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Paulick

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[54] **RECEIVER HAVING CONCEALED EXTERNAL ANTENNA**

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Related U.S. Application Data

[63] Continuation of Ser. No. 23,234, Feb. 25, 1993, abandoned.

[51] **Int. Cl.**[6] **H04B 1/03**; H04B 1/08

[52] **U.S. Cl.** **455/90**; 455/128; 455/129; 455/349; 455/351; 343/702; 361/814

[58] **Field of Search** 455/89, 90, 128, 455/129, 269, 280, 347–351; 379/57, 58, 61, 433; 340/311.1, 825.44; 343/702; 361/814

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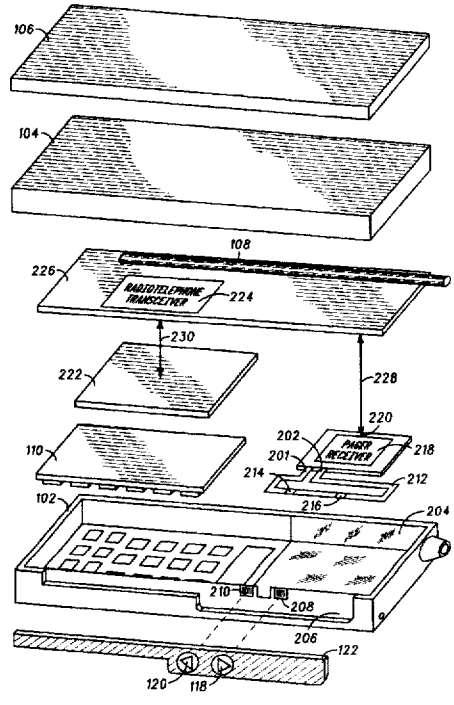
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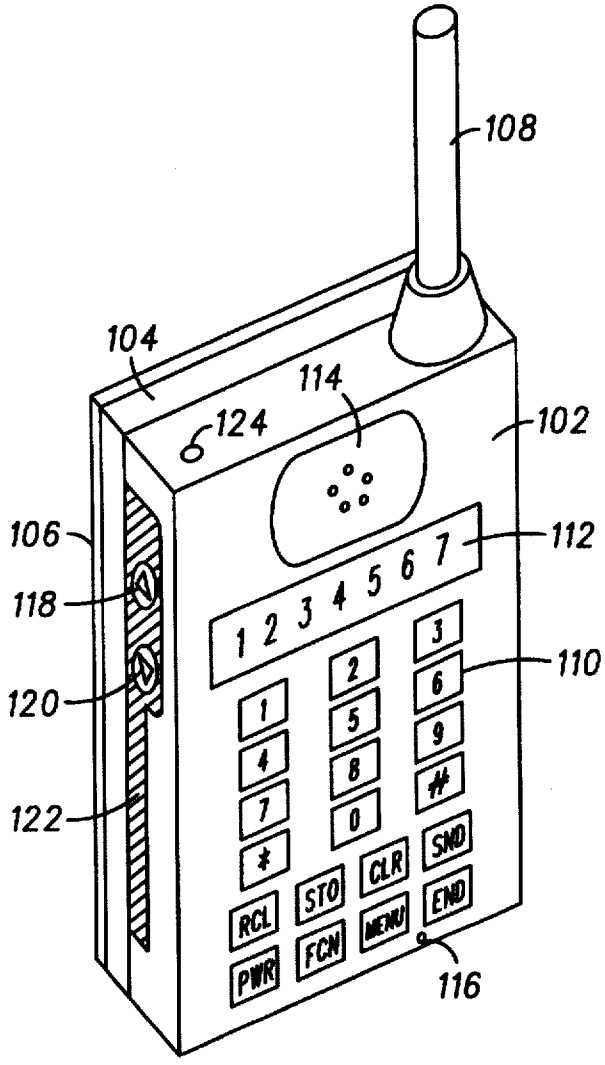
Primary Examiner—Chi H. Pham
Attorney, Agent, or Firm—Kevin D. Kaschke

[57] **ABSTRACT**

A radiotelephone/pager unit (**100**) includes a housing enclosing (**102**, **104**) radiotelephone circuitry (**224**) coupled to a radiotelephone antenna (**108**) operable at radiotelephone frequencies and pager circuitry (**218**) coupled to a pager antenna (**212**) operable at pager frequencies. The radiotelephone antenna (**108**) is located outside the housing (**102**, **104**) in a conventional manner. The pager antenna (**212**) is located outside the housing (**102**, **104**) and concealed under or integrally formed with a hand grip (**122**), a display lens (**402**), an escutcheon (**502**), a keypad (**110**), or a cap (**601**) such that the pager antenna's presence is unnoticeable to a user. The pager antenna (**212**) forms a loop antenna substantially surrounding a user interface element such as a display (**112**), a keypad (**110**), an earpiece (**114**) or volume control buttons (**118**, **120**) to minimize space.

23 Claims, 5 Drawing Sheets

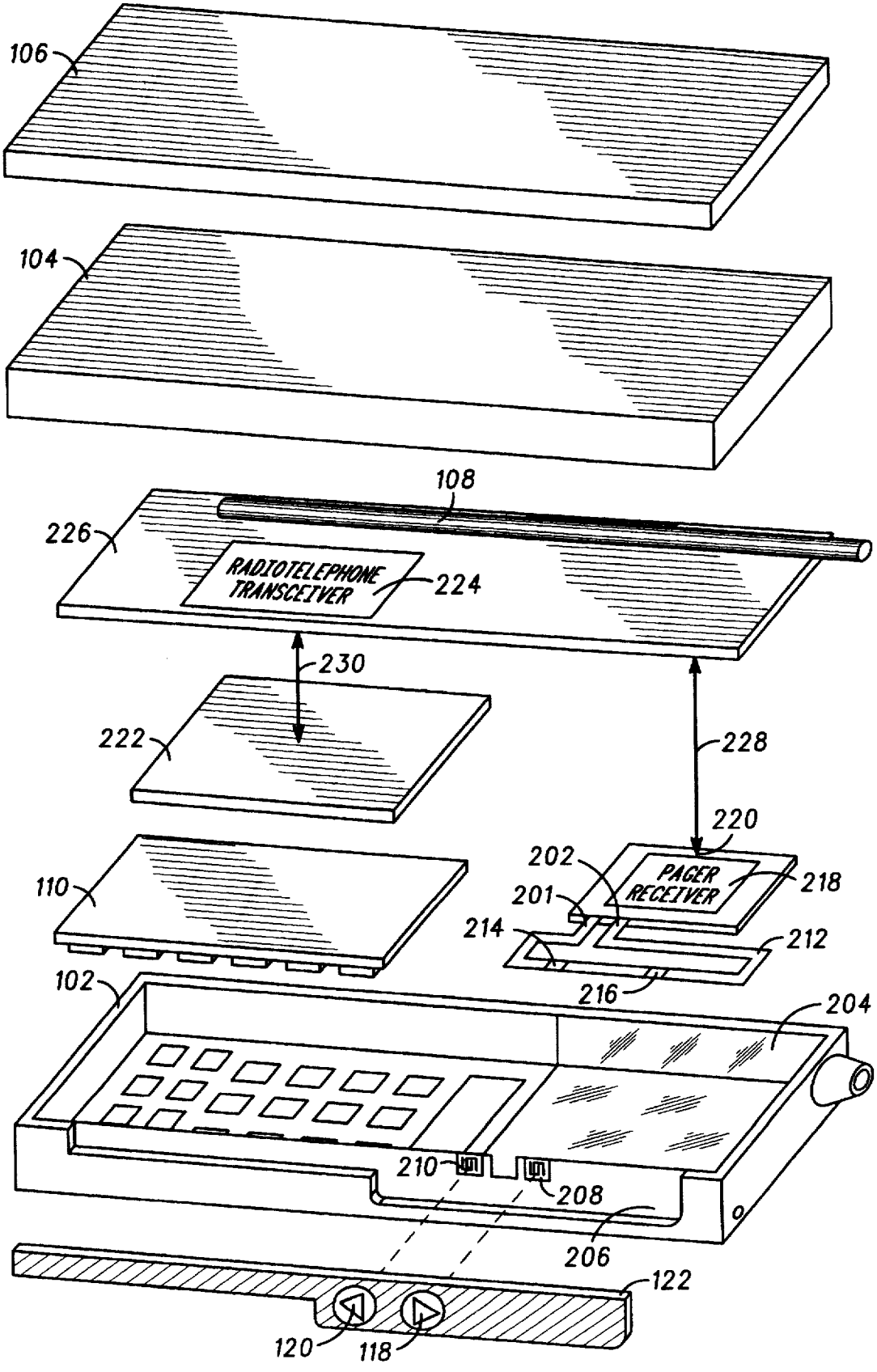



108
104
114
124
102
106
112
118
1 2 3 4 5 6 7
110
120
122
RCL
STO
CLR
SND
PWR
FCN
MENU
END
116

100

FIG. 1

FIG. 2


106
104
108
226
RADIOTELEPHONE TRANSCEIVER
224
230
222
228
220
110
202
PAGER RECEIVER
218
201
214
212
216
102
204
210
208
206
122
120
118

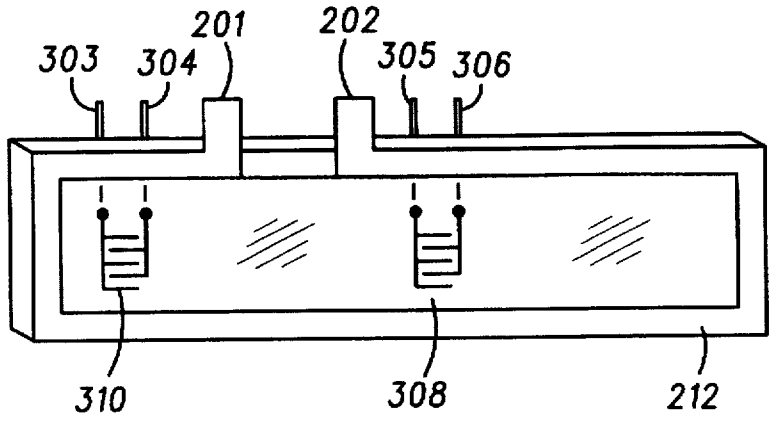

303
304
201
202
305
306
310
308
212

FIG. 3

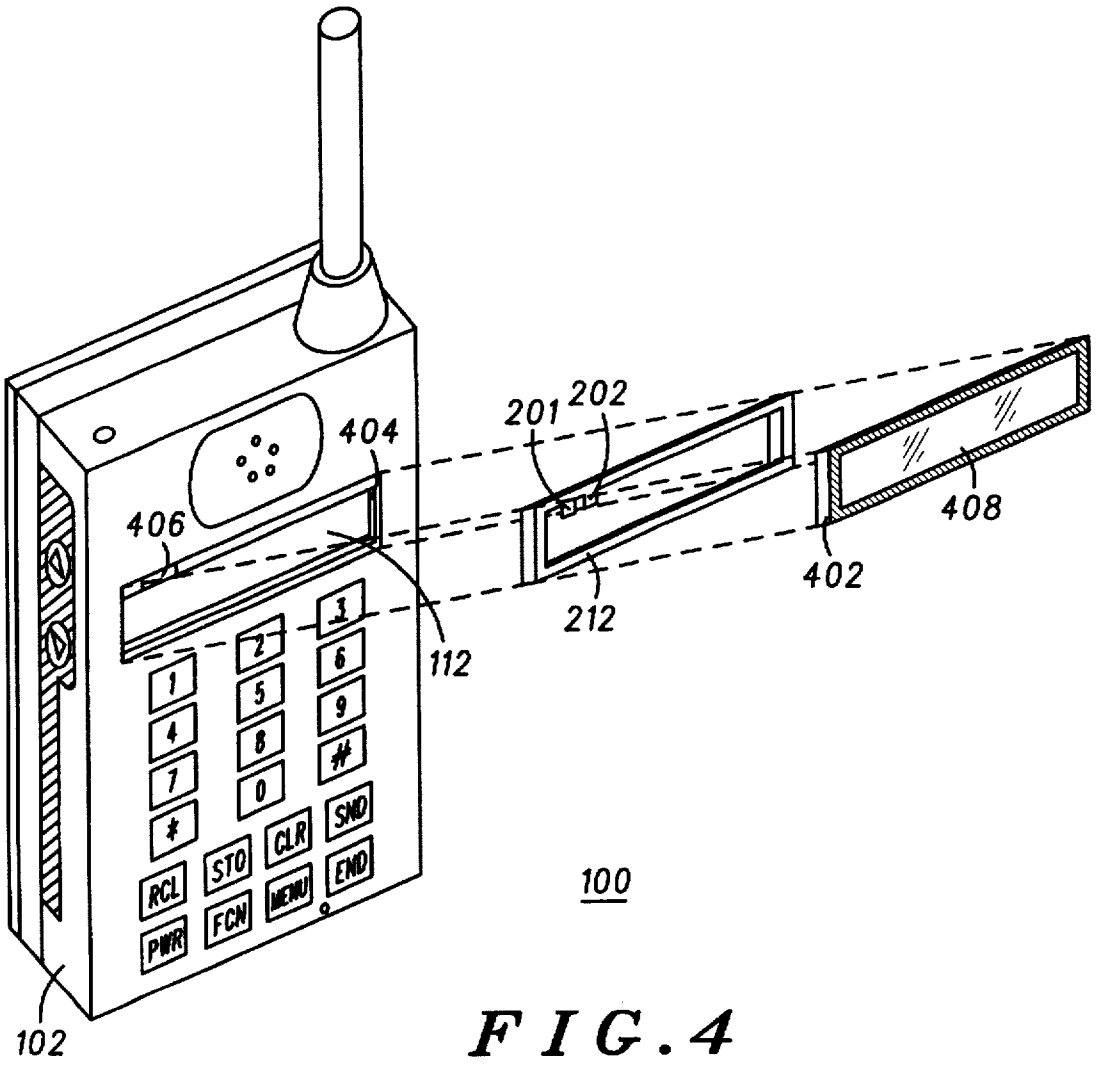

404
406
201
202
408
402
212
112
1
2
3
4
5
6
7
8
9
*
0
#
RCL
STO
CLR
SND
PWR
FCN
MENU
END
100
102

FIG. 4

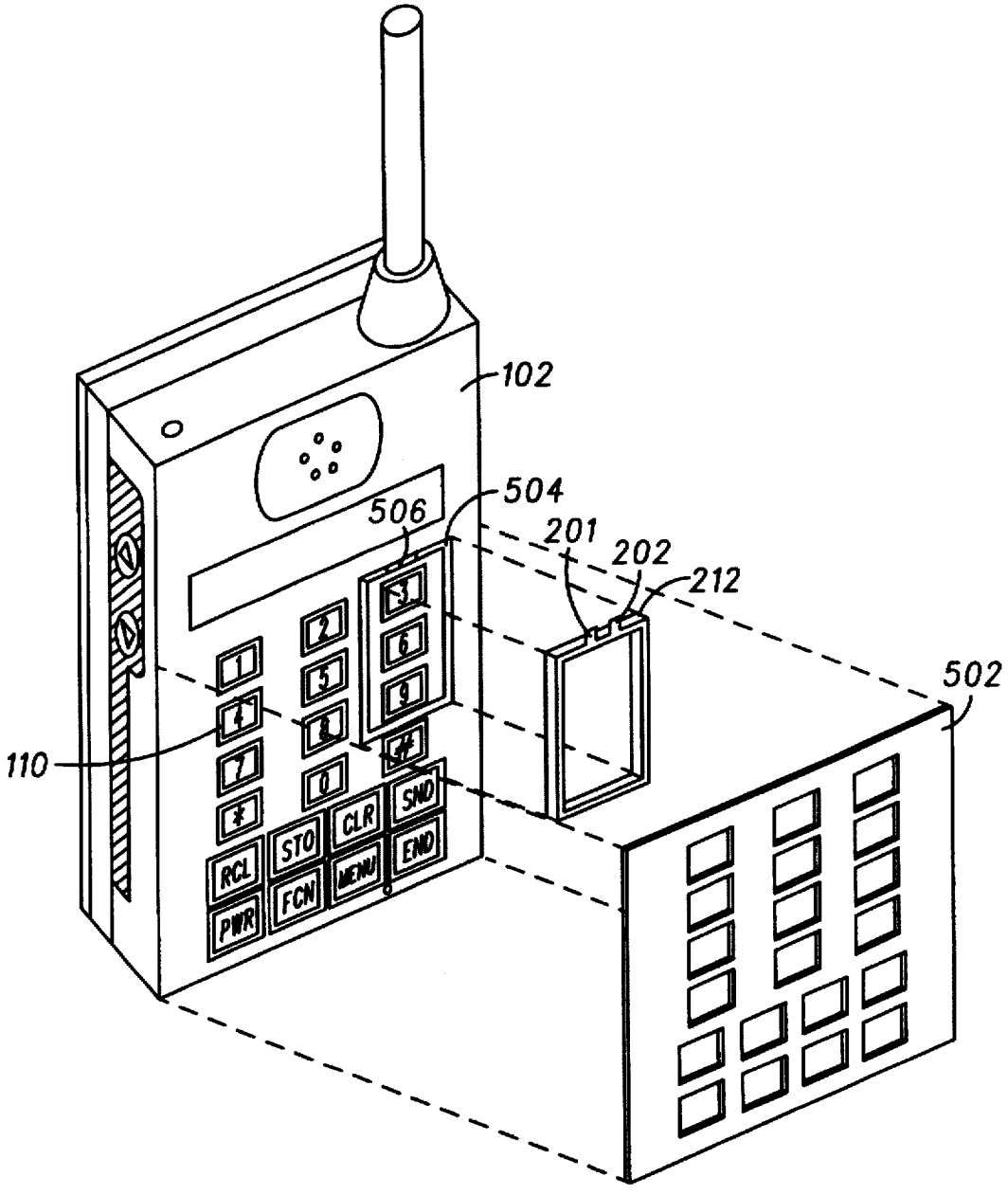


FIG. 5

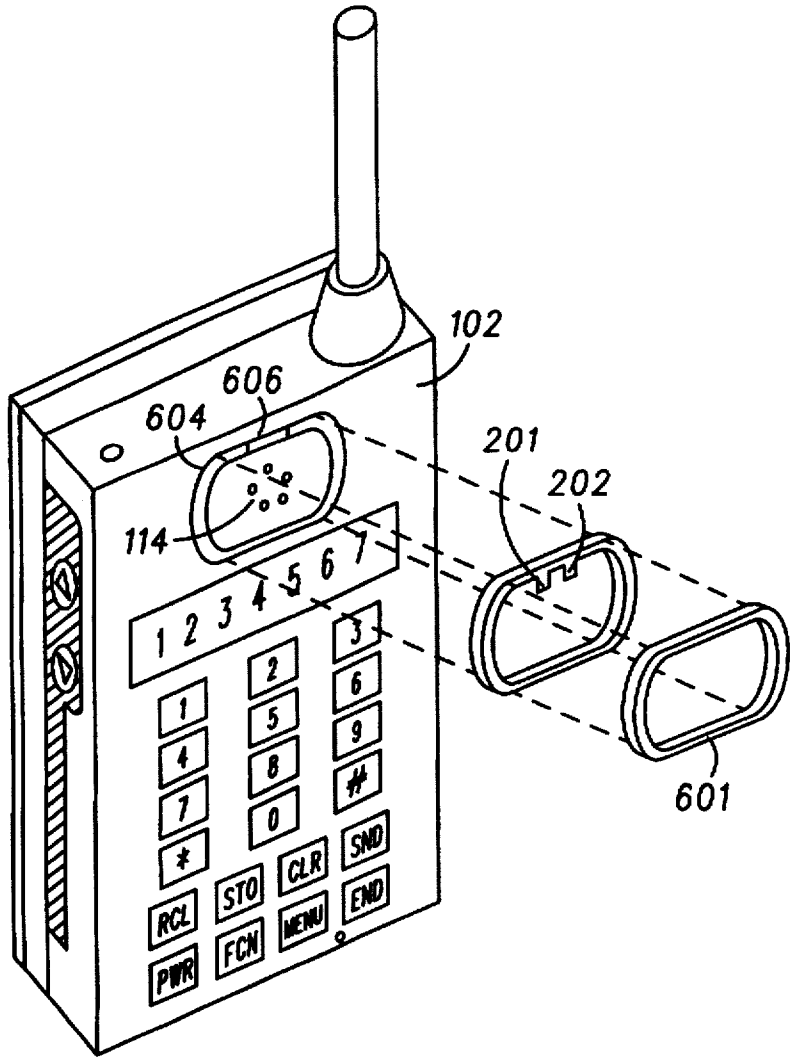

102
606
604
201
202
114
1 2 3 4 5 6 7
1
2
3
4
5
6
7
8
9
*
0
#
RCL
STO
CLR
SND
PWR
FCN
MENU
END
601

FIG. 6

RECEIVER HAVING CONCEALED EXTERNAL ANTENNA

This is a continuation of application Ser. No. 08/023,234, filed Feb. 25, 1993 and now abandoned.

FIELD OF THE INVENTION

The present invention relates generally to antennas and more particularly to concealment of a pager antenna external to a radiotelephone/pager unit.

BACKGROUND OF THE INVENTION

Paging systems And radiotelephone systems, such as cellular radiotelephone systems, have gained widespread acceptance over the years. The trend in growth of these systems has continued to be positive, especially as the technology has evolved to enable reductions in the size and weight of pagers and portable cellular radiotelephones. Many of the users of portable cellular radiotelephones have continued to be users of pagers, which has resulted in the requirement that those users carry not only a portable cellular radiotelephone but also a pager. With the trend in technology continuing to enable further miniaturization of both portable cellular radiotelephones and pagers, it is now possible to combine both elements into a single portable unit. Such a combination, however, has been shown to create problems not previously encountered when both the portable cellular radiotelephone and the pager were separate units.

The portable radiotelephone typically has an antenna outside an at least partially shielded housing for transmitting and receiving radio frequency signals at radiotelephone frequencies. The pager typically has an antenna inside an unshielded housing for receiving radio frequency signals pager frequencies. When a pager is combined with the portable radiotelephone into a single unit, the location of the radiotelephone antenna and the pager antenna is considered.

The most likely place for the radiotelephone's antenna is at its conventional location outside the radiotelephone housing. Consideration is given to the location of the pager's antenna both inside and outside the radiotelephone's housing. The pager antenna can not be located inside the radiotelephone's shielded housing portion, since the shielded housing would prevent the pager's antenna from receiving paging signals. The pager's antenna can be located inside an unshielded portion of the radiotelephone's housing, however, the compactness of a single unit makes unshielded locations rare. Furthermore, remotely locating the pager's antenna from the pager circuitry to reach an unshielded location produces inefficiencies in the pager's antenna. The pager antenna can be located outside the radiotelephone's housing. However, locating the pager antenna in addition to the radiotelephone antenna outside the radiotelephone's housing would change the external appearance of the radiotelephone and possibly increase its size.

Thus, there is a need for a beneficial location for the pager antenna without compromising the antenna's performance or the appearance and size of the unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a radiotelephone/pager unit constructed in accordance with the present invention.

FIG. **2** is an exploded view of the radiotelephone/pager unit of FIG. **1** showing a first location of a pager antenna.

FIG. **3** is a perspective view of the pager antenna of FIG. **2** integrally formed with switch contacts.

FIG. **4** is an exploded view of the radiotelephone/pager unit of FIG. **1** showing a second location of the pager antenna.

FIG. **5** is an exploded view of the radiotelephone/pager unit of FIG. **1** showing a third location of the pager antenna.

FIG. **6** is an exploded view of the radiotelephone/pager unit of FIG. **1** showing a fourth location of the pager antenna.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**, there is shown a perspective view of a combination radiotelephone/pager unit **100** constructed in accordance with the present invention. The unit **100** generally includes: a front housing **102**, a back housing **104**, a battery **106**, a radiotelephone antenna **108**, a keypad **110**, a display **112**, an earpiece **114**, a microphone **116**, volume control buttons **118** and **120**, a hand grip **122** and an alert **124**.

The external appearance and functionality of the unit's radiotelephone portion is similar to that of a conventional portable cellular radiotelephone, model number 1293A, manufactured and available from Motorola, Inc. The functionality of the unit's pager portion is similar to that of a conventional pager, named "Bravo", also manufactured and available from Motorola, Inc. The user interface such as the keypad **110**, volume control buttons **118** and **120**, display **112** and alert **124** are commonly used by both the radiotelephone portion and the pager portion of the unit **100**.

The unit **100** uses the radiotelephone antenna **108** to conventionally transmit and receive radiotelephone signals at radiotelephone frequencies. The unit **100** uses a pager antenna (not shown in FIG. 1) to conventionally received pager signals at pager frequencies.

A unique element of the present invention which will be shown and discussed later in the preferred embodiments of the present invention is that the pager antenna is located outside the radiotelephone's housing and yet not noticeable to a user. The following preferred embodiments of the present invention will show the pager's antenna being concealed by covers forming conventional radiotelephone parts including but not limited to the hand grip **122**, the keypad **110**, a lens of the display **112** and also by a cap secured to the front housing **102**. Benefits of concealing the pager antenna with these covers outside the radiotelephone's housing include maintaining the radiotelephone's external appearance, having the pager's antenna outside any shielded portion of the radiotelephone's housing and keeping the pager's antenna close to the pager's circuitry. The following preferred embodiments of the present invention will also show the pager's antenna forming a loop substantially surrounding the tactile, visual and acoustic user interface of the unit **100** including but not limited to the volume control buttons **118** and **120**, the keypad **110**, the display **112**, and the earpiece **102**. Surrounding user interface of the unit **100** with a loop antenna beneficially minimizes the space consumed by the antenna for the unit **100**.

Referring now to FIG. **2** there is shown an exploded view of the radiotelephone/pager unit **100** of FIG. **1** showing a first preferred location of a pager antenna. FIG. **2** generally includes: the hand grip **122** having the volume control buttons **118** and **120**, the front housing **102** including a shielded portion **204**, a recess **206** and discrete volume control contacts **208** and **210**, a pager antenna **212** including capacitors **214** and **216**, pager receiver circuitry **218** on a printed circuit board **220**, the keypad **110**, a keypad printed

circuit board **222**, radiotelephone transceiver circuitry **224** on a printed circuit board **226**, the radiotelephone's antenna **108**, the rear housing portion **104** and the battery **106**.

The radiotelephone's antenna **108** is coupled to the radiotelephone's transceiver circuitry **224** for transmitting and receiving radio frequency signals at radiotelephone frequencies. The pager antenna **212** is coupled to the pager receiver circuitry via terminals **201** and **202** for receiving radio frequency signals at pager frequencies. Arrow **228** represents electrical interconnection between the pager receiver circuitry **218** and the radiotelephone transceiver circuitry **224**. Arrow **230** represents electrical interconnection between the keypad printed circuit board **222** and the radiotelephone transceiver circuitry **224**. All of the elements of FIG. **2** with the exception of the pager's antenna **212** are conventionally assembled to produce the completed unit **100**. Note that although three printed circuit boards **220**, **222** and **226** are shown in FIG. **2**, they are permitted to be combined into one circuit assembly if desirable.

The pager antenna **212** forms a conventional loop antenna having tuning capacitors **216** and **214** permitting adjustment of the loop antenna. The loop antenna is used for its space saving attributes in confined areas. Preferably, the loop antenna is formed as a conductive pattern disposed on a insulated substrate, such as a conventional circuit board.

The first preferred location of the pager antenna **212** is disposed outside the shielded portion **204** of the front housing **102**, under the hand grip **122** and surrounding the volume control buttons **118** and **120** and their corresponding contacts **208** and **210**. The pager antenna **212** is disposed in a recess **206** formed in the front housing portion **102** such that the presence of the pager's antenna under the hand grip **122** is unnoticeable to the user. When the pager antenna and the hand grip **122** are assembled with the front housing **102**, the hand grip **122** maintains an essentially planar position with respect to the front housing **102**.

Referring now to FIG. **3**, there is shown a perspective view of the pager antenna of FIG. **2** integrally formed with the contacts **208** and **210** to produce integral contacts **308** and **310**. The pager antenna **212** formed as a conductive pattern loop and the contacts **308** and **310** are formed as conductive patterns disposed on an insulated substrate such as a circuit board. Terminals **201** and **202** provide coupling for the loop antenna and terminals **303–306** provide coupling for the integral contacts **308** and **310**. This design approach provides the advantages of lower parts count, cost and assembly time over the discrete contacts **208** and **210** of FIG. **2**.

Referring now to FIG. **4**, there is shown an exploded view of the radiotelephone/pager unit **100** of FIG. **1** showing a second preferred location of the pager antenna **212**. The second preferred location of the pager antenna **212** is disposed outside the front housing **102**, under a display lens **402** and surrounding the display **112**. The pager antenna forms a loop antenna configured to be disposed on a recessed ledge **404**. The pager antenna terminals **201** and **202** couple to the pager receiver circuitry **218** via a hole **406** in the front housing **102**. The display lens **402** has has opaque boarder **408** for concealing the pager antenna **212** under the display lens **402**. Note that with the location of the pager receiver circuitry at the earpiece end of the unit **100**, the pager antenna at the display area remains close to the pager receiver circuitry.

Referring now to FIG. **5**, there is shown an exploded view of the radiotelephone/pager unit of FIG. **1** showing a third preferred location of the pager antenna. The third preferred location of the pager antenna **212** is disposed outside the front housing **102**, under an escutcheon **501** and surrounding a portion of the keypad **110**. The pager antenna forms a loop antenna configured to be disposed in a recess **504**. The pager antenna terminals **201** and **202** couple to the pager receiver circuitry **218** via a hole **506** in the front housing **102**. The escutcheon **502** has an opaque surface for concealing the pager's antenna **212** under the escutcheon **502**. Note that this location of the pager antenna is close to pager receiver circuitry located under the keypad **110** of the unit **100**. The escutcheon **502** for the keypad **110** is generally considered to be a separate cover attachable to the unit **100** including but not limited to a nameplate. An alternative practice for concealing the pager antenna that is equivalent to using the escutcheon is a membrane keypad wherein at least the top surface of the keypad exposed to the user covers not only the pager antenna **212** but also the portion of the front housing **102** between individual keypad buttons.

Referring now to FIG. **6**, there is shown an exploded view of the radiotelephone/pager unit **100** of FIG. **1** showing a fourth preferred location of the pager antenna. The fourth preferred location of the pager's antenna **212** is disposed outside the front housing **102**, under a cap **601** and surrounding the earpiece **104**. The pager's antenna forms a loop antenna configured to be disposed in a recess **604**. The pager's antenna terminals **201** and **202** couple to the pager receiver circuitry **218** via a hole **606** in the front housing **102**. The cap **601** has an opaque surface, preferably matching the front housing, for concealing the pager's antenna **212** under the cap **601**. The cap **601** is attachable to the front housing **102** and shaped to provide styling for the unit **100**. Note that this location of the pager antenna is dose to pager receiver circuitry located in the earpiece portion of the unit **100**. Note that the earpiece **114** represents any electroacoustic transducer including but not limited to the microphone **116** and the alert **124**.

The discussion for each of the four preferred locations for the pager's antenna describe the pager antenna being located within a recess of the front housing **102**. An alternative design to the housing recess producing an equivalent result as the housing recess is to place the recess in the part itself (i.e. a recess in the hand grip **122**, lens **402**, escutcheon **502** and the cap **601**) rather than in the front housing **102**. Additionally, the pager antenna may also be integrally formed with the part rather than being a separate part. This is accomplished by molding or assembling the loop antenna into the the hand grip **122**, lens **402**, escutcheon **502**, keypad **110** and the cap **601**, for example.

Although the preferred embodiments disclose the pager antenna as a loop antenna for space saving benefits, other antenna structures such as a dipole antenna producing substantially equivalent results may be substituted.

What is claimed is:

1. A combination radiotelephone/pager unit including a user interface, comprising:

a housing enclosing radiotelephone and pager circuitry;

a radiotelephone antenna coupled to the radiotelephone circuitry; and

a pager antenna coupled to the pager circuitry;

wherein the pager antenna forms a loop surrounding at least a portion of the user interface and is disposed between an outside surface of the housing and the at least a portion of the user interface.

2. A combination radiotelephone/pager unit according to claim **1** further comprising a shield for shielding at least one of the radiotelephone and pager circuitry.

3. A combination radiotelephone/pager unit according to claim 1 wherein the user interface further comprises at least one of the following: an acoustic, a visual and a tactile interface.

4. A combination radiotelephone/pager unit according to claim 3 wherein the acoustic, visual and tactile interface further comprises an electroacoustic transducer, a display and a switch, respectively.

5. A combination radiotelephone/pager unit according to claim 1 wherein the pager antenna is integrally formed with at least a portion of the user interface.

6. A combination radiotelephone/pager unit comprising:

radiotelephone and pager circuitry;

a housing substantially enclosing the radiotelephone and pager circuitry;

an electromagnetic shield, disposed in the housing and at least partially covering at least one of the radiotelephone and pager circuitry, formed of an electrically conductive, electromagnetic wave-absorbing material for absorbing electromagnetic energy radiated by or towards the at least one of the radiotelephone and pager circuitry;

a radiotelephone antenna coupled to the radiotelephone circuitry;

a pager antenna coupled to the pager circuitry, carried on an outside, nonconductive surface of the housing and disposed outside the electomagnetic shield; and

a substantially planar and detachable cover, attached to the outside, nonconductive surface of the housing, for concealing the pager antenna between the cover and the outside, nonconductive surface of the housing such that the pager antenna is unnoticeable to a user of the unit.

7. A combination radiotelephone/pager unit according to claim 6 wherein the cover further comprises at least one of the following: a hand grip, a keypad, a lens, an escutcheon, a keypad and a cap.

8. A combination radiotelephone/pager unit according to claim 6 wherein the pager antenna is disposed between the outside surface of the housing and the cover.

9. A combination radiotelephone/pager unit according to claim 6 wherein the pager antenna is integrally formed with the cover.

10. A combination radiotelephone/pager unit according to claim 9 wherein the user interface further comprises at least one of the following: an acoustic, a visual and an active interface.

11. A combination radiotelephone/pager unit according to claim 10 further comprises a user interface substantially surrounded by the loop antenna.

12. A combination radiotelephone/pager unit according to claim 11 wherein the user interface further comprises at least one of the following: an acoustic, a visual and a tactile interface.

13. A receiver including a user interface comprising:

a housing;

receiver circuitry disposed in the housing; and

an antenna coupled to the receiver circuitry;

wherein the antenna forms a loop surrounding at least a portion of the user interface and is disposed between an outside surface of the housing and the at least a portion of the user interface.

14. A receiver according to claim 13 wherein the user interface further comprises at least one of the following: an acoustic, a visual and a tactile interface.

15. A receiver according to claim 14 wherein the acoustic, visual and tactile interface further comprises an electroacoustic transducer, a display and a switch, respectively.

16. A receiver according to claim 13 wherein the antenna is integrally formed with at least a portion of the user interface.

17. A receiver comprising:

receiver circuitry;

a housing substantially enclosing the receiver circuitry;

an electromagnetic shield, disposed in the housing and at least partially covering the receiver circuitry, formed of an electrically conductive, electromagnetic wave-absorbing material for absorbing electromagnetic energy radiated by or towards the receiver circuitry;

an antenna coupled to the receiver circuitry, carried on an outside, nonconductive surface of the housing and disposed outside the electomagnetic shield; and

a substantially planar and detachable cover, attached to the outside, nonconductive surface of the housing, for concealing the antenna between the cover and the outside, nonconductive surface of the housing such that the antenna is unnoticeable to a user of the receiver.

18. A receiver according to claim 17 wherein the cover further comprises at least one of the following: a hand grip, a keypad, a lens, an escutcheon, a keypad and a cap.

19. A receiver according to claim 17 wherein the antenna is disposed between the outside surface of the housing and the cover.

20. A receiver according to claim 17 wherein the antenna is integrally formed with the cover.

21. A receiver according to claim 17 wherein the antenna further comprises a loop antenna.

22. A receiver according to claim 21 further comprises a user interface substantially surrounded by the loop antenna.

23. A receiver according to claim 22 wherein the user interface further comprises at least one of the following: an acoustic, a visual and a tactile interface.

* * * * *