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MONOPOLE ANTENNA INCLUDING ELECTRICAL SWITCHING MEANS FOR VARYING THE LENGTH OF THE OUTER COAXIAL CONDUCTOR WITH RESPECT TO THE CENTER CONDUCTOR

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FIG. 1

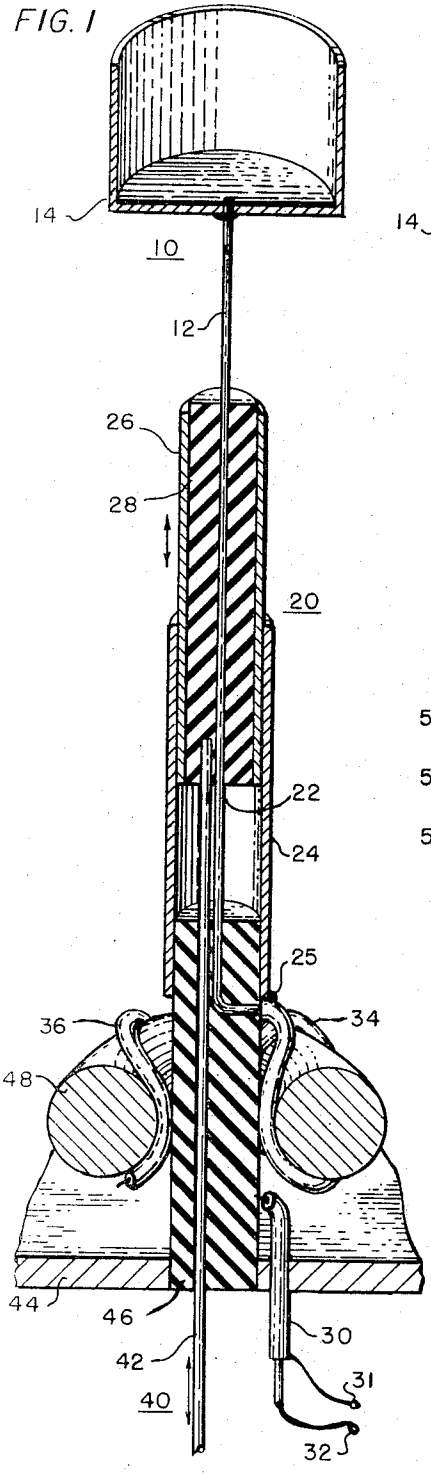


FIG. 3

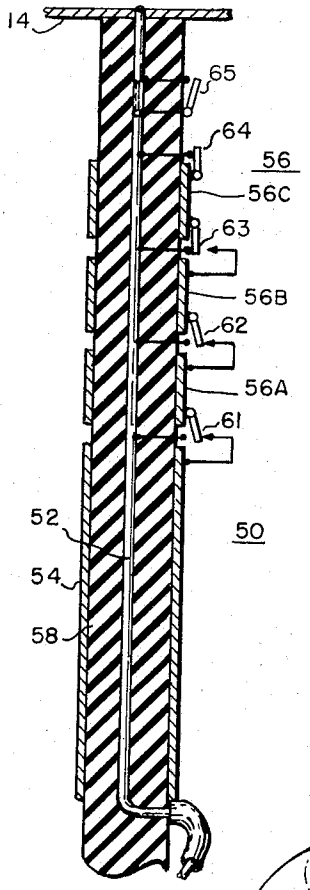
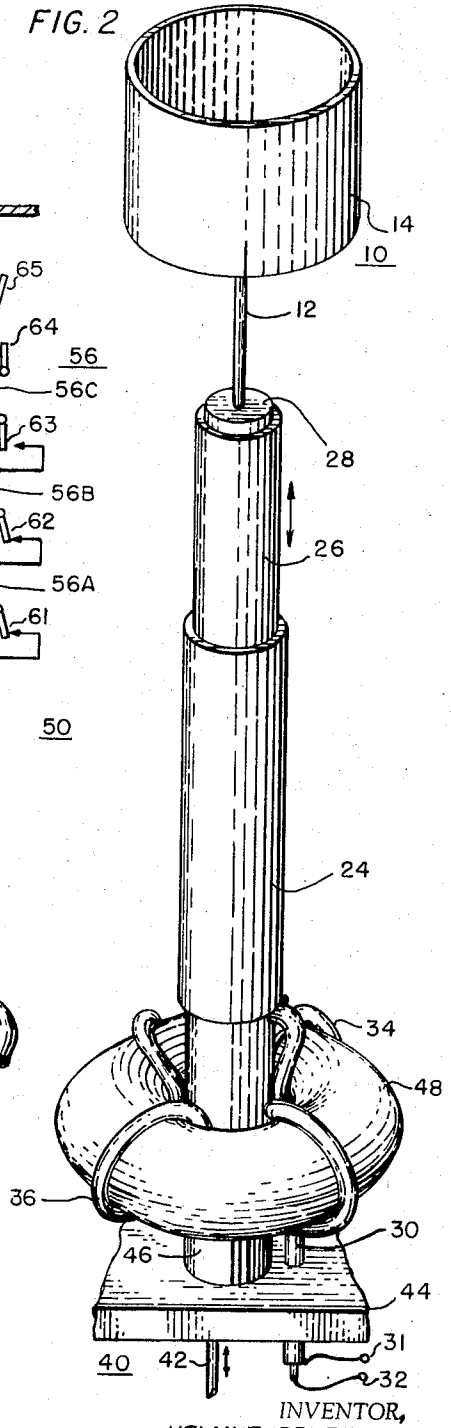


FIG. 2



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MONOPOLE ANTENNA INCLUDING ELECTRICAL SWITCHING MEANS FOR VARYING THE LENGTH OF THE OUTER COAXIAL CONDUCTOR WITH RESPECT TO THE CENTER CONDUCTOR

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3 Claims. (Cl. 343—791)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to antennas and particularly to coaxialyl-fed monopoles and dipoles. More particularly, this invention relates to a means for controlling the effective impedence of a coaxially-fed, monopole or dipole antenna.

Impedance matching systems are well known and several types have been applied to antennas. Most of these use some form of matching transformers, L–C circuits, or distributed-constants networks that are connected between the transmitter and the antenna; usually at some distance from the antenna. These may be fixed or variable according to the teachings of the prior art.

These systems all require additional circuitry which introduces additional losses and bulk. They are subject to uncontrolled distribution of current and voltage and great variation of losses between the matching devices and the radiating element itself with frequency, line length and line attenuation.

It is therefore an object of this invention to provide an improved antenna matching device that is part of the antenna and functions at the feed-point of the antenna.

It is a further object of this invention to provide an efficient, compact and simplified impedance matching system that is effective over a wide range of input frequencies and impedances.

It a further object of this invention to provide an improved impedance matching system that is easily adjustable to an optimum value and that may readily be readjusted to compensate for the electrical effects of varying conditions of the antenna environment, such as soil conductivity, nearby conductors, etc.

It is a further object of this invention to provide an improved matching system that provides the minimum of losses in the feed system between the antenna and the radio set.

These and other objects are accomplished by providing an extendable outer conducting sleeve for the coaxial feed line of an antenna. This conducting sleeve extends above the ground plane of a monopole (or plane of symmetry in the case of dipoles) to a feed-point that may be varied to vary the effective input impedance of the antenna. The feed-point is varied by controlling the effective length of the outer sleeve. The effective length of the outer sleeve is varied by motion of a concentric cylindrical mechanism or by electrically switching a sequence of discrete, shielding, sleeve elements. One system mechanically varies the position of the effective feed-point and the other system varies the position of the effective feed-point by electrical switching.

This invention will be better understood and other objects of this invention will become apparent from the following specification and the drawings, of which:

FIG. 1 is a cross-section of the mechanically controllable species of this invention;

FIG. 2 is an isometric drawing of this species; and

FIG. 3 is a cross-section of the portion of the antenna wherein the electrical switching takes the place of mechanical motion.

Referring now more particularly to FIG. 1, a radiating antenna **10** is fed by rigid coaxial line section **20**, which is energized through a flexible coaxial line **30** that connects to input terminals **31** and **32**.

The antenna **10** has an upper portion **12** that is directly connected, or may be an extension of, the center conductor of the rigid coaxial line section **20**. The upper portion of the antenna may also have a capacitive top element **14** of one of the types well known in the art.

The rigid coaxial line section of this device has a center conductor **22** that connects to the antenna conductor **12**. The outer, shielding portions of the rigid, coaxial line section **20** comprise a fixed cylindrical conductor **24**, and a movable, concentric, cylindrical conductor **26** that makes slidable, electrical contact with the fixed, cylindrical conductor **24** at all times.

The movable conductor **26** has an insulator **28** that provides constant spacing and constant electrical properties between the central conductor **22** and the cylindrical conductors **24** and **26** of the coaxial line **20**.

The insulator **28** may be attached to the sliding conductor **26** and movable with respect to the center conductor **22**, or it may be attached to the center conductor and have the conductor **26** movable with respect to it. In this latter case it may fill the entire space between the center conductor **22** and the outer conductors **24** and **26**; allowing only enough space for the motion between the insulator **28** and the slidable conductor **26**.

In FIG. 1, however, the insulator is attached to the outer conductor and moves with the slidable conductor **26**. This permits a controlling mechanism **40** to include a rod **42** that attaches to the insulator to provide motion of the insulator and cylindrical conductor without making contact with the electrical portions of the conductors of the coaxial line.

The rod **42** is fastened to the insulator **28** and extends, axially and slidably, through the base **44** and mounting portions **46** of the antenna structure, to a convenient location for the manipulation of the rod.

The entire antenna structure is mounted to the plate **44** which will normally be the effective ground plane for the antenna. The rigid coaxial portion **20** of the antenna is mounted on the insulator **46**, which, in turn, is mounted on the plate **44**.

In this antenna, an additional, inductive, loading portion is provided to increase the effective length of the antenna in a well known manner. This inductive loading is provided by winding some of the flexible portion **34**, **36** of the coaxial feed line **30** around a toroidal core **48** that is mounted between the plate **44** and the rigid coaxial portion of the antenna. The toroidal core **48** may be a material with high permeability, such as ferrite, but can also be any other insulating material.

FIG. 2 shows an isometric drawing of this same species to more clearly illustrate the arrangement of the elements. Those parts of FIG. 1 that are visible in FIG. 2 are similarly numbered.

This antenna system is basically a fixed-frequency, pre-tuned system but it may be used in many and variable locations and mountings as well as with a variety of feed systems and transmitters wherein the effective impedance may vary over a considerable range. Also, the actual antenna impedance at which there will be maximum transfer of energy, and optimum efficiency, may vary with many mechanical and electrical situations. This antenna system provides a wide range of impedance matching.

The antenna can be tuned to a given impedence or to any desired impedance to accommodate a wide range of situations and to correct for variable conditions.

FIG. 3 illustrates a means for varying the effective feed-point of the antenna electrically, rather than

mechanically as in the system of FIGS. 1 and 2. In FIG. 3, the mounting and other portions of the antenna that are similar to those of FIGS. 1 and 2 are omitted for simplicity, and those portions that are the same have the same or similar numbers.

In FIG. 3, the rigid coaxial line section is **50**. The portion **54** is equivalent to the fixed portion and the portion **56** is equivalent to the variable portion **26** of the other figures. The change is the effective position of the feed-point is accomplished electrically by the connecting of successive increments, or sections or coaxial shield, such as **56A**, **56B**, and **56C** in series with the fixed, cylindrical, conducting shield **54**.

The successive increments of coaxial shield can be connected to the shield **54** by means of the switches **61**, **62**, and **63** to increase the effective height of the feed-point or they can be connected to the center conductor **52**, by the same switches, to become part of the radiating portion of the antenna to reduce the effective height of the feed-point. For example, if the switch **63** connects the section of shield **56C** to the center conductor, and the switches **61** and **62** connect the portions of shield **56A** and B to the shield **54**, the effective feed-point of the antenna is at the location of the switch **63**.

It is not actually necessary to short-circuit the section of the coaxial shield, such as **56C**, to the center conductor, since the effective length of the radiating portion of the antenna will be the same in either case. However, if these sections of shield are not shorted, they will produce other effects on the standing wave structure and the currents in the radiating portion of the antenna. Consequently, the switches **61**, **62**, and **63** are provided with the alternative position for shorting the center conductor to the shield sections, and the additional switch **64** is provided for shorting the upper end of the last section of shield **56C** to the center conductor to eliminate any effect of a shield section on the electrical length of the antenna which governs its resonance frequency.

An additional switch **65** is provided to connect or disconnect the capacitive element **14** from the radiating portion of the antenna at will.

These switches can be operated manually, at their locations, to set the feed-point to the desired position, or the switches can be operated by mechanical or electrical means in accordance with any of the well known remote switching techniques. The sequence of switching and the combinations of switches used can be chosen to produce any desired effect within the limitations of the available sections and switching circuits.

What is claimed is:

1. In combination with a monopole antenna mounted on a base plate and having a center conductor projecting

substantially above said base plate; an outer coaxial, shielding conductor surrounding said center conductor adjacent to said base plate and extending along a portion of said center conductor; said coaxial, shielding conductor comprising a first portion of coaxial, shielding conductor adjacent to said base plate; at least one secondary portion of coaxial, shielding conductor adjacent to said first portion in the direction away from said base plate; electrical switching means for connecting said first portion of coaxial, shielding conductor to said secondary portion of coaxial, shielding conductor to vary said length of said outer, coaxial, shielding conductor with respect to said center conductor; and a coaxial feed line having an inner conductor connected to said center conductor and an outer shield connected to said outer, coaxial, shielding conductor.

2. An antenna as in claim **1** wherein said coaxial, shielding conductor comprises a first portion of coaxial, shielding conductor adjacent to said base plate; a plurality of secondary segments of coaxial shielding conductor positioned in series with each other, and with said first portion of coaxial, shielding conductor, along said center conductor, a plurality of electrical switching means connected to provide a series connection of said first portion and said secondary segments of said coaxial, shielding conductors; and means for actuating said electrical switching means to sequentially connect any desired number of said secondary segments in series with said first portion of said coaxial, shielding conductors to vary the effective impedance of said antenna.

3. In an antenna as in claim **2** each of said electrical, switching means having a second position that connects its segment of coaxial, shielding conductor to the adjacent portion of said center conductor; and means for holding all of said electrical, switching means in said second position until said means for actuating said electrical switching means connects said secondary segments in series with said first portion of said coaxial, shielding conductor.

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