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H. BRUECKMANN

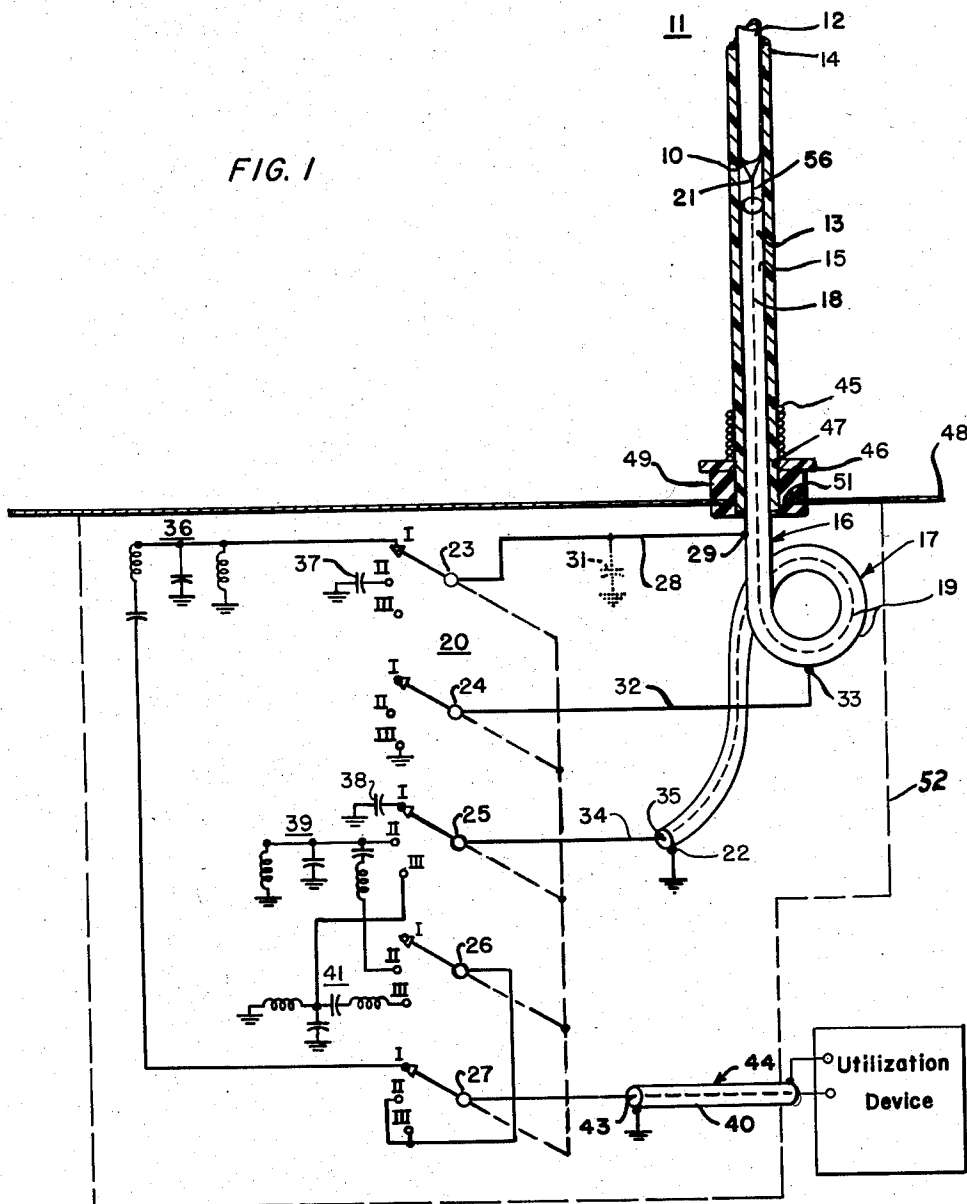
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BROAD BAND VERTICAL ANTENNA

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2 Sheets-Sheet 1

FIG. 1



INVENTOR,
HELMUT BRUECKMANN.
BY *Fredrick M. Stader*

ATTORNEY.

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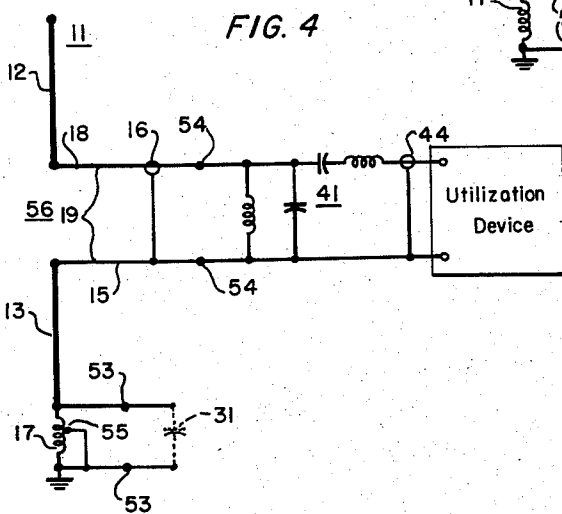
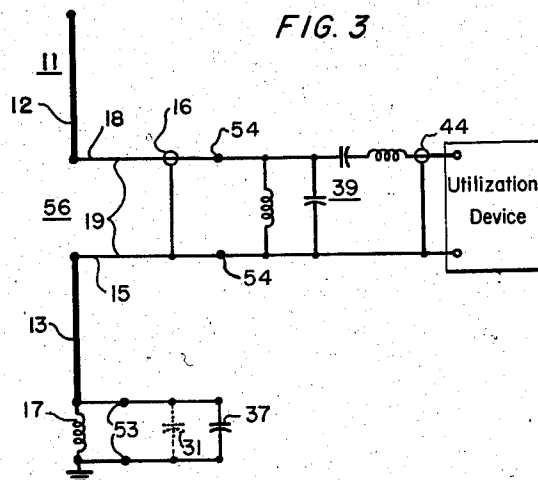
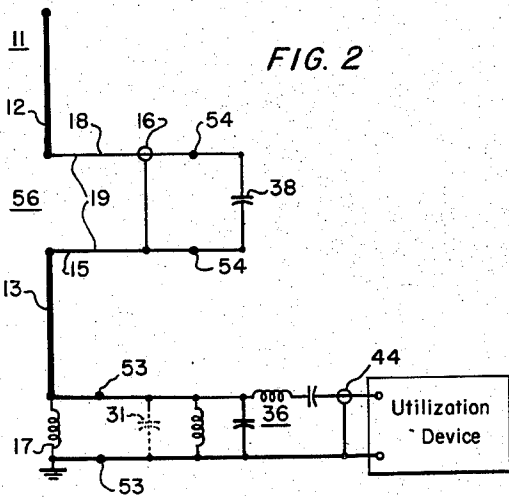
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INVENTOR,
HELMUT BRUECKMANN.
BY *Fredrick M. Stender*
ATTORNEY

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BROAD BAND VERTICAL ANTENNA

Helmut Brueckmann, Little Silver, N.J., assignor to the United States of America as represented by the Secretary of the Army

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(Granted under Title 35, U.S. Code (1952), sec. 266)

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

The present invention relates to a broad band vertical antenna and more particularly to a broad band vertical antenna for vehicular application constructed in the form of a whip and employing a double feed system, facilitating its use over a broad band of frequencies.

In the prior art, whip antennas for vehicular use required complicated circuitry and the antennas were not conveniently adjustable for operation over a wide frequency range (broad band of frequencies). The present invention is a vertical whip antenna (operating for example, over the frequency range from 20 to 70 mc.) which will permit considerable simplification of the antenna circuitry of vehicular radio sets, especially with respect to simplification of the matching circuitry of the radio sets, and which would also permit an increase in antenna efficiency. These improvements are achieved without introducing any movable parts except switches or relays.

The antenna system described herein comprises an antenna having upper and lower sections. In the lower part of the frequency range the antenna is fed at the base terminal of the lower section, and a reactance is inserted between the lower and upper sections, thereby increasing the electrical length of the antenna; and in the upper part of the frequency range the antenna is fed at or near its midpoint (between the upper and lower sections), while the base terminal is used to insert a reactance between the base of the lower section and ground, thereby reducing the electrical length of the antenna.

Another feature of the antenna is that the lower section thereof is a portion of a coaxial cable having another portion thereof wound into a coil and inclosed within a metal case wherein the coil portion is electrically shielded. This coil portion of the coaxial cable is connected between the base terminal of the lower section of the antenna and ground. The upper section of the antenna is formed from an outer conductor of a coaxial cable or any other type flexible conductor.

An object of the present invention is to provide a simplified, efficient whip antenna for vehicular use.

Another object of the present invention is to provide a simplified switching circuit to be used with a whip antenna for vehicular use.

A further object of the present invention is to provide a whip antenna employing a double feed system.

Still another object of the present invention is to provide a broad band whip antenna.

A still further object of the present invention is to provide in a whip antenna a portion thereof to be wound into a coil.

The exact nature of this invention as well as other objects and advantages thereof will be readily apparent from consideration of the following specification relating to the annexed drawings in which:

Figure 1 is a schematic illustration of the invention;

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Figure 2 is the equivalent circuit of the whip antenna for the low frequency band;

Figure 3 is the equivalent circuit of the whip antenna for the medium frequency band; and

Figure 4 is the equivalent circuit of the whip antenna for the high frequency band.

As herein used the term radiator should be understood to be generic to both receiving and transmitter antennas.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Figure 1 a double feed whip antenna system comprising antenna 11 having a single, tubular, conductive upper section (upper radiator) 12 and tubular, conductive lower section (lower radiator) 13, the two sections 12 and 13 being inclosed within fiberglass jacket 14. Lower radiator 13 is the upper portion of outer conductor 15 of coaxial cable 16. The lower portion of outer conductor 15 of coaxial cable 16 is cable choke 17. Inner conductor 18 and outer conductor 15 of coaxial cable 16 form a coaxial stub 19. Upper radiator 12, an outer conductor of a coaxial cable, having its lower portion formed as a cone 10, is electrically connected at the apex 21 of cone 10 to inner conductor 18. Outer conductor 15 of coaxial cable 16 is connected to ground at point 22.

It should be understood, that instead of being of single unit construction, lower radiator 13 and cable choke 17 can each be fabricated as separate units. If this type of construction is used, the two separate units, lower radiator 13 and cable choke 17, would be electrically connected by an electrical connector, i.e., in Figure 1, the base of lower radiator 13 should be connected to cable choke 17 by the electrical connector. This configuration is not depicted in any of the figures.

Switching network 20 comprises five ganged switches 23, 24, 25, 26 and 27—each having a switch arm and three switch positions I, II, III. Conductive wire 28 is electrically connected between point 29 of outer conductor 15 of coaxial cable 16 and the switch arm of switch 23. Dotted capacitor 31, representing stray capacitance, is illustrated as connected between conductive wire 28 and ground. Conductive wire 32 is electrically connected between point 33 of outer conductor 15 of coaxial cable 16 and the switch arm of switch 24, and conductive wire 34 is electrically connected between point 35 of inner conductor 18 of coaxial cable 16 and the switch arm of switch 25.

Matching network 36 is electrically connected between position I of switch 23 and position I of switch 27. Capacitor 37 is electrically connected between position II of switch 23 and ground. Position III of switch 23, positions I and II of switch 24, and position I of switch 26 are open circuited; and position III of switch 24 is connected to ground. Matching network 39 is electrically connected between position II of switch 25 and position II of switch 26, and matching network 41 is electrically connected between position III of switch 25 and position III of switch 26.

The switch arm of switch 26 is electrically connected to positions II and III of switch 27, and the switch arm of switch 27 is electrically connected to inner conductor 43 of coaxial cable 44. Outer conductor 40 of coaxial cable 44 is connected to ground. Coaxial cable 44 is connected to a utilization device, e.g., a transmitter or receiver, depending on the use of the antenna.

Spring 45, coaxial with lower radiator 13 at the lower end thereof, is positioned outside of and adjacent to fiberglass jacket 14. Holding member 46, having an aperture 47 therein to allow coaxial cable 16 to pass through, is insulated from vehicle body member 48 by insulating member 49. Vehicle body member 48 has an opening 51 therein to allow coaxial cable 16 to pass

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therethrough. Opening 51 is surrounded by insulating member 49, and holding member 46 in juxtaposition to spring 45, thereby holds the antenna in position.

Ganged switching network 20 permits changing the inductance or capacitance of the reactors (matching network, filter choke, and capacitors) connected to the radio set by inner conductor 43 of coaxial cable 44. It may be remotely controlled from the radio set and activated automatically from a band selector. Preferably, however, the capacitors, matching networks, ganged switching network, and cable choke are encased within metal container 52 which is mounted to and within vehicle body member 48 about opening 51 therein.

In a preferred embodiment of the invention antenna 11 is 100 inches in length (upper radiator 12 being 60 inches and lower radiator 13 being 40 inches) and is used to cover a frequency range from 20 to 70 mc. The separate matching networks with fixed components (one for each switch position of the ganged switching network 50) are employed so that the voltage standing wave ratio (VSWR) can be kept below 2:1 in coaxial cable 44 (RG 62/U feed cable with a 93 ohms characteristic impedance).

An essential feature of antenna 11 is that it has two terminal pairs, base terminals 53 (shown in Figures 2, 3 and 4) being the two ends of cable choke 17, and center terminals 54 being the output terminals of stub 19.

In Figure 1 base terminals 53 are points 22 and 29 and center terminals 54 are points 35 and 22. Point 22 is common to both the base and center terminals.

It should also be noted that tap 55 of cable choke 17, as depicted in Figure 4, is connected to ground and is used to short out turns of cable choke 17 when antenna 11 is to operate at the high frequency end of the frequency band. Tap 55 is depicted as point 33 in Figure 1 and is used so that, at the high frequency end of the frequency band, the inductance across base terminals 53 can be reduced. This is necessary since the value of inductance of cable choke 17 is limited, at the high frequency end of the frequency band, to a value sufficiently low for obtaining the desired reactance of the parallel combination of cable choke 17 and the lumped capacity—the lumped capacity resulting from the capacitance due to insulating member 49, the connector for connecting the lower radiator 13 to cable choke 17 (if such a construction is used), and stray capacitance 31 of cable choke 17 itself. At the low frequency and medium frequency range of the frequency band, a greater cable choke inductance is in general permissible and useful. Furthermore, it is convenient and advantageous when a high Q is desirable to make the inductance of the full cable choke 17 equal to the maximum value desired over the whole frequency range and to short part of it for obtaining a lower value of inductance in the highest frequency region.

It should be noted that the schematic diagram, Figure 1, shows cable choke 17 consisting of only one turn merely for reasons of convenience in drawing the figure, and that the shorting of a portion of one turn is not unusual in adjusting inductors at very high frequencies.

Figures 2, 3 and 4 will be used in conjunction with Figure 1 in describing the operation of the present invention to allow for a better understanding thereof. In these figures stub 19 has its input terminals connected to center feed point 56, i.e., stub 19 has its input terminals connected to upper radiator 12 and lower radiator 13 respectively. This center feed point 56 is also depicted in Figure 1.

When ganged switching network 20 is in switch position I, as shown in Figure 1 (depicted in equivalent circuit Figure 2), antenna 11 is connected for operation at the low frequency range of the frequency band. It is desirable, when operating at this low frequency range, that antenna 11 have an electrical length which is approximately a quarter wavelength. The reactor con-

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nected to the center terminals 54 as shown in Figure 2 (points 35 and 22 of Figure 1) can be either an inductor or capacitor depending upon the electrical length and characteristic impedance of coaxial stub 19. The purpose of connecting this reactor is to give coaxial stub 19 the desired inductive value. If for example, the electrical length of coaxial stub 19 is a little shorter than a quarter wavelength, capacitor 38 as depicted in Figures 1 and 2, is connected between the center terminals 54 by switch 25 of ganged switching network 20. Capacitor 38, connected across coaxial stub 19 at center terminals 54, controls the reactance of stub 19 at the low frequency range so that an inductive reactance appears at center feed point 56 (between the upper and lower radiator 12 and 13 respectively). This will effectively lengthen the electrical length of antenna 11. This mode of operation is similar to shunt excitation of a vertical antenna with a loading coil inserted between the upper and lower radiators except that the loading coil is replaced by a coaxial stub. Matching network 36 and the stray capacitance depicted by dotted capacitor 31 are connected in parallel between base terminals 53 (points 22 and 29 of Figure 1), shown in Figure 2, and coaxial cable 44 by switches 23 and 27 of ganged switching network 20. Coaxial cable 44 is in turn connected to the receiver. Matching network 36 allows antenna 11 to be electrically matched to the receiver.

When ganged switching network 20 is in switch position II (depicted in the equivalent circuit Figure 3), antenna 11 is connected for operation in the mid-frequency range of the frequency band. It is desirable, when operating at this mid-frequency range, that antenna 11 have an electrical length which is between approximately a quarter wavelength and approximately a half wavelength. Stray capacitance, depicted by dotted capacitor 31, and capacitor 37 are connected in parallel between base terminals 53 by switch 23. The value of capacitor 37 depends upon the stray capacitance, and the inductance of cable choke 19. Capacitor 37 will effectively shorten the antenna length. This mode of operation is similar to the conventional excitation of a vertical antenna on a ground plane, except that the antenna is connected to ground through a reactor. Switch 25 simultaneously connects matching network 39 between center terminals 54 and coaxial cable 44. Coaxial cable 44 is in turn connected to the receiver. Matching network 39 allows antenna 11 to be electrically matched to the receiver.

For antenna 11 to operate over the high frequency range of the frequency band, ganged switching network 20 is switched to switch position III (equivalent circuit depicted in Figure 4). It is desirable, when operating at this high frequency range, that antenna 11 have an electrical length of approximately a half wavelength. In this operation some of the turns of cable choke 17 are shorted by switch 24 (the switch arm being connected to ground) for reasons stated above and stray capacitance, depicted by dotted capacitor 31, is connected across base terminals 53. This combination results in reducing the electrical length of antenna 11. Simultaneously, matching network 41 is switched between center terminals 54 and coaxial cable 44 allowing antenna 11 to be electrically matched and connected to the receiver.

In summation it can be said that the antenna described herein will operate over a wide frequency band. This is accomplished partly because of the unique construction of the antenna structure, i.e., lower radiator 13, cable choke 17, and coaxial stub 19 being of unit construction; and partly by the switching of the reactive elements connected to base terminals 53 and center terminals 54 by ganged switching network 20. When antenna 11 is to operate over the lower frequency range of the frequency band, ganged switching network 20 inserts across center terminals 54 a reactance which is suitable for increasing the electrical length of antenna 11. Simultaneously,

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switching network 20 inserts across cable choke 17 (across the base terminals 53) matching network 36 to match antenna 11 to the receiver. At the higher frequency range this ganged switching network 20 inserts a reactance across the base terminals 53 to reduce the electrical length of antenna 11 while at the same time connecting either matching networks 39 or 41 between terminals 54 to match antenna 11 to the receiver.

It should be understood, of course, that the foregoing disclosure, relates to only a preferred embodiment of the invention and that numerous modifications or alterations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A broad band whip antenna for vehicular use comprising an antenna having upper and lower sections, said lower section having a base terminal; a cable choke, said cable choke and said lower section being an integral unit, said integral unit being the outer conductor of a coaxial cable, said outer conductor having its lower end electrically connected to ground, said upper section being a flexible conductor; an electrical reactor; a matching network; a switching network, said switching network connecting said reactor and said matching network interchangeably between said base terminal and ground and between said upper and lower sections to allow said antenna conductor to operate over two distinct frequency bands.

2. An antenna system for vehicular use comprising an antenna insulated from and projecting outwardly from the structure of the vehicle so as to be electrically exposed to space, said antenna having an upper and a lower radiator, said lower radiator having a base terminal at its lower extremity; a reactor; a matching network having input and output terminals; a cable choke connected between said base terminal and ground; a transmission line having an input and an output, said input of said transmission line between said upper and lower radiators; and a switching network, said reactor having one terminal connected to said switching network and the other terminal electrically grounded, said output terminals of said matching network being for connection to a utilization device, said input terminals of said matching network connected to said switching network; said switching network connecting said reactor to said output of said transmission line thereby increasing the electrical length of the antenna conductor and simultaneously connecting said input terminals of said matching network across said cable choke when it is desirable to operate said antenna over the low range of a frequency band; said switching network connecting said reactor across said cable choke thereby decreasing the electrical length of said antenna and simultaneously connecting said input terminals of said matching network to said output of said transmission line when it is desirable to operate said antenna over the high range of said frequency band.

3. The antenna system of claim 2 wherein said antenna is approximately one quarter wavelength when operating over said low frequency range of said frequency band and approximately one half wavelength when operating over said high frequency range of said frequency band.

4. An antenna system comprising an antenna having upper and lower radiators, said radiators having a common axis, said lower radiator having at its lower extremity a base terminal; a fiberglass jacket encasing said antenna; a cable choke, said cable choke having one end connected with said base terminal and having the other end electrically grounded; said cable choke and said lower radiator forming the outer conductor of a coaxial cable, said coaxial cable having an inner conductor, said upper radiator having the lower end thereof conically shaped, one end of said inner conductor being connected to said conically shaped end of said upper radiator at the apex thereof, said inner and outer conductors behaving as a

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transmission line, said transmission line having the input thereof between said apex and the upper extremity of said lower radiator, said transmission line and said cable choke each having output terminals for connecting electrical circuits depending upon what frequency range is desirable for the operation of the antenna.

5. A broad band whip antenna for vehicular use comprising an antenna having upper and lower sections, said lower section having a base terminal; a fiberglass jacket encasing said antenna; a cable choke, said cable choke and said lower section being an integral unit, said integral unit being the outer conductor of a coaxial cable, said base terminal being the junction of said lower section to said cable choke, said coaxial cable having an inner conductor, said cable choke having an end thereof electrically connected to ground, said upper section being a flexible conductor having one end thereof conically shaped, one end of said inner conductor being connected to said conically shaped end of said upper section at the apex thereof; a switching network, the other end of said inner conductor being connected to said switching network, said inner and outer conductors of said coaxial cable behaving as a transmission line having as output terminals said other end of said inner conductor and said end of said cable choke; a reactor having one end connected to said switching network and the other end connected to ground; and a matching network having input and output terminals, one input terminal and one output terminal connected in common to ground and having the other input terminal and the other output terminal connected to said switching network, said output terminals being for coupling to a radio receiver; said antenna operating at the low frequency range of a frequency band when said switching network simultaneously connects said reactor across said output terminals of said transmission line, said other input terminal of said matching network to said base terminal, and said other output terminal of said matching network to the radio receiver; said antenna operating at the high frequency range of said frequency band when said switching network simultaneously connects said reactor to said base terminal and said matching network between said output terminals of said transmission line and the radio receiver.

6. A broad band whip antenna for vehicular use comprising an antenna having upper and lower sections, said lower section having a base terminal; a fiberglass jacket encasing said antenna; a cable choke, said cable choke and said lower section being an integral unit, said integral unit being the outer conductor of a coaxial cable, said base terminal being the junction of said lower section with said cable choke, said coaxial cable having an inner conductor, said cable choke electrically connected to ground at its extremity, said upper section being a flexible conductor having the lower end thereof conically shaped, one end of said inner conductor being connected to said conically shaped end of said upper section at the apex thereof; a ganged switching network having first, second, third, fourth and fifth switches, each of said switches having first, second and third switch positions and a switch arm; a first, second, and third matching network each having one input and one output terminal electrically grounded, said first matching network having its other input terminal connected to said first position of said first switch and its other output terminal connected to said first position of said fifth switch, said second matching network having its other input terminal connected to said second position of said third switch and its other output terminal connected to said second position of said fourth switch, and said third matching network having its other input terminal connected to said third position of said third switch and its other output terminal connected to said third position of said fourth switch; a first and second reactor each having an end electrically grounded, said first reactor having its other end connected to said second position

of said first switch, said second reactor having its other end connected to said first position of said third switch, said third position of said second switch electrically connected to ground, said second and third positions of said fifth switch connected to said switch arm of said fourth switch, said switch arm of said first switch connected to said base terminal, said cable choke having an electrical tap connected to said switch arm of said second switch, the other end of said inner conductor connected to said switch arm of said third switch; a coaxial cable connector having an inner conductive wire and an outer electrical conductive casing, said outer conductive casing being electrically grounded, said inner conductive wire having an end thereof connected to said switch arm of said fifth switch; said antenna operating at the low frequency range of a frequency band when said ganged switching network electrically connects each of said switch arms to each of said first switch positions of each of said switches; said antenna operating at the mid-frequency range of said frequency band when said ganged switching network electrically connects each of said switch arms to each of said second switch positions of each of said switches; said antenna operating at the high frequency range of said frequency band when said ganged switching network electrically connects each of said switch arms to each of said third switch positions of each of said switches.

7. The broad band whip antenna for vehicular use of claim 6 further comprising a metal container, said ganged switching network, said matching networks, said reactors, and said cable choke being incased within said metal container, said container being adapted for mounting to and within a vehicle body, the vehicle body

having an opening therein, said antenna conductor extending through said opening, said metal container being below and surrounding said opening.

8. The broad band whip antenna for vehicular use of claim 7 further comprising a holding member, said holding member having an aperture therein to allow said antenna conductor to extend therethrough; an insulating member to insulate said holding member from said vehicle body, said insulating member surrounding said opening; a spring member connected to said lower section at the lower end thereof, said spring member being outside of and adjacent to said fiberglass jacket and in juxtaposition to said holding member thereby holding said antenna conductor in position.

9. The broad band whip antenna for vehicular use of claim 8 wherein said first and second reactors are capacitors.

10. The broad band whip antenna for vehicular use of claim 9 where said antenna conductor is approximately 100 inches in length, said upper section being approximately 60 inches and said lower section being approximately 40 inches, said antenna, in operation, covering a frequency range from 20 to 70 mc.

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