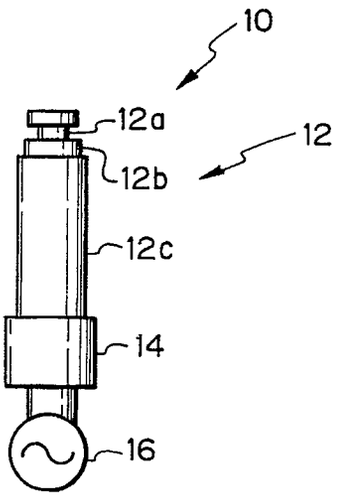


Fig. 2

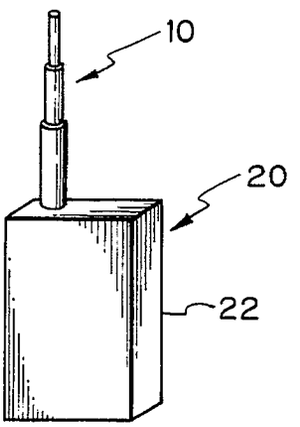


Fig. 3

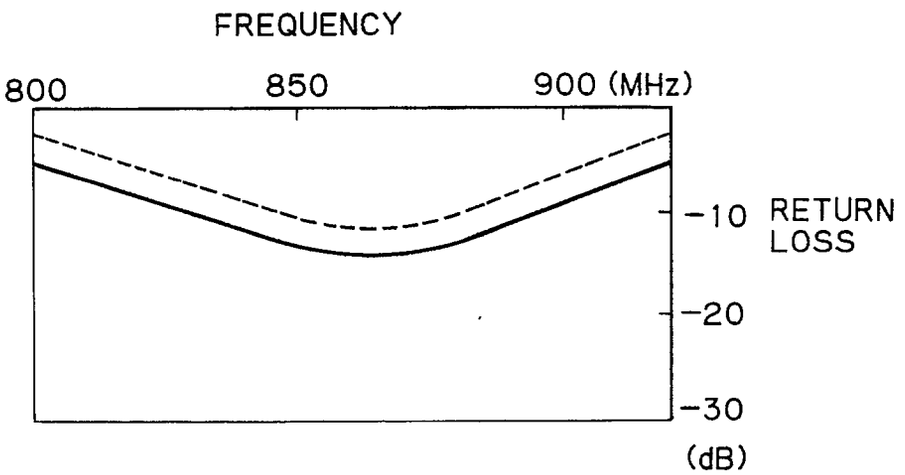


Fig. 4

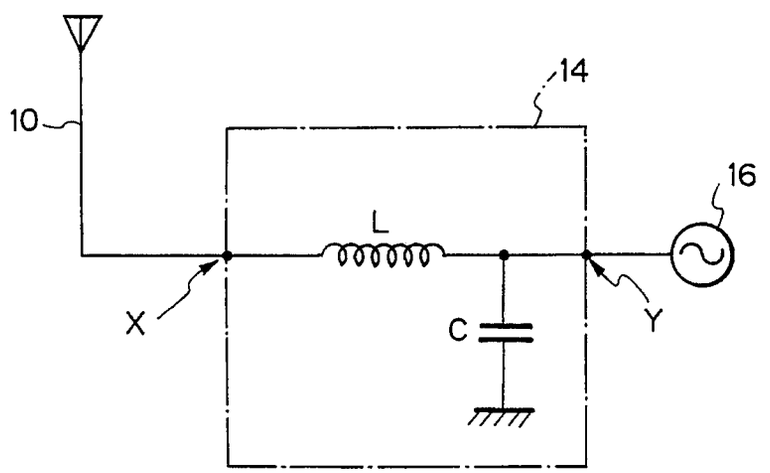


Fig. 5A

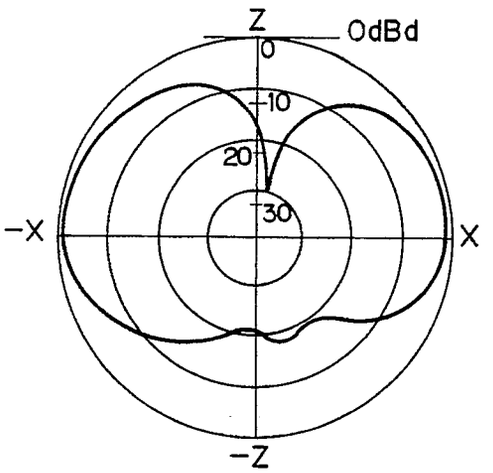


Fig. 5B

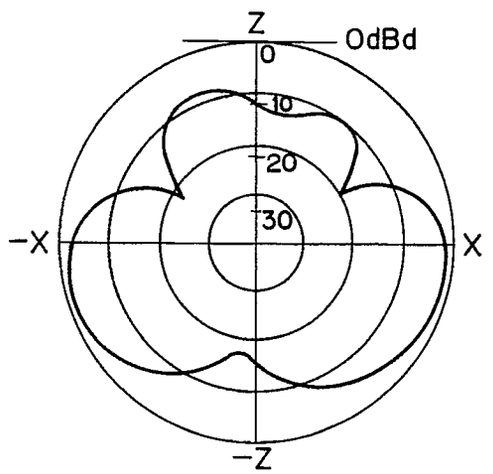


Fig. 6

