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(56) Documents Cited:
GB 2036447 A **JP 090238018 A**
JP 040287407 A **US 6806836 B2**
US 6559811 B1 **US 6140973 A**
US 3858220 A

(58) Field of Search:
INT CL **H01Q**
Other: **EPODOC, WPI**

(54) Title of the Invention: **Antenna**
Abstract Title: **Compact vertically polarised omni-directional antenna**

(57) An antenna comprises a vertically polarized omni-directional radiating element. The radiating element may include: a tuning whip portion 1 of adjustable length; upper and lower helix portions 2, 4; an impedance transformer 3 and a fed point 5. The feed point 5 may be located off the centre of the antenna, with the upper portion 1, 2 being two thirds of the antenna length and the lower portion 4 being one third of the length. The lower coil portion 4 is arranged with a pitch which is half that of the upper portion 2. The radiating element may be a single or multiple frequency band antenna. The multiple band antenna arrangement may include a number of tapped and branching formations associated with the upper and the lower antenna portions. The antenna may use a PVC or fibre-glass tube to support the antenna portions. Some branching antenna potions may be located within the support tube and some may be multifilar formations. The antenna may provide a single band antenna operating at 10 MHz with an overall length, including a counterpoise, of 3m and a footprint of only 96 cm^2. The compact antenna may be used in low visibility or stealth functions.

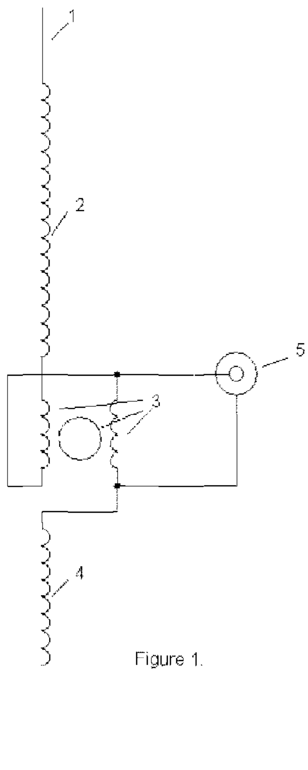

Figure 1.

GB 2484160 A

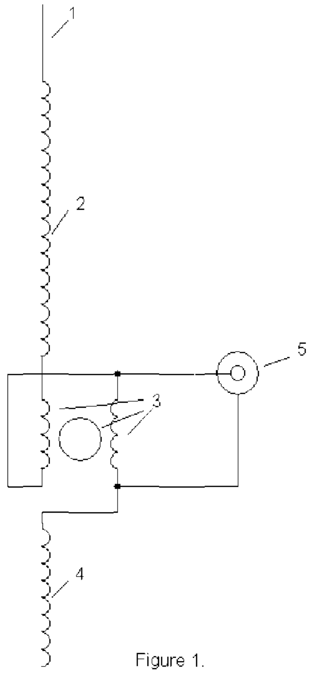

Figure 1.

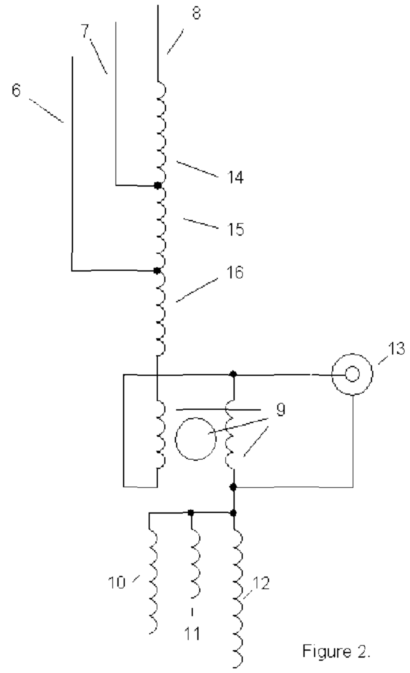

Figure 2.

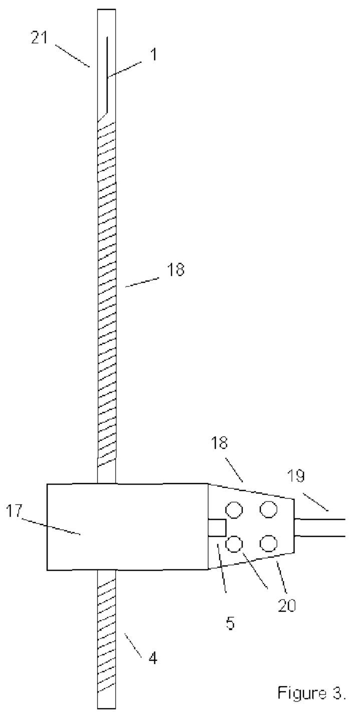

Figure 3.

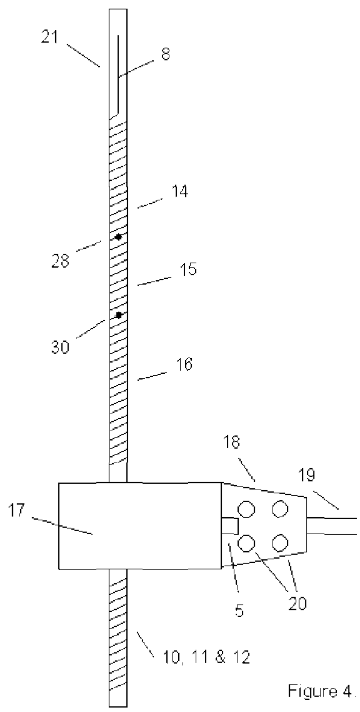

Figure 4

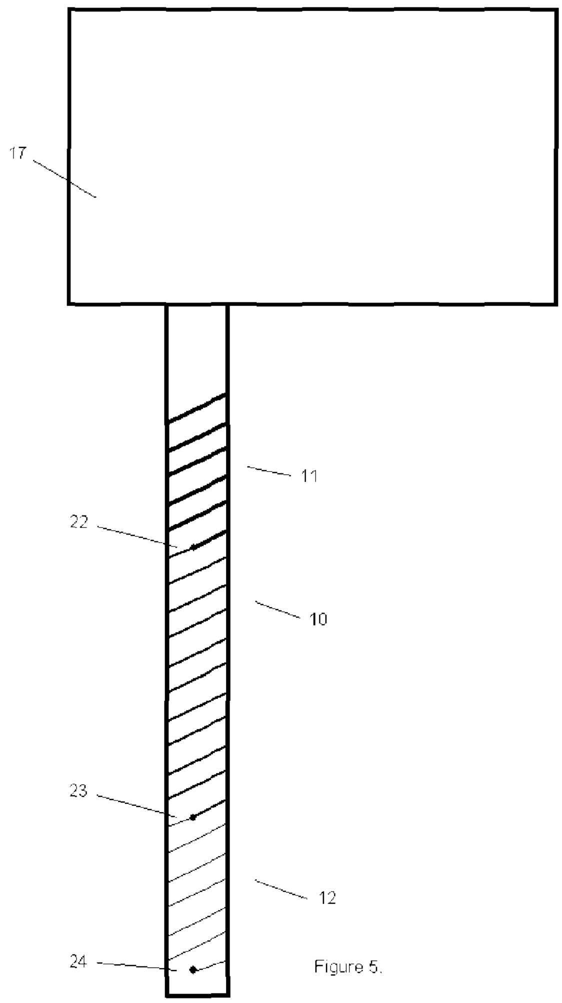

Figure 5.

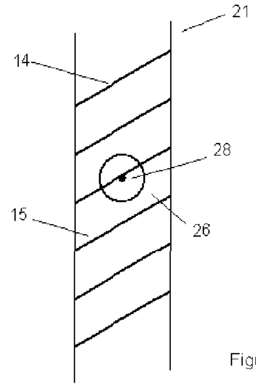

Figure 6.

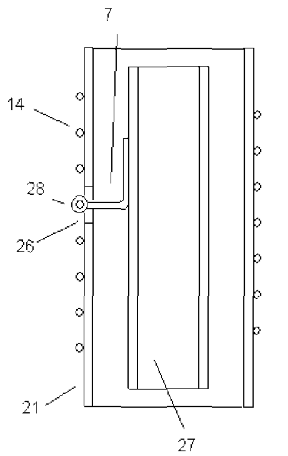

Figure 7.

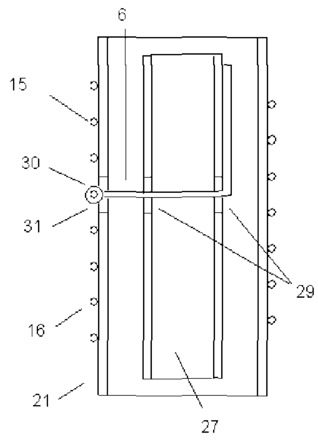

Figure 8.

Antenna

Description

This invention is a new type of compact omni-directional antenna used for radio communications.

This new design significantly reduces the overall size of a resonant vertically polarized omni-directional radio antenna. In radio communications the size of the antenna is generally related to the radio frequency operating wavelength. In most circumstances the shortest length a resonant antenna would approximate to one quarter of the operating wavelength. Reducing the size of the antenna has drawbacks; the efficiency is reduced.

The original prototype design for a single band 10.1MHz vertically polarized antenna operating at a wavelength of 30m, the radiating element alone would be 7.5m tall. This is assuming the antenna is one quarter of the wavelength at this operating frequency, this new design reduces the overall antenna size including radiating and counterpoise elements to 3m. With a footprint of only 96cm^2 (15 square inches, 5x3 inches).

In this new design, the radiating elements are in length a half wave dipole, the radiating elements for the 10.1MHz prototype are 15m long, and the actual size of the antenna is physically one fifth the size of the equivalent electrical half wave dipole.

The reduction in size is accomplished by winding the two radiating elements into a more compact form. They are wound as two helixes. Instead of the radiating element and the counterpoise being long straight electrical conductors, they are wound into coils, one atop, and one below the electrical feed point. In addition a straight conductor (tuning whip if required) is attached to the top coil (helix) and this is trimmed to length to set the antenna exactly onto the operating frequency. Both helixes are wound in the same direction. For example, both wound clockwise ascending the helix former. The tuning whip can be shortened further by winding this into a slow helix without significantly affecting resonance and the VSWR of the antenna.

The electrical feed point is not fed to the centre of the antenna; instead it is fed off centre. The two radiating elements (radiator and counterpoise) are not the same size, the lower element forms approximately a third of the total antenna winding length, and the top helix forms approximately two thirds of the antennas winding length. Having an offset antenna complicates the impedance matching. Whereas a conventional half wave dipole at the central feed point would exhibit a 75 to 50Ω impedance, this design presents a higher impedance of 200Ω to the radio transceiver. A transformer is employed to match the antenna impedance to the transmission line feed point. The radios impedance is 50Ω and the antenna has to match this figure in order to get maximum power transfer to the antenna. The loss through the transformer is minimal, less than 0.35dB, nominally 0.2dB (measured).

The winding pitch of each helix is of importance, the upper helix pitch is set, and the lower helix pitch is half this value. This will equate to the electrical inductance for each resonant winding, top and bottom resonant windings, being the same value of electrical inductance at its resonant operating frequency.

The primary use of the antenna was initially designed for amateur radio frequencies operating between 1.8 and 30MHz. However changing the components used, the antenna can be put to other uses on lower and higher radio frequencies, including military, maritime, PMR (Private Mobile Radio), CB (Citizens Band), aeronautical and mobile phone technologies to name but a few.

The antenna in both single band and three band variations were found to be functional and shown to exhibit low VSWR (Voltage Standing Wave Ratio) of less than 1.4:1 over the desired operating frequencies both as single and multi-band versions (nominally less than 1.2:1). The multi-band version was limited to three frequencies, but it is possible by adding further windings, taps and whips to tune the antenna to additional frequencies. Both single and multi-band antennas work on the same basic principles.

The invention will now be described by way with reference to the accompanying drawings:

Figure 1. Shows the electrical schematic of a single band antenna

Figure 2. Shows the electrical schematic of a three band antenna.

Figure 3. Shows the basic mechanical construction of a single band antenna.

Figure 4. Shows the basic mechanical construction of a three band antenna.

Figure 5. Shows the basic construction of the bottom trifilar, bifilar and single winding helixes of the three band antenna (counterpoise element).

Figure 6. Shows the top helix tap between helix and internal tuning whip, top helix tap only shown.

Figure 7. Shows basic mechanical construction of the top helix at the top tap, intermediate frequency tuning whip tap.

Figure 8. Shows basic mechanical construction of the top helix at the lower tap, high frequency tuning whip tap.

In Figure 1, the electrical schematic showing the components of the single band antenna.

1. The tuning whip which is adjusted in length to bring the antenna into resonance, i.e. the operating frequency. 2. The upper helix (radiating element), the winding length of which forms 65% of the half wavelength of the operating frequency of the antenna. 3. The 4:1 impedance transformer. 4. The lower helix (counterpoise element) winding length forms 35% of the operating half wavelength. 5. The antenna feed point, 50 ohms, radio connection.

In Figure 2. the electrical schematic showing the components of the three band antenna.

6. The high frequency tuning whip. 7. The intermediate frequency tuning whip. 8. Low frequency tuning whip. 9. The 4:1 impedance transformer. 10. Intermediate frequency lower helix. 11. High frequency lower helix. 12. Low frequency lower helix. 13. 50 ohm antenna feed point, radio connection. 14. Total upper helix winding including 15 and 16 and the tuning whip 8 resonate at the low frequency. 15. Intermediate upper helix winding including 16 and tuning whip 7 resonate at the intermediate frequency. 16 High frequency lower helix and the tuning whip 6 resonate at the high frequency.

In Figure 3, the ooutline of the single band antenna construction.

1. Tuning whip, trimmed to exact operating frequency. 2. Upper helix. 17. Weatherproof plastic box (IP65) housing impedance transformer. 5. Radio connector (BNC, N-type, etc). 18. Antenna mounting plate to horizontal boom. 19. Horizontal mounting boom. 20 U-bolts to secure mounting plate to horizontal boom 19. 21. Helix former (PVC, fibre glass tubing).

In Figure 4, the ooutline of a three band antenna construction.

17. Weatherproof plastic box (IP65) housing impedance transformer. 5. Radio connector (BNC, N-type, etc). 18. Antenna mounting plate to horizontal boom. 19. Horizontal mounting boom. 8. Low frequency tuning whip. 14. Top helix portion operating with the helixes 15 and 16 and tuning whip 8 to resonate at the low frequency. 15. Intermediate helix operating with helix 16 and tuning whip 7 in figure 2 to resonate on intermediate frequency. 16. Lower helix portion and tuning whip 6 in figure 2 to resonate on the higher frequency. 10, 11 & 12. Lower helix wound as a trifilar/bifilar/single winding. 28. Tapping point for intermediate

frequency tuning whip. 30. Tapping point for high frequency tuning whip. 20. U-bolts to secure mounting plate to horizontal boom 19.21. Helix former (PVC, fibre glass tubing). 6 and 7 tuning whips not shown, they are mounted internally as shown in figures 8 and 7.

In Figure 5, the detail of the three band lower helix construction.

17. Weatherproof plastic box (IP65) housing impedance transformer. 22. End of high frequency lower helix trifilar winding. 23. End of intermediate frequency lower helix bifilar winding. 24. End of low frequency lower helix single winding. 11. High frequency lower helix trifilar winding. 10. Intermediate frequency lower helix bifilar winding. 12. Low frequency lower helix single winding.

In Figure 6, the detail of the upper helix tapping point.

21. Helix former, plastic (PVC, fibre glass tubing) former is the base for top and bottom helixes (one continuous form). 28. Tapping point between helix and internal tuning whip (only the top helix tap is shown). 14. Top helix winding. 26. Hole drilled in helix former to allow soldered connection to inner tuning whip. 15. Intermediate top helix winding.

In Figure 7, the cross sectional detail of top internal tap and former 27, three band antenna.

21. Helix former, plastic (PVC, fibre glass tubing) former is base for top and bottom helixes (one continuous form). 28. Soldered tap between top helix and the intermediate frequency tuning whip. 14. Top helix wound around former 21. 7. Intermediate frequency tuning whip soldered to helix 14 at point 28. 27 Inner former to accommodate internal tuning whips (PVC, fibre glass tubing). 29. Hole drilled in helix former to facilitate connection of helix to internal intermediate frequency tuning whip.

In Figure 8, the cross sectional detail of lower internal tap, three band antenna.

21. Helix former, plastic (PVC, fibre glass tubing) former is basis for top and bottom helixes (one continuous form). 15. Top helix wound around former 21. 6. High frequency tuning whip soldered to upper winding at point 30. 27 Inner former to accommodate internal tuning whips (PVC, fibre glass tubing). 31. Hole drilled in helix former to facilitate connection of helix to internal high frequency tuning whip. 29. Holes drilled in inner tuning whip former to facilitate feeding through high frequency tuning whip on opposite side of former to intermediate tuning whip, electrical isolation.

In all figures the outer weather proof protective sleeving has not been detailed for clarity of the antennas description.

In Figure 1, the electrical schematic diagram for a single band antenna, this shows the primary components for the antenna. The antenna electrical feed is applied to the transformer via connector 5. The signal is fed to the primary winding of the impedance transformer 3. Connection of the impedance transformer 3 provides impedance matching to the antenna elements 2 and 4. The length of the transformer helixes are 35% of the operating (resonant) frequency half wavelength for the lower helix 4, and 65% for the top helix 2. The antenna is set into resonance with the top tuning whip whereby shortening the tuning whip 1 increases the resonant frequency. Lengthening the whip reduces the resonant frequency.

In Figure 2, the schematic diagram of the three band version is shown. This operates on three frequencies and resonance on the three different frequencies is achieved in this way.

The lowest frequency in resonance utilizes the total top helix winding 14, 15 and 16 in series and the tuning whip 8. Along with the lower helix winding12 is utilized to bring the antenna into resonance.

The intermediate frequency in resonance utilizes helixes 15 and 16 in series and tuning whip 7. Along with the lower helix winding 10 is utilized to bring the antenna into resonance.

The high frequency in resonance utilizes only helix 16 in series and tuning whip 6. Along with the lower helix winding 11 is utilized to bring the antenna into resonance.

In Figure 3, the physical construction of a single band antenna. The helix former 21 for both top and bottom helixes is one continuous form (tube). The wire used in the helix construction is passed from the outside of the former (from either top or bottom helix) with the provision of holes drilled a short distance from the plastic enclosure housing the coaxial connector 5 and the impedance transformer 3 mentioned in figure 1. Where the helix former 21 enters enclosure 17, holes are drilled in the tube internally to the enclosure 17 that allow the connections to the top and lower helix to pass to the impedance transformer 3. The top helix integrates with the top tuning whip 1.

A metal mounting plate 18 is fashioned to mount the transformer housing 17 to the horizontal boom 19. This is provided by two U-clamps shown as 20. The vertical axis of the antenna is mounted approximately 600mm (two feet) away from a vertical mast.

In Figure 4, the basic physical construction of a three band antenna. The helixes are wound on one single continuous former 21, top and bottom. The lower frequency tuning whip is integrated into the antenna former as provided in the single frequency version.

The top helix is one winding 14, 15 and 16 with taps at points 28 and 30. Tuning whip for the lowest frequency is shown at 8. The two tuning whips for the intermediate and high frequencies are electrically connected internally to the top helix at points 28 and 30. The intermediate and high frequency whips are mounted internally to the external upper helix on an additional internal former.

The bottom helix comprising windings 10, 11 & 12 from Figure 2 are a complicated trifilar/bifilar and single winding wound on the lower helix assembly.

In Figure 5, this details the lower helix winding, from the top – trifilar winding 11. Point 22 shows the termination of the trifilar winding and the start of the bifilar winding. Point 23 shows the end of the bifilar winding and the start of the single winding. Point 24 shows the termination of the single winding.

The lower winding pitch for this winding is 3.5mm and is fabricated from enamelled copper wire. The upper winding pitch is 7.0mm and is fabricated from enamelled copper wire.

In Figure 6, shows the helix former 21 (PVC, fibre glass tubing), the winding of the top helix 14 and the external winding 15. The hole drilled in the helix former to facilitate connection to one of the inner tuning whips 7. 28. shows the electrical connection between the helix and the internal tuning whip. Only one tap is shown.

In Figure 7, a cut away side view showing the helix former 21, upper helix winding 14, hole 26, tap 28, intermediate frequency internal tuning whip 7, and the internal tuning whip former 27 (PVC, fibre glass tubing).

In Figure 8, a cut away side view showing a lower portion of the helix former 21, intermediate helix winding 15, hole 31, tap 30, high frequency internal tuning whip 6, and the internal tuning whip former 27 (PVC, fibre glass tubing). Holes 29 are drilled in the internal tuning whip former to facilitate the mounting of the second internal tuning whip on the opposite side of the oval tubing to provide minimum capacitive coupling and maximum electrical isolation between the two internal tuning whips. The tuning whips are trimmed and set in place after tuning with adhesive PVC tape.

Antenna

Claims:

1. The antenna is a vertically polarized omni directional antenna.

2. The size of a single band antenna is one fifth the size of a resonant half wave dipole operating on the same frequency.

3. Low visibility, can be regarded as a stealth antenna.

4. Low angle of radiation, less than twenty degrees when mounted three metres above the ground.

5. Gain > 0dB.

Application No:	GB1105598.5	**Examiner:**	Mr John Watt
Claims searched:	1	**Date of search:**	24 June 2011

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 at least	GB 2036447 A (PYE) see figs.1 - 6 and page 2, lines 6 - 14 and 29 - 66.
X	1 at least	US 6140973 A (ANNAMAA ET AL) see figs.1 - 5b and co.3, lines 26 - 39.
X	1 at least	US 6559811 B1 (PULIMI ET AL) see figs.1 - 10 and col.2, lines 33 - 60.
X	1 at least	JP 04287407 A (NT&T) see figs.1 - 6 and abstract.
X	1 at least	JP 09238018 A (MATSUSHITA) see figs.1 -9 and abstract.
X	1 at least	US 6806836 B2 (OGAWA ET AL) see whole document.
A	-	US 3858220 A (ARNOW) see whole document.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

H01Q

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
H01Q	0009/16	01/01/2006
H01Q	0001/48	01/01/2006
H01Q	0005/00	01/01/2006