A mobile vehicular antenna (10) formed of a monopole portion (12) operable at low frequencies and one or more dipole (14) and/or monopole portions operable at high frequencies, with the secondary or dipole/monopole portions atop the first monopole portion, and insulated therefrom. Coaxial cable (18) or other conductors for the one or more dipole and/or monopole portions extends through or along the monopole portion (12) for electrical connection to the dipole arms (14a and 14b), with the monopole portion having separate leads. In a first embodiment, the antenna is not retractable. In second and third embodiments, the portions are in telescoping relation and retractable.
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AXIAL MULTIPOLe MOBILE ANTENNA

TECHNICAL FIELD

This invention relates to mobile antennas, and in particular to multipole mobile antenna devices.
BACKGROUND ART

Antennas for automobiles are generally AM-FM monopole antennas. When high frequency radio devices are utilized within the vehicle, another, usually fixed, non-retractable, monopole antenna is installed. The use of such monopole antennas has become more common with the advent of cellular or satellite relayed telephone communications, the former of which typically operate at a frequency of about 850 MHz.

Designs for antennas have taken numerous forms in attempts to make them more compact, retractable and versatile. One such antenna is shown and described in United States Patent No. 2,371,539 issued to Morch on March 13, 1945 for "ANTENNA". In this patent the antenna includes a combination of vertical and horizontal antennas with means for switching to select one or the other.

An antenna configured for use with a vehicle is shown and described in United States Patent No. 2,537,481 issued to Parsons on January 9, 1951 for "RADIO ANTENNA", the device being an antenna constructed of tubular telescoping members, extended or retracted by a motor driven cable in the interior thereof with a spool provided for reeling the cable upon retraction.

United States Patent No. 2,866,198 issued to Kirby, et al on December 23, 1958 discloses a "TELESCOPING DIPOLE ANTENNA" which is collapsible and includes a main supporting mast to which the two arms of a dipole attach at right angles, with extension and retraction of the dipole involving swivelng of dipole members about an articulated joint.

An "EXTENSIBLE ANTENNA" is shown in United States Patent No. 2,913,073 issued to Wendling on November 17, 1959 and includes a trigger mechanism responsive to immersion in water for extending the antenna.
United States Patent No. 3,268,903 issued to Kuecken, et al on August 23, 1966 for an "EXTENDIBLE DIPOLE ANTENNA" shows an antenna in which the dipole arms are flexible conductors supported by a rigid dielectric element and retractable for storage on reels, with the reels coupled for retraction of the flexible elements at different rates bearing a predetermined ratio.

Another device is shown and described in United States Patent No. 3,359,559 issued to Guinn on December 19, 1967 for "IMPULSE-TYPE TELESCOPING ANTENNA", the antenna sections being projected into an extended position by a compressible coil spring, and retracted by an overpowering spiral spring.

Such antennas of the prior art are limited in use, have complex mechanisms for extension and retraction, do not adequately serve the multiple purpose of the present invention and are generally not compatible with the requirements for vehicular antennas.
Accordingly, it is an object of the present invention to provide a new multipole mobile antenna.

It is another object of the present invention to provide a new and multipurpose mobile antenna of uncomplicated construction which eliminates the necessity for placing multiple antennas on a vehicle.
SUMMARY OF THE INVENTION

The foregoing and other objects of the invention are accomplished by providing an antenna formed of monopole and/or dipole portions of various descriptions. In the particular case illustrated in the following specification a dipole portion is mounted atop a monopole portion and is insulated therefrom to form two separate antennas. Coaxial cable for the dipole portion extends through or along the monopole portion (shown tubular) for electrical connection to the dipole arms, with the monopole portion having separate leads.

In a first embodiment, the antenna is not retractable. In a second embodiment, the portions are in telescoping relation to each other and are retractable. In a third embodiment, the dipole of either the first or second embodiments can be replaced by another monopole with the appropriate phasing circuitry which eliminates the need for a ground plane.
ADVANTAGEOUS EFFECTS OF THE INVENTION

The invention has the following advantages over other devices now in use for the same purposes:

It combines multiple antennas used on vehicles for AM-FM and short-wave-broadcast reception and cellular or satellite-relayed mobile telecommunications systems into a single antenna.

It provides for retractability of the entire antenna into the body of the vehicle when not in use.

It allows enhanced reception and transmission of the high-frequency radio waves of mobile telecommunications systems by the positioning of the respective antenna-element sufficiently high above the body of the vehicle to avoid blockage of the signal by the vehicle itself.

It gives the flexibility of design needed to produce a multi-element phased-array antenna whose properties may be either fixed or electronically controlled. A phased-array antenna is envisioned as being useful in future satellite-relayed telecommunications systems.
BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention will become apparent from a reading of the specification when taken in conjunction with the drawings, in which like reference numerals refer to like elements in the several views.

FIGURE 1 is a side elevational view, in cross-section, of an antenna according to the invention;

FIGURE 2 is a side elevational view, in cross-section, of an alternate embodiment of the antenna of FIGURE 1;

FIGURE 3 is a view in projection of an extensor-retractor mechanism for use with the antenna of FIGURE 2; and

FIGURE 4 is a view in projection of an alternate extensor-retractor mechanism for use with the antenna of FIGURE 2.
DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, and particularly to FIGURE 1 there is shown an antenna, generally designated 10, which includes a lower monopole portion, generally designated 12, an an upper dipole portion, generally designated 14, the two portions being separated by a dielectric member 16. Although the monopole portion 12 in FIGURE 1 is shown with a cutaway portion, it is to be understood that the monopole portion has a length sufficient for reception of relevant frequency ranges, that is, AM and FM radio frequencies.

As shown, the monopole portion 12 and the dipole portion 14 may be formed of tubular material of common diameter, with a coaxial cable 18 extending through the center thereof. At the lower end of the monopole portion 12, the antenna 10 is mounted to a vehicle 20 through an aperture 22 therein with an insulating base 24 having the monopole portion 12 extending therethrough and suitably secured, such as by threaded fasteners as is common with vehicle antenna mounting structures.
From bottom to top, as viewed in FIGURE 1, the various components of the antenna 10 include the monopole portion 12, the electrically insulating dielectric portion 16, the first dipole section 14a of the dipole portion 14, a second dielectric section 17, the second dipole section 14b and a dielectric cap member 26, which seals the interior of the antenna 10 from the weather. The dielectric sections 16 and 17 may be formed of any convenient material such as nylon, teflon, acrylic or other generally rigid insulating material of high tensile strength. The dipole sections 14a and 14b are of such length as is required for transmitting and receiving the proper frequency, such as 850 MHz for cellular telephone communications, or other high frequency communications, such as those for satellite-relayed telephone systems.

The various sections may be axially aligned with the interior thereof having the coaxial cable 18 fed therethrough or along with the outer jacket of the cable 18 suitably electrically insulating the cable 18 from the interior metallic surface of the antenna. At the upper end of the cable 18, the insulation is stripped away for electrical connection to the two poles of the dipole portion 14. The inner conductor
18a of the coaxial cable 18 is electrically attached to the dipole section 14b, such as by a set screw 28 threadably attached to the dipole section so that tightening of the set screw 28 brings it into contact with conductor 18a inside of dielectric member 17. Similarly, the outer jacket of the cable 18 is stripped away to reveal the coaxial second conductor 18b, which can be likewise electrically connected to the other dipole section 14a by means of a second set screw 30 threaded through the dipole section 14a and tightened against conductor 18b. Other standard methods of securing permanent electrical contact of cable 18 to dipole sections 14 are envisioned as part of the specification.

Monopole antennas generally require a ground plane or phasing circuitry to simulate the effect of a ground plane. The monopole portion 12 may be of either of these two types. However, dipole portion 14 does not require a ground plane or this kind of phasing circuitry for its operation; it is another advantage of the invention that the high frequency antenna, as a matter of course, is positioned high enough above the body of the vehicle 20 to avoid blockage of signal reception and transmission by the vehicle itself, without the necessity of roof mounting a separate antenna.
In the first and second embodiments, the monopole portion 12 and the dipole portion 14 have separate electrical feed lines, designated 18a and 18b for the coaxial cable 18 which feeds the dipole portion 14, and leads 32 and 33 for the monopole portion 12, with lead 33 providing the ground to the vehicle for the ground plane. Having separate electrical feed lines eliminates the difficulty associated with electrically matching one antenna portion to the other to enable simultaneous operation over both high and low frequencies. The leads 18a' and 18b' provide the dipole-antenna connections to the telephone equipment, while the leads 32 and 33 provide the antenna connections to the standard AM-FM radio equipment in the vehicle.

In the third embodiment, the dipole can be replaced by another monopole with the appropriate phasing circuitry which eliminates the need for a ground plane. In this configuration, the monopole-dipole becomes a dual-monopole antenna with some further simplifications of the design. Furthermore, replacing the dipole with a monopole allows antennas of a higher gain, with respect to the dipole, under the normal conditions of impedance matching of the antenna to its drive circuitry.
Referring now to FIGURE 2, the antenna 10 of the invention in the second embodiment may be formed as a telescoping retractable antenna, designated 10' in FIGURE 2. FIGURE 1 is provided with a dotted line A-A at the approximate midpoint of the dielectric section 16 which separates the monopole portion 12 from the dipole portion 14. In FIGURE 2, the upper end of the antenna structure is provided with a horizontal dotted line designated A-A. The structure in FIGURE 2 will be substituted for that below the dotted line A-A in FIGURE 1 to provide a retractable antenna 10'. In essence the structure of the dipole portion 14 above the dotted line A-A in FIGURE 1 will be mounted atop the structure shown in FIGURE 2 to complete the antenna 10. In FIGURE 2, to provide the telescoping relation, the monopole portion 12' is formed of a first section 12a' of larger diameter tubular stock, with a second monopole portion 12b' telescopically received therein, much as in the manner of conventional monopole vehicular antennas. The lowermost portion 16' of the dipole portion is equivalent to the dielectric section 16 in FIGURE 1, and is a dielectric tubular member with an extensor-retractor sleeve 36 securely attached to the bottom thereof, this sleeve 36 being coupled to an extensor-retractor cable 40.
In operation and use of the antenna 10', it is to be understood that it is necessary to elevate the dipole portion 14' of the antenna 10' to a fully extended height for effective use, and at full extension, the dielectric section 16' separates the monopole portion 12' from the dipole portion 14' to minimize any electromagnetic coupling between them. At less than full extension, the metallic outer surface of the lower dipole section 14a would be in electrical contact with the inner metallic surface 12b' of the upper section of the monopole portion 12', unless the entire dipole is covered with an insulating jacket, which can have the added function of protecting the dipole from the weather.

In conventional, retractable, vehicle antennas, a motor driven stiff nylon cable is threaded through the center of the antenna sections with the upper end of the nylon cable being secured to the lowermost end of the uppermost telescoping section of the antenna. In accordance with the present invention the extensor-retractor cable 40 has been modified to provide either a hollow interior for passage of a coaxial cable therethrough, or alternatively, by providing a specially jacketed coaxial cable which has a jacket of
sufficient rigidity to serve the function of the stiff nylon cable previously used, while providing the additional function of electrical connection. The former modification has the limitations that the smaller the diameter of the coaxial cable, the greater the attenuation per unit length, the more likely the occurrence of signal leakage, and the more likely the occurrence of interference with stray signals which may impinge upon it. In order to maintain the largest outer diameter of the antenna 10' at a diameter consistent with those in present use for vehicles, the alternative modification will enable the maximum diameter of the coaxial cable within the constraints of the standard diameters of such antennas.

FIGURES 3 and 4 illustrate two mechanisms for allowing for the winding and unwinding of the extensor-retractor cable 40 for use in the antenna 10' of FIGURE 2. As shown in FIGURE 3, with the coaxial cable 18 mounted within the extensor-retractor cable 40, a motor driven spool 44 is provided within a housing 46, with the end 18c of the coaxial cable 18 remaining stationary during raising or lowering of the antennas. In order to maintain the end 18c stationary, the
cable 18 extends out from the interior of the extensor-retractor cable 40 at the very end, then coils freely for several turns before terminating at its end 18c. The paying out or reeling in of the extensor-retractor cable 40 will cause this free coil of the coaxial cable 18 to contract or expand in diameter, respectively, while maintaining the end 18c fixed for connection to the radio circuitry. In retractable antennas, the outer surface of the extensor-retractor cable 40 is sometimes provided with molded teeth or the like to allow frictional gripping by appropriate gears to positively drive the extensor-retractor cable 40 in both directions. The mechanisms of FIGURE 3 with the modified cable 40 having coaxial cable 18 therein, enables fabrication of an extensor-retractor cable 40 with a toothed surface for positive gear drive.

FIGURE 4 depicts an alternative drive mechanism which includes a first spool 48 within a first housing 50 and an auxiliary spool 49 within an auxiliary housing 51. In this embodiment, a small diameter extensor cable 40 and the coaxial cable 18 are separable, and in generally side-by-side relation. The primary spool 48 is motor driven for engagement with the extensor-retractor cable 40 which is payed out from, or stored
on, the spool 48. The auxiliary spool 49 receives the coaxial cable 18 thereon, and is spring biased in a direction to retract the coaxial cable 18 as the main spool 48 is receiving the retracting antenna 10'. During raising of the antenna sections, the extensor-retractor cable 40 is payed out, and the coaxial cable 18 unwinds from spool 49 against the force of the spring bias. The coaxial cable 18 is provided with a free coil at the end thereof to enable the end of cable 18 to remain fixed during raising and lowering of the antenna 10' for permitting electrical connection to the radio equipment.

If the antenna 10' is to be fabricated for manual extension or retraction without the necessity for the electrical drive, then there is no need for the extensor-retractor cable 40, and in this instance only a spring-loaded take-up reel such as auxiliary spool 49 is needed. In accordance with the present invention the antenna 10 and the antenna 10' depict a vertical monopole dipole antenna of simple construction, which is effective for vehicular radio transmission and reception in the AM-FM bands as well as at the high frequencies for telephone communications.
Furthermore, although the description has referenced one dipole portion in stacked relation and vertical alignment with a monopole portion, it is to be understood that one or more additional dipole portions of differing designs may be stacked thereon with separate electrical feed connections for each additional dipole portion, with the overall construction resembling that of the single-shaft monopole antenna. Such a construction would enable the antenna to operate as a linear phased array with either fixed or electronically controlled directional properties. It is also to be understood that monopoles can be substituted for any or all of the dipoles mentioned and that other types of tubular, cylindrical, helical, corrugated, or linear conductive elements may act in place of the simple conductors described herein.

While there have been shown and described preferred embodiments, it is furthermore to be understood that various other adaptations and modifications may be made within the spirit and scope of the invention.
CLAIMS

1. In an antenna, the combination comprising:
   a monopole portion;
   a dipole portion having first and second
   sections in general alignment with an insulating
   section therebetween;
   a dielectric member affixed to and
   electrically separating said monopole portion and said
   dipole portion with said monopole portion and said
   dipole portion in axial alignment; and
   separate means of electrical connection for
   each of said monopole and dipole portions.

2. The combination according to Claim 1 wherein
   said antenna is configured for mounting substantially
   upright on a vehicle and said dipole portion is in
   stacked relation atop said monopole portion.

3. The combination according to Claim 1 wherein
   said dipole portion is in telescoping relation with
   said monopole portion.
4. The combination according to Claim 2 wherein said monopole portion, said dipole portion and said dielectric member are tubular, said dipole portion is in telescoping relation with said monopole portion, and said dipole portion is uppermost on said antenna with said antenna extended.

5. The combination according to Claim 4 wherein said separate means of electrical connection includes electrical conductor means coextending with said monopole portion, said dielectric member, and said dipole portion for electrical connection to the sections of said dipole portion.

6. The combination according to Claim 5 wherein said tubular dielectric member is the lowermost part of said dipole portion and telescopes within at least one section of said monopole portion.

7. The combination according to Claim 6 further including means for retracting and extending said antenna.
8. The combination according to Claim 7 wherein said electrical conductor means includes a coaxial cable extending through the so-connected tubular members for electrical connection to the sections of said dipole portion.

9. The combination according to Claim 8 wherein said means for retracting and extending said antenna includes spool means for receiving said coaxial cable antenna.

10. In an antenna, the combination comprising:
    a monopole portion;
    means for mounting said monopole portion in generally upright position on a vehicle;
    at least one dipole portion having first and second sections with an insulating section therebetween;
    a dielectric member affixed to and electrically separating said monopole portion and said dipole portion;
Claim 10. continued

    electrical conductor means coextending with said monopole portion for electrical connection to said first and second sections of said dipole portion; and separate means of electrical connection for said monopole portion.

11. The combination according to Claim 10 wherein said dipole portion is in telescoping relation with said monopole portion.

12. The combination according to Claim 11 wherein said dielectric member is the lowermost part of said dipole portion and telescopes within at least one section of said monopole portion.

13. The combination according to Claim 12 further including means for retracting and extending said antenna.

14. The combination according to Claim 13 wherein said retracting and extending means includes spool means for receiving said coaxial cable thereon.
15. The combination according to Claim 14 wherein said spool means are spring biased in a direction for retraction of said coaxial cable thereon.

16. In an antenna, the combination comprising:
   a first tubular monopole portion;
   a second tubular monopole portion in general alignment with said first tubular monopole portion;
   a tubular dielectric member affixed to and electrically separating said first and second monopole portions with said first and second monopole sections in axial alignment;
   separate means of electrical connection for each of said first and second monopole portions; and
   phasing circuitry means electrically coupled to at least one of said monopole portions.

17. The combination according to Claim 16 wherein said antenna is configured for mounting generally upright on a vehicle and said second monopole portion is in stacked relation atop said first monopole portion.
18. The combination according to Claim 16 wherein said first monopole portion is in telescoping relation with said second monopole portion.

19. In an antenna, the combination comprising:
   a first monopole antenna portion;
   means for mounting said monopole portion in generally upright position on a vehicle;
   a second antenna portion in general axial alignment with said monopole portion;
   a dielectric member affixed to and electrically separating said monopole portion and said second antenna portion with said monopole portion and said second antenna portion in general axial alignment;
   coaxial cable means coextending with said monopole portion for providing separate electrical connection means to said monopole antenna portion and said second antenna portion.

20. The combination according to Claim 19 wherein said second antenna portion comprises at least one dipole portion having first and second members in general axial alignment with an insulating section therebetween.
21. The combination according to Claim 19 wherein said separate electrical connection means includes phasing circuitry means electrically coupled to at least one of said antenna portions.

22. The combination according to Claim 20 wherein said dipole portion is in stacked relation atop said monopole portion in telescoping relation therewith.

23. The combination according to Claim 21 wherein said second antenna portion is in stacked relation atop said first monopole portion in telescoping relation therewith.

24. The combination according to Claim 22 further comprising spool means for retracting and extending said antenna, said spool means rotatably receiving said coaxial cable thereon, and including means for maintaining the pick-up end of said coaxial cable stationary for connection to the signal input circuitry.
25. The combination according to Claim 23 further comprising spool means for retracting and extending said antenna, said spool means rotatably receiving said coaxial cable thereon, and including means for maintaining the pick-up end of said coaxial cable stationary for connection to the signal input circuitry.

26. The combination according to Claim 24 wherein said spool means further comprises:

   first and second spools in generally side-by-side relation, said first spool having an extensor-retractor cable rotatably stored thereon said second spool rotatably receiving said coaxial cable thereon;
   said second spool being spring biased in a direction for retraction of said coaxial cable thereon; and
Claim 26. continued

said extensor-retractor cable and said coaxial
cable being connected whereby paying out of said
extensor-retractor cable causes said coaxial cable to
unwind from said second spool against the force of the
spring bias, the coaxial cable being provided with a
free coil at the end thereof to enable said end to
remain fixed during raising and lowering of said
antenna for maintaining electrical connection to the
signal input equipment.
**INTERNATIONAL SEARCH REPORT**

**I. CLASSIFICATION OF SUBJECT MATTER**

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4): H01Q 1/10, 9/22
US. CL. 343/715, 790, 903

**II. FIELDS SEARCHED**

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Documentation Searched other than Minimum Documentation to the extent that such documents are included in the Fields Searched

**III. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>US,A, 4,282,528 (ASPINWALL) 04 AUGUST 1981 See Figure 1 and Col. 2, lines 11-39.</td>
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<td>Y</td>
<td>US,A, 3,879,735 (CAMPBELL et. al.) 22 APRIL 1975 See Figure 3 and Col. 3, lines 51-56.</td>
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<td>Y</td>
<td>US,A, 2,366,299 (VAN BENSCHOTEN) 02 JANUARY 1945 See the entire document.</td>
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<td>US,A, 2,538,885 (SCHUMANN) 23 JANUARY 1951 See Col. 3, line 74 to Col. 4, line 3.</td>
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<tr>
<td>A</td>
<td>US,A, 3,139,620 (LEIDY et. al.) 30 JUNE 1964 See Figure 1.</td>
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* Special categories of cited documents:

- **A**: document defining the general state of the art which is not considered to be of particular relevance
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- **O**: document referring to an oral disclosure, use, exhibition or other means
- **P**: document published prior to the international filing date but later than the priority date claimed
- **T**: later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- **X**: document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- **Y**: document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- **S**: document member of the same patent family

**IV. CERTIFICATION**

Date of the Actual Completion of the International Search: 04 SEPTEMBER 1986

Date of Mailing of this International Search Report: 15 SEP 1986

International Searching Authority: ISA/US

Signature of Authorized Officer: Michael Winer

Form PCT/ISA/210 (second sheet) (May 1986)