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Martino et al.

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[54] **TUNABLE SLEEVE ANTENNA**

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[52] **U.S. Cl.** **343/745**, 343/750

[51] **Int. Cl.** **H01Q 9/00**

[58] **Field of Search** 343/745, 749, 750, 861

[56] **References Cited**

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[57] **ABSTRACT**

A tunable antenna structure including an elongated radiating element, supported at one end, a resonant tuning coil coupled to the radiating element at the supporting end, and a tuning element electrically coupled to the tuning coil for varying the electrical characteristics of the coil and matching the antenna impedance to a transmission line. A flush mounting base for mounting the radiating element and tuning means with a moisture proof seal. Both fiberglass and metal whip antennas for half wavelength and quarter wavelength operation are described. The movable tuning element is at ground potential so that one's body or hand capacitance does not affect resonance of the tuning coil during antenna tuning.

8 Claims, 6 Drawing Figures

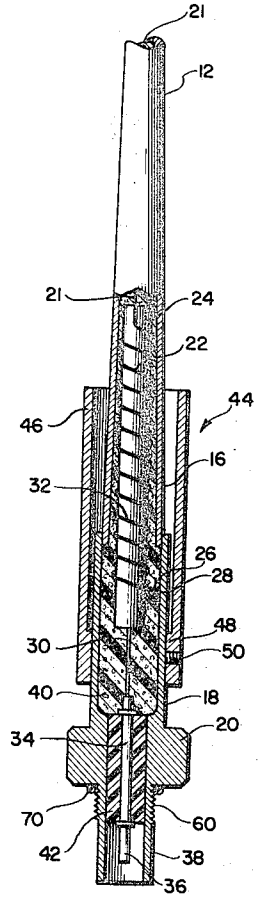


FIG. 1

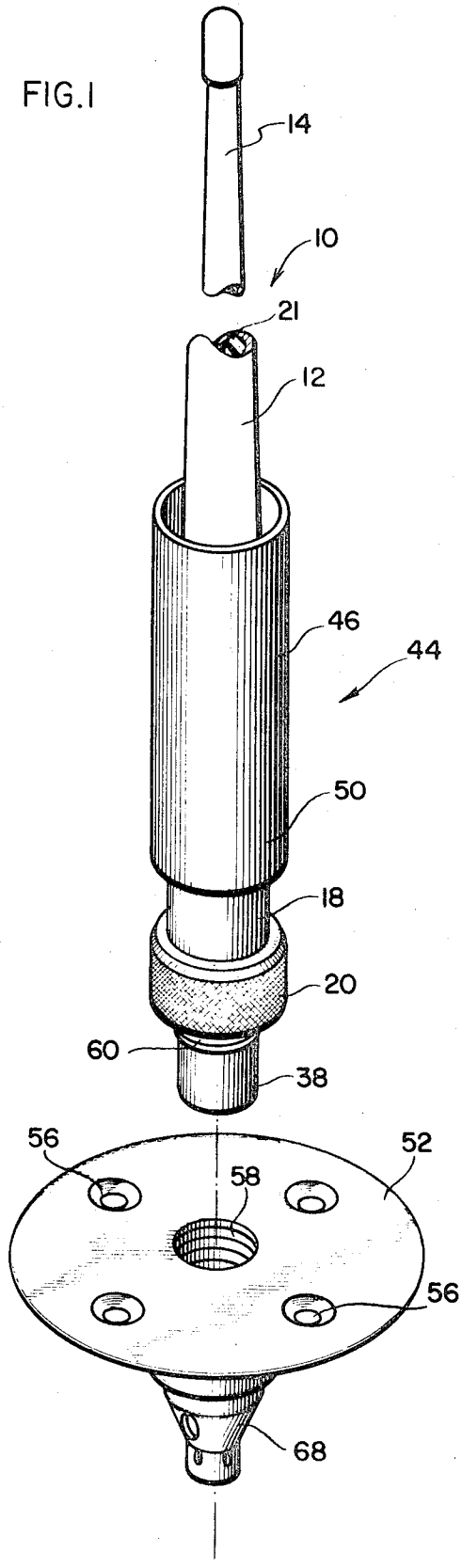

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FIG. 2

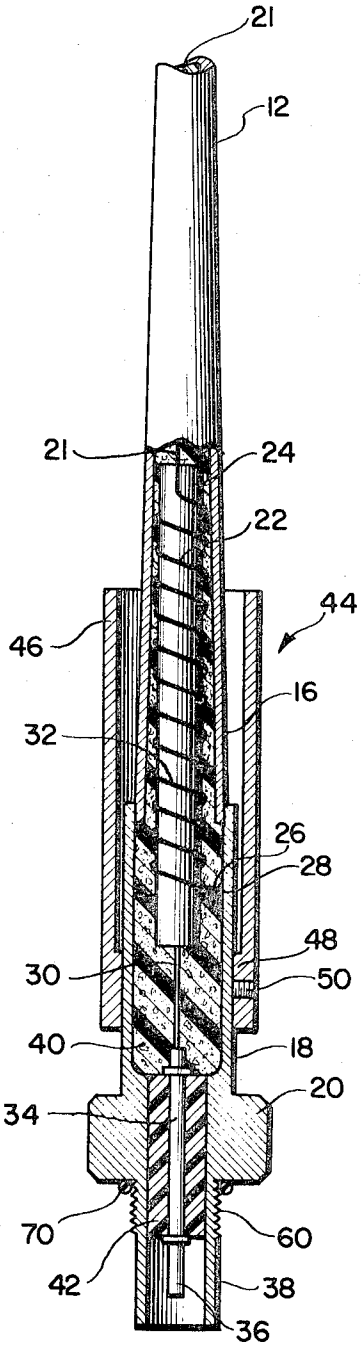

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FIG. 3

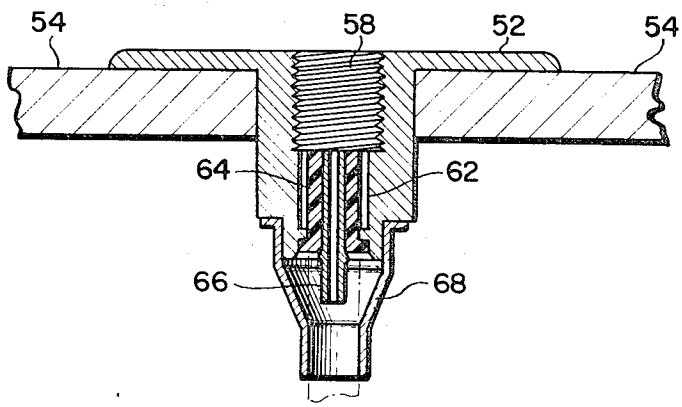


FIG. 4

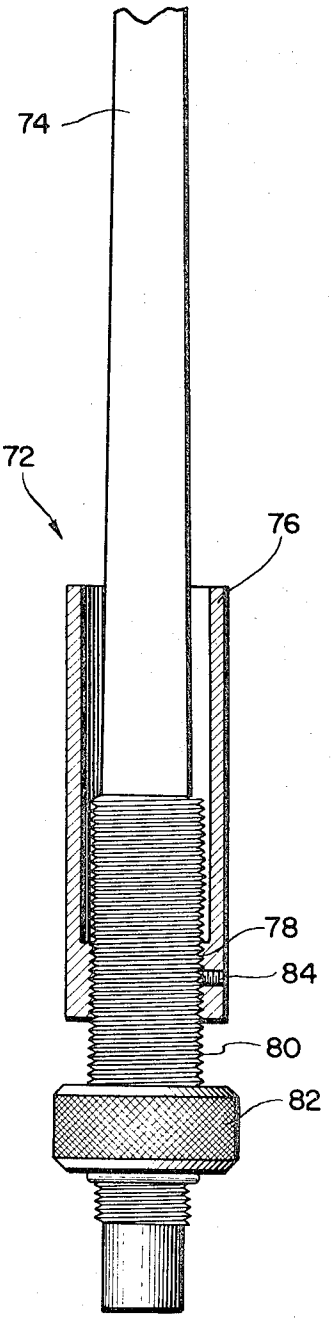


FIG. 5

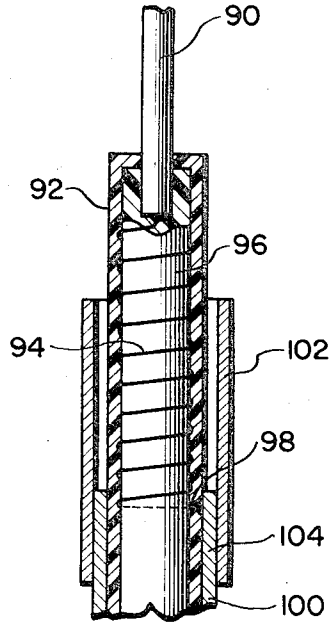
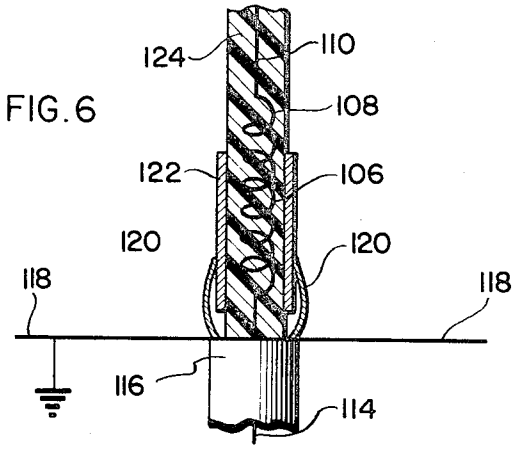


FIG. 6



TUNABLE SLEEVE ANTENNA

This invention relates to antennas and more particularly to antenna apparatus including means for tuning to change the antenna's electrical characteristics.

Antennas known as "whip antennas" or "whips" are commonly used in either quarter or half wavelength configurations for mobile use in Citizens' Band communications. As an example, marine antennas generally employ a half wave length radiating element formed of a long member (6–8 feet) with a center loading coil. Normally, such antennas are untunable, but stringent manufacturing procedures are used to maintain the standing wave ratio (SWR) less than 2.1. However, the structure of such antennas, particularly the variables in loading coil length and spacing between coil turns can vary the SWR from the desired minimum.

In some tunable whip antennas the physical length of a telescoping radiating element can be varied, however, one's hand detunes the antenna, thus requiring several time consuming tuning steps.

It is therefore desired to provide a tunable whip antenna structure, and particularly an antenna which may be readily tuned without one's hand upsetting the resonance of the radiating element introducing body or hand capacitance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of the tunable sleeve antenna and base;

FIG. 2 is a sectional view of the angenna showing the details of construction of the tuning portion thereof;

FIG. 3 is a sectional view of a flush mounting antenna base;

FIG. 4 is an alternative embodiment showing threadable engagement of the tuning sleeve;

FIG. 5 is an illustration of another embodiment showing a tunable sleeve antenna having a long metal radiating element; and

FIG. 6 is an illustration of another embodiment showing a tunable sleeve antenna in a radiating element over ground plane configuration.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided an antenna structure having a whip-like radiating member including a tuning coil and a center conducting wire extending therefrom. The tuning coil is mounted adjacent a supporting member located at electrical ground with respect to the tuning coil and center conductor. A tuning element at ground potential is mounted adjacent the tuning coil such that the electrical characteristics of the antenna can be changed and matched to a transmission line by varying the position of the tuning element with respect to the coil. Since the tuning element is at electrical ground, movement thereof by one's hand does not upset the resonance of the radiating element. Thus, using this invention, tuning of the antenna can be readily accomplished in a single step rather than the time consuming multistep tuning procedures of the prior art. In addition the tuning element minimizes downward traveling waves on the supporting structure, thereby preventing distortion in the radiating pattern and power loss. Mounting means are also provided to enable the tuning element and radiating member to be detachably mounted on a flush mounting base in a moisture sealed position.

DETAILED DESCRIPTION

Referring now to FIGS. 1-3, there is illustrated an antenna structure 10 embodying the principles of the present invention. An elongated tubular member 12 formed of insulating material such as fiberglass includes an upper free end 14 and a lower fixed end 16. As is shown in more detail in FIG. 2, the tubular member is tapered such that the wider diameter portion at the fixed end 16 is rigidly mounted within a cylindrical flange 18 integrally extending from a conductive supporting member 20.

An electrical conducting wire 21 longitudinally extends within the tapered tubular member 12 from the free end 14 to connect to an electrical helical coil 22. The coil 22 is formed of multiple helical turns of electrical conductive wire on an insulative material coil form 24. The bottom end 26 of coil 22 is electrically connected at point 28 to the cylindrical flange 18. It is understood that a loading coil (not shown) may be utilized in the radiating member to shorten the physical length of the antenna if desired. However, the present invention is applicable to antennas with or without such loading coils.

A conductive lead 30 is connected to one of the helical turns at contact point 32 near the bottom end of coil 22. The other end of conductor lead 30 is electrically connected to a center conductor 34 which terminates in a center pin 36 to provide an electrical connection to the antenna mounting structure. A skirt portion 38 extends from the support member 20 to form the outer conductor for the electrical connector at the bottom of the base support member and to protect pin 36 from mechanical damage.

Insulating material 40 is inserted within tubular member 12 and the cylindrical flange 18 so as to maintain the coil 22 and elongated conductive wire 21 in position. It may be noted that suitable insulating material 42 is also provided to maintain the center conductor 34 and center pin 36 rigidly in position. Such insulating materials are well known in the art, and it is preferred that the insulating material 40 is formed of a foaming agent so as to insure that all of the free space within the tubular member 12 and the cylindrical flange 18 is occupied.

FIGS. 1 and 2 illustrate a tuning element 44 utilized in connection with the coil 22 to introduce a variable electrical capacitance in the vicinity of the coil 22, thereby causing the coil to be resonated to the exact frequency desired. The tuning element 44 is therefore used to match the impedance of the antenna structure to a transmission line coupled to 36, 38. In the embodiment shown in FIGS. 1 and 2, the tuning element 44 includes a hollow cylindrical conductive sleeve 46 having a smaller inner diameter portion 48 at the bottom end thereof which slidably engages the exterior surface of the longitudinally extending, cylindrical flange 18. A set screw 50 is provided for locking the tuning sleeve in the desired position.

It may be particularly noted that since the tuning sleeve 46 is constructed of electrically conductive material, and the supporting member 20 is normally at electrical ground, a person in contact with the tuning sleeve is in the ground circuit. Thus, using the tunable antenna structure of the present invention, one can

vary the position of the tuning sleeve 46 so as to effect the resonance of coil 22 without any detuning due to body or hand capacitance which is evident in prior art structures where tuning is accomplished somewhere along the length of the antenna—as by varying the length of an extendable, telescoping, radiating element.

Referring now to FIGS. 1 and 3, there is illustrated a mounting base 52 which can be attached to a surface 54 so as to be flush fitting therewith. This base is particularly advantageous when utilized on any wood, metal or fiberglass deck area of a boat. Attachment of the flush fitting mounting base 52 to the deck surface 54 is provided by standard screws, etc. through aperatures 56. Mounting base 52 includes a threadable inner diameter portion 58 for threadably engaging the threaded portion 60 of supporting member 20. In addition, a cylindrical cavity 62 is provided within the mounting base, with an insulating plug 64 for maintaining a center conductor pin 66. The outer conductor is provided by a conductive member 68 which is rigidly attached to the mounting base 52.

Mounting of the tunable antenna structure 10 to the mounting base 52 is accomplished by inserting the cylindrical extension 38 into cavity 62, the center connector also engaging the center conductor 66 of the mounting base. The components are sized such that tightening of the threadable engagement between the antenna structure and the mounting base by rotating the support member 20 assures a firm electrical connection with the respective inner and outer conductors of the antenna structure and the mounting base. An O-ring 70 is provided at the top of the threaded portion 60 so as to place a moisture seal between the antenna and the mounting base 52. Thus, when the mounting base 52 is flush fitted onto the deck area of a boat, the antenna 10 can be easily removed from the mounting base to prevent the danger of tripping etc. which usually occurs on projections along the deck. If desired, a plug can be inserted into the threaded portion 58 to form a moisture seal when the antenna is detached from the mounting base.

Referring now to FIG. 4, there is illustrated an alternative embodiment of the tunable antenna structure of the present invention. The tunable antenna 72 includes a tapered longitudinally extending tubular member 74 and a coil (not shown) similar to the embodiment shown in FIGS. 1 and 2. However, rather than a slidable arrangement between the tuning sleeve and the cylindrical extension of the supporting member, there is instead provided a threadable engagement.

As shown in the partial sectional view of FIG. 4, a hollow, cylindrical sleeve 76 includes a bottom portion 78 having a slightly smaller inner diameter than the inner diameter of the remaining portion of sleeve 76. The inner diameter portion 78 of sleeve 76 is threaded so as to threadably engage the threaded shank portion 80 of supporting member 82. In this embodiment of the invention, tuning is accomplished by rotating sleeve 76, a set screw 84 being provided for locking the sleeve in the desired position.

The manner in which the tunable antenna structure 10 or the alternative embodiment 72 may be tuned in order to obtain the maximum power transfer both to and from the antenna is readily understood. Briefly, the antenna would be mounted in position. A suitable signal generator and standing wave ratio meter is then connected to the antenna structure. The signal generator would be set at a constant power output, and the tunable sleeve 46 or 76 would be moved so as to obtain the lowest standing wave ratio possible. Under normal circumstances, using the tunable antenna structure of the present invention, a standing wave ratio of about 1.1 to 1.2 can be obtained.

In a constructed version of the invention, a center loaded whip antenna for half wavelength operation in the Citizen's Band (27MHz) had a whip length of eight feet. A similar six feet antenna was also constructed. In either case the tuning coil 22 and tuning sleeve 46 each were about five inches in length and the sleeve was constructed with a diameter of about one inch.

The present invention can also be utilized in connection with antennas having a metal whip member. As shown in FIG. 5, an elongated metal whip member 90 is connected to one end 92 of a helical tuning coil 94. The helical coil 94 is wound around a coil form 96 and the bottom coil end 98 is connected to a metal base 100. The tuning coil can be tapped as shown in connection with FIG. 2 (reference 32) for feeding the antenna. A cylindrical tuning sleeve 102 is movably mounted on the base upright portion 104 and locking means (not shown) may be used to lock the sleeve in position with respect to coil 94 following tuning of the antenna. Tuning is accomplished by varying the position of the tuning sleeve 102 to effect the resonance of coil 94.

FIG. 6 is a partially schematic illustration of a tunable quarter wavelength operating antenna utilizing the present invention. A tuning coil 106 is connected at one end 108 to an elongated whip element 110 and at the other end 112 to the center conductor 114 of an electrical cable having an outer conductor 116. Outer conductor 116 is schematically shown as connected to a ground plane 118. A ring of conductive fingers 120 of spring metal are connected at their bottom end to the ground plane 118. The other end of conductive fingers 120 depressingly and conductively engage a hollow, conductive sleeve 122. The sleeve 122 is sized so that it can be slidably moved on a cylindrical insulating member 124 surrounding the whip element 110 and tuning coil 106 so as to effect the resonance of coil 106.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A tunable antenna structure for matching the impedance of said antenna structure to a transmission line, said antenna structure comprising:

an elongated radiating element extending from an electrically groundable support end to a free end;

a resonant tuning coil encased in a dielectric at said support end;

means for interconnecting said elongated radiating element at said support end to said transmission line;

an electrically conductive tuning sleeve element electrically coupled to said resonant tuning coil; and

conductive mounting means for movably mounting said electrically conductive tuning sleeve element in electrical and sliding contact with said support end and adjacent said tuning coil for varying the resonant frequency of said coil without hand capacity detuning.

2. A tunable antenna structure for matching the impedance of said antenna structure to a transmission line, said antenna structure comprising:

a thin tube extending from a support end to a free end;

an electrically groundable support base mounted to said tube support end for supporting said tube;

a multiple turn coil encased in a dielectric mounted within said tube at said support end; A FIRST CONDUCTING WIRE CONNECTED TO ONE END OF SAID MULTIPLE TURN COIL AND EXTENDING WITHIN SAID TUBE TO SAID FREE END:

a second conductor means within said support base including a center conductor insulatably supported from said support base and means coupling said center conductor to the other end of said coil;

an electrically conductive tuning sleeve element electrically coupled to said multiple turn coil; and

conductive mounting means for movably mounting said electrically conductive tuning sleeve element in electrical and sliding contact with said support base and adjacent said multiple turn coil for varying the resonant frequency of said coil without hand capacity detuning.

3. An antenna structure as claimed in claim 2, including,

means for connecting the other end of said multiple turn coil to said support base, and

means for connecting said center conductor to one of said turns of said multiple turn coil adjacent said other end of said coil.

4. An antenna structure as claimed in claim 2, wherein said tuning element comprises:

a hollow conductive sleeve, surrounding at least a portion of said multiple turn coil; and

positioning means for locking said sleeve in position with respect to said coil.

5. An antenna structure as claimed in claim 4, wherein said support base includes a flange portion extending therefrom mounted to said tube;

said hollow, conductive sleeve movably mounted on said flange portion for introducing a variable electrical capacitance in the vicinity of said coil.

6. An antenna structure as claimed in claim 5, including means for threadably engaging said hollow, conductive sleeve with said flange portion.

7. An antenna structure as claimed in claim 5, wherein said positioning means comprises a locking set screw threadably engaging said hollow, conductive sleeve for detachable locking engagement with said flange portion.

8. An antenna structure as claimed in claim 2, wherein said support base includes,

a cylindrical shoulder portion having a smaller diameter, threaded, elongated portion extending from a junction with said shoulder;

an O-ring mounted in said junction;

said antenna structure further including;

a mounting base comprising:

a flange, including means for flush mounting said flange; and

threaded cavity means within said flange for receiving said threaded, elongated portion of said support base;

said O-ring thereby sealingly engageable with said flange to form a moisture seal.

a first conducting wire connected to one end of said multiple turn coil and extending within said tube to said free end;

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,798,654 Dated March 19, 1974

Inventor(s) Louis J. Martino et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 33, "angenna" should be --antenna--.

Column 5, lines 9 through 13, "A FIRST...FREE END:" should be lower case and ended with a semicolon.

Column 6, lines 32 through 34, "a first...free end;" should be deleted.

Signed and sealed this 10th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents