US 20010041544A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2001/0041544 A1**

Lang (43) **Pub. Date: Nov. 15, 2001**

(54) **RETRACTABLE MULTIBAND RADIATOR WITH SWITCHING CONTACT FOR WIRELESS COMMUNICATION DEVICES**

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(21) Appl. No.: **09/907,389**

(22) Filed: **Jul. 17, 2001**

Related U.S. Application Data

(62) Division of application No. 09/303,937, filed on May 3, 1999.

Publication Classification

(51) **Int. Cl.**[7] **H04B 1/38**

(52) **U.S. Cl.** **455/90**; 455/575

(57) **ABSTRACT**

A retractable antenna for a wireless communicator includes an elongate radiator that slides through a helical radiator. An electrical contact alternately contacts one of the elongate radiator and the helical radiator depending on a position of the elongate radiator relative to the helical radiator. Mechanical disengagement is accomplished by the movement of the elongate radiator into a contact position with the electrical contact to disengage the helical conductor. A preferred feature of the antenna is that one of the helical radiator and elongate radiator make electrical contact with the wireless communicator circuits, even when the antenna is placed between a fully retracted and fully extended position. Multiple band operation is another feature of the retractable antenna due to its periodic nature. Ease of assembly is achieved through individual snap fit components.

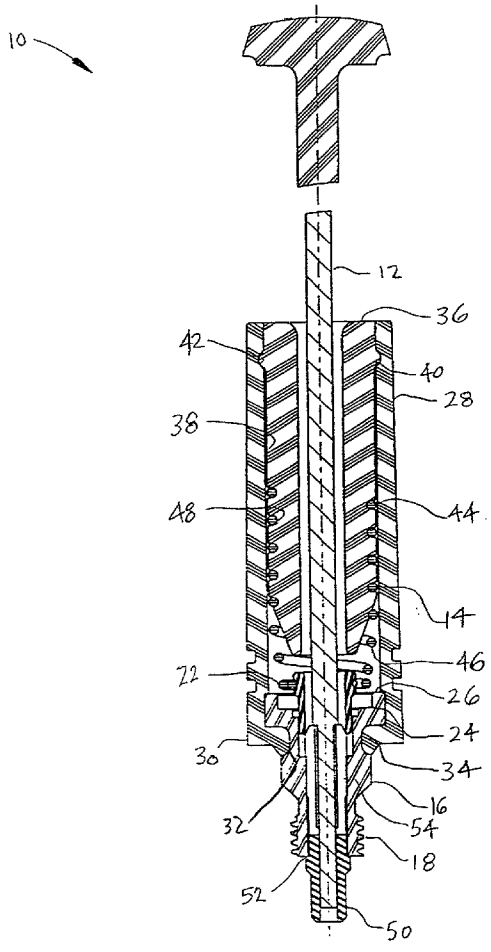


FIG. 1

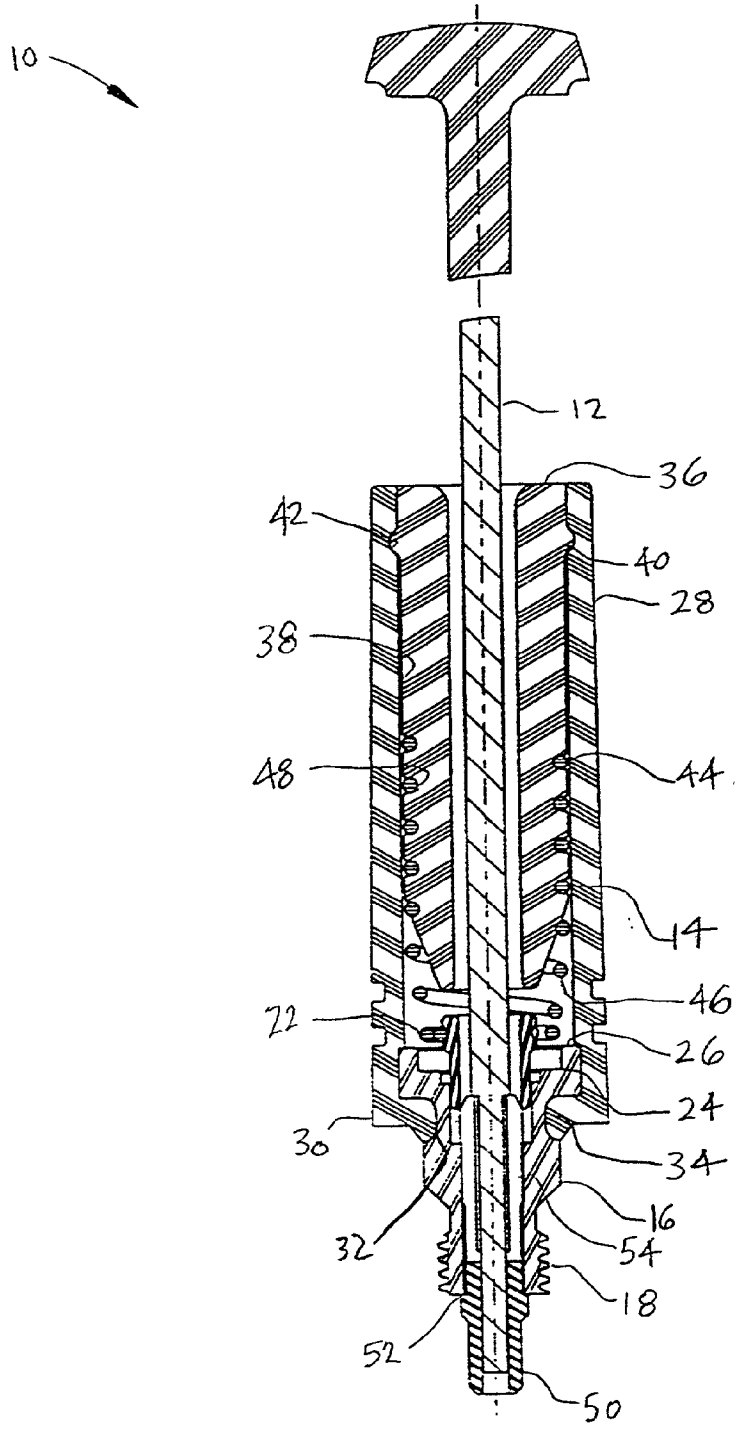
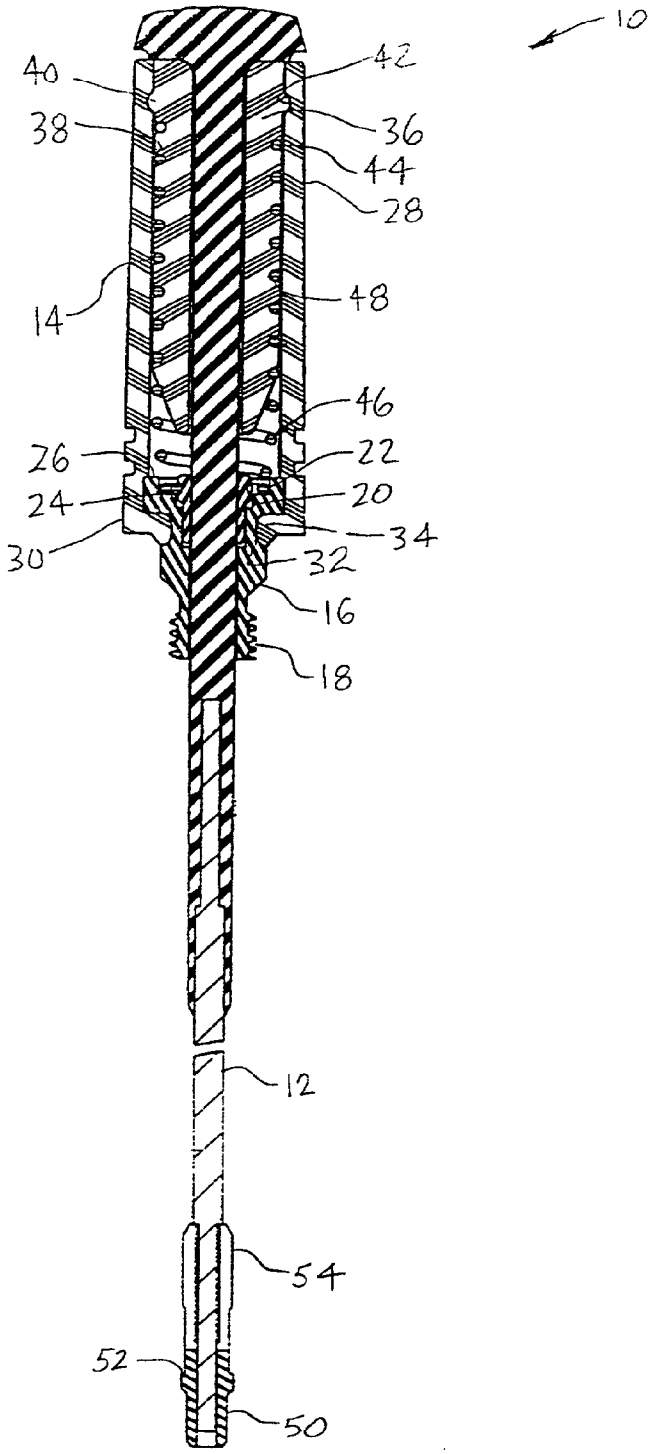


FIG. 2



RETRACTABLE MULTIBAND RADIATOR WITH SWITCHING CONTACT FOR WIRELESS COMMUNICATION DEVICES

FIELD OF THE INVENTION

[0001] The present invention generally concerns antennas for a wireless communication device. More specifically, the present invention concerns antennas which are unique in that they operate effectively in both an extended and retracted position. The antenna design is diverse due to its ability to operate in multiple frequency bands and continue to function in partially extended positions.

BACKGROUND OF THE INVENTION

[0002] New generation portable communicators, particularly wireless phones, operate in multiple frequency bands. Portable phones used in wireless applications that function in multiple frequency bands would require more than one antenna radiator to allow use in both the cellular and digital frequency bands and still have the ability to extend and retract without degradation to the electrical performance of the portable device. Additional costs are incurred in a phone using multiple antennas. They include additional components costs, added assembly procedures requiring labor intensive operations, rejection ratio increase due to manufacturing issues such as crimping/soldering repeatability, and reliability concerns involving the complexity of the electrical connection of the two separate antennas.

SUMMARY OF THE INVENTION

[0003] Wireless phones that use antennas that are retractable alleviate this problem. They function in two modes of operation. In the retracted position, the phone is in standby, ready to receive a call and still convenient for the user to store and transport. After a call is made or received the antenna can be extended, and known as the enhanced mode of operation. With the antenna in the fully extended position, optimal reception is achieved allowing fringe area coverage. Also, from the standpoint of the safety, coupling to the user's head is greatly decreased resulting in better phone performance with the added benefit of reducing the absorption of RF energy by the user.

[0004] The retractable antenna's functionality, when designed properly, is greatly improved if it has the ability to operate in two separate frequencies bands. This is important for user that must travel extensively for business reasons. Because both cellular and digital systems are used across the country, only one wireless phone would be necessary to accommodate any situation encountered when traveling.

[0005] Such needs are met or exceeded by the present dual radiator antenna. The present antenna is in continuous contact with the phone circuits in both the extended, partially extended, and retracted positions and operates in two frequency bands simultaneously. Ease of assembly is a natural by-product of this design which lends itself to efficiency in the production and reliability of the product.

[0006] More specifically, the present antenna includes both a helical and elongate radiator. The helical is held between a core and a sheath. The core snap fits to an inside surface of the sheath. A conductive ferrule secures at an end of the sheath to make an electrical contact between the helical and the elongate of the antenna/wireless communicator interface. A pusher element is disposed on the elongate radiator from the ferrule when the elongate is located in the first position (extended). The bumper is slid to move in a space between the core and the ferrule. Being held between the core and the sheath, the helical radiator extends at least partially into the space between the ferrule and the core to electrically contact the ferrule when not compressed by the pusher (extended partially or fully).

[0007] The switching contact multiple band antenna functions in both the retracted (standby) or extended (enhanced) modes at two different frequency band simultaneously. In the retracted position, the helical radiates in both the cellular and digital frequency bands. At cellular band, the helical is approximately &lgr/ and presents a 50 ohm impedance to antenna input of the phone, while in the digital frequency band the coil is &lgr/with an impedance of about 600 ohms and is matched to the pone's antenna input impedance via conventional matching techniques. This phenomena is also exhibited in the extended position with only the elongate radiating.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other features and advantages of the invention will be apparent to those skilled in the art with reference to the detailed description and the drawings, of which:

[0009] **FIG. 1** is a cross-sectional view of a fully assembled antenna with a elongate radiator located in a fully extended position according to the present invention; and

[0010] **FIG. 2** is a cross-sectional view of the antenna with the elongate radiator located in a fully retracted position according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0011] Turning now to the drawings, and particularly **FIG. 1, a** retractable antenna indicated generally as **10** is shown for a portable communicator such as a Cell phone. An elongate radiator **12** of the antenna moves by sliding through a helical radiator **14** to alternately make electrical contact to a conductive ferrule **16**. In particular, the ferrule **16** alternately contacts either the elongate radiator **12** and the helical radiator **14** depending on a position of the elongate radiator **12** relative to the helical radiator **14**. At the cellular frequency band the elongate radiator and helical radiator are &lgr/ long when extended and &lgr/ long when retracted. This gives the engineer impedance flexibility and allows single or multiple band design. It should be noted that multiple band antennas require additional matching components in the form of discrete components.

[0012] In addition to making electrical contact to the radiators (**12, 14**), the ferrule **16** couples to a Cell phone or other device through threads **18** to electrically and mechanically connect the antenna with phone circuits. Engineers will appreciate that the mechanical mounting of the ferrule to the phone may be modified so long as radiators of the antenna are able to alternately make electrical contact with the ferrule **16**.

[0013] The present invention also includes a bumper **20** responsive to movement of the elongate radiator **12** into a contact position with the ferrule **16**, to disengage the helical

conductor **14**. A bottommost turn **22** of the helical radiator **14** securably snap fits into the bumper **20** which must be produced of a non conductive material in embodiments like the one shown in **FIGS. 1 and 2**. This helps prevent jamming because the non conductive bumper **22** is always partially connected by the ferrule **16**. However, in alternate embodiments the bumper **22** may be produced from conductive material. Also, a snap fit is desirable, but not necessary, since the bumper **20** need only be capable to engage and compress the helical radiator **14**.

[**0014**] A diameter of the helical radiator **14** preferably tapers toward the ferrule **16** so that the bottommost turn **22** fits by sliding into a corresponding recess **24** of the ferrule **16** to make electrical contact with the ferrule. The taper allows the helical radiator **14** to fit within the recess **24** of the ferrule **16** and to expand while the helical radiator **14** is under a compressive force. It is also contemplated, however, that a top edge **26** of the ferrule **16** does not contain a recess **24** and the helical radiator **14** electrically contacts the top edge **26** of the ferrule **16**.

[**0015**] Attached to the ferrule **16** is a hollow sheath **28** which mechanically connects to the ferrule **16**. As shown, the ferrule **16** connects near a bottom end **30** of the sheath **28**. To connect the sheath **28** to the ferrule **16**, it is preferred that the ferrule **16** snap fits into the sheath **28**, but alternately the sheath **28** may be injection molded onto the ferrule **16**. To accommodate snap fitting, the ferrule **16** includes at least one detent **32** that corresponds to at least one projection **34** on the sheath **28**. Engineers will appreciate, however, that the ferrule **16** could include a projection and the sheath **28** could include a corresponding detent. Snap fitting is a preferred method of connecting components of the present invention since such an operation reduces the cost and difficulty in assembling the pieces.

[**0016**] Snap fit assembly is also preferably utilized to secure a core **36** to an inside surface **38** of the sheath **28**. To accommodate assembly, the core includes at least one projection **40** that corresponds to at least one detent **42** in the sheath **28**. It can be appreciated, however, that the sheath can include the projection and the core can include the detent. At least an upper portion **44** of the helical radiator **14** is held between the core **36** and the sheath **28**, and a lower portion **46** extends into a space between the core **36** and the ferrule **16** to electrically contact the ferrule **16**. Preferably, to hold the upper portion **44** of the helical radiator **14** in place, an outer surface of the core **36** includes threads **48** that accommodate the upper portion **44** of the helical radiator **14**. Moreover, the lower portion **46** of the helical radiator **14** is free from the core **36** to allow compression of the lower portion **46** of the helical radiator **14** when the bumper **20** moves away from the ferrule **16**.

[**0017**] Also included in the core **36** is the elongate radiator **12** which is positioned to slide through the core **36** and the ferrule **16** and electrically contact the ferrule **16** when, for example, located in a fully extended position as displayed in **FIG. 1**. To electrically contact the ferrule **16**, the elongate radiator **12** includes a contact element **50**. The contact element **50** includes a lip **52** to stop the extension of the elongate radiator **12** when the lip **52** abuts the ferrule **16**. Located above the contact element **50** is a pusher **54** (best shown in **FIG. 2**) to displace the bumper **20** and disengage the helical radiator **14** from electrical contact with the ferrule **16** when the elongate radiator **12** is moved into the fully extended position. The pusher **54** is sized to fit through the ferrule **16** and tapered at its top to avoid mechanically jamming when the elongate radiator **12** is moved to the fully extended position.

[**0018**] Referring now to **FIG. 2**, the elongate radiator **12** is shown in a fully retracted position. Since the helical radiator **14** is under a compression force when pushed away from the ferrule **16**, the helical radiator **14** expands to engage the ferrule **16** and resume electrical contact with the ferrule **16** as soon as the elongate radiator **12** disengages therefrom. When the elongate radiator **12** disengages from the ferrule **16**, the pusher **54** moves away from the bumper **20** and the compressed helical radiator **14** expands to push the bumper **20** towards the ferrule **16**. As the bumper **20** sits in the ferrule **16**, the bottommost turn **22** electrically contacts the ferrule **16** to make contact with the ferrule **16** immediately as the elongate radiator **12** begins to retract and disengage from electrical contact with the ferrule **16**. Preferably, the helical radiator is still slightly compressed when reaching the ferrule **16**, so the spring force exerted on the ferrule **16** assures good electrical contact.

[**0019**] From the foregoing description, it should be understood that an improved antenna has been shown and described which has many desirable attributes and advantages. The antenna is adapted to make electrical contact with phone circuits while in a fully retracted position, a fully extended position, and positions therebetween. Additionally, components of the antenna are snap fit together to reduce a cost of manufacturing and increase ease of assembly.

[**0020**] Other alterations and modifications will be apparent to those skilled in the art. Accordingly, the scope of the invention is not limited to the specific embodiments used to illustrate the principles of the invention. Instead, the scope of the invention is properly determined by reference to the appended claims and any legal equivalents thereof.

What is claimed is:

1. A retractable antenna for a portable communicator, the antenna comprising:

a hollow sheath;

a core secured to an inside surface of said sheath;

a conductive ferrule secured at an end of said sheath;

an elongate radiator positioned to slide in said core and said ferrule and electrically contact said ferrule when located in a first position;

a bumper slidably positioned to move in a space between said core and near said ferrule;

a helical radiator held between said core and said sheath and extending partially into the space between said ferrule and said core to electrically contact said ferrule; and

a pusher element disposed on said elongate radiator to slidably displace said bumper and disengage said bottom end of said helical radiator from said ferrule when said elongate radiator is located in said first position.

2. The antenna according to claim 1, wherein at least one of said helical radiator and said elongate radiator make electrical contact with said ferrule for any position. of said elongate radiator.

3. The antenna according to claim 1, wherein the antenna is constructed with snap fit assembly.

4. The antenna according to claim 3, wherein said core snap fits into said sheath.

5. The antenna according to claim 4, wherein said sheath includes at least one detent that corresponds to at least one projection on said core to accommodate snap fit construction.

6. The antenna according to claim 3, wherein said ferrule snap fits into said sheath.

7. The antenna according to claim 6, wherein said ferrule includes at least one detent that corresponds to at least one projection on said sheath to accommodate snap fit construction.

8. The antenna according to claim 3, wherein at least a bottommost turn of said helical radiator snap fits into said bumper.

9. The antenna according to claim 1, wherein said sheath is molded onto said ferrule.

10. The antenna according to claim 1, wherein an outer surface of said core includes threads to accommodate at least a portion of said helical radiator such that said threads hold said helical radiator in place.

11. The antenna according to claim 1, wherein said first position of said elongate radiator is a fully extended position relative to the portable communicator.

12. The antenna according to claim 1, wherein said helical radiator contacts said ferrule when said elongate radiator is first disengaged from said ferrule.

13. The antenna according to claim 1, wherein said bumper is produced of a nonconductive material.

14. The antenna according to claim 1, wherein at least part of said bumper moves within said ferrule.

15. The antenna according to claim 1, wherein said elongate radiator has a contact located at a bottom end of said elongate radiator.

16. The antenna according to claim 15, wherein said pusher is located above said elongate radiator contact.

17. The antenna according to claim 16, wherein said pusher is sized to pass through said ferrule.

18. The antenna according to claim 1, wherein a diameter of said helical radiator tapers towards said ferrule.

19. The antenna according to claim 18, wherein said tapered helical radiator fits in a portion of said ferrule.

20. A retractable antenna for a portable communicator, the antenna comprising:

an elongate radiator with a pusher element formed thereon, said elongate radiator electrically contacting a ferrule when said elongate radiator is located in a first position;

a helical radiator electrically contacting said ferrule in an extended state; and

a bumper element attached to at least a bottommost turn of said helical radiator, said bumper being displaced by said pusher element to compress and disengage said helical radiator from said ferrule when said elongate radiator is moved into said first position.

21. The antenna according to claim 20, wherein at least one of said helical radiator and said elongate radiator make electrical contact with said ferrule for any position of said elongate radiator.

22. The antenna according to claim 20, wherein said first position of said elongate radiator is a fully extended position relative to the portable communicator.

23. A retractable antenna for a portable communicator, the antenna comprising:

an elongate radiator slidably movable through a helical radiator;

an electrical contact alternately contacting one of said elongate radiator and said helical radiator depending on a position of said elongate radiator relative to said helical radiator; and

a disengager responsive to movement of said elongate radiator into a contact position with said electrical contact to disengage said helical conductor.

24. The antenna according to claim 23, wherein said helical radiator is under a compression force when disengaged from said electrical contact.

25. The antenna according to claim 23, wherein said helical radiator engages said electrical contact as soon as said elongate radiator disengages from said contact position.

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