

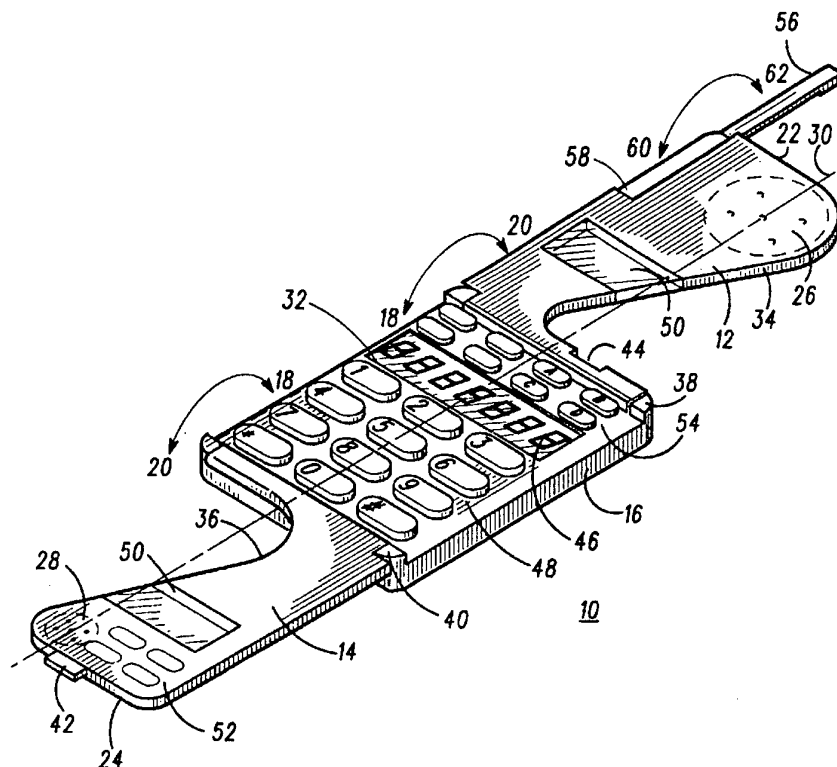
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: HOUSING ASSEMBLY FOR A WIRELESS COMMUNICATION DEVICE

## (57) Abstract

A wireless communication device (10) is provided for maintaining acceptable acoustic coupling, increasing display and data input device capability and increasing antenna performance to encourage further miniaturization and weight reduction thereof. Two moveable housing portions (12) and (14) are moveable between a closed (18) and an open (20) housing position and matively engage to provide an expandable housing while aligning earpiece (26) and microphone (28) transducers on a center axis (30) of the device (10). Paging and radiotelephone functions of the device are configured responsive to the position of the housing portion (12). The housing portion has a lens for viewing a display (46) thereunder and keycaps for actuating a keypad (54) thereunder when the housing portion (12) is in the closed housing position (18). An antenna (56) is extendable beyond the moveable housing portion (12).



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## Housing Assembly for a Wireless Communication Device

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### Field of the Invention

10       The present invention relates generally housing assemblies and, more particularly, to housing assemblies as used with wireless communication devices.

### Background of the Invention

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Advances in computing, wireless transceivers, displays, data input devices, batteries, materials and mechanics have promoted the miniaturization and weight reduction of wireless communication devices such as portable radiotelephones. However, there are tradeoffs associated with the advantages of such miniaturization.

Firstly, smaller devices result in a shorter distance between the earpiece and microphone transducers. Since the  
25       typical distance between a human ear and mouth remains unchanged, acceptable acoustic coupling between the earpiece transducer and the human ear, and between the microphone transducer and the human mouth is becoming more difficult to maintain. Various solutions have addressed this problem  
30       by slidably or rotatably coupling one or more moveable housing elements to the main body portion of the radiotelephone. The housing elements have earpiece or microphone transducers disposed therein. The distance between the earpiece and microphone transducers is increased by moving the housing  
35       element to an open position during use and decreased by

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moving the housing element to a closed position when not in use. Thus, reliable acoustic coupling is achieved when the radiotelephone is in use without compromising miniaturization when the radiotelephone is not in use.

- 5 Examples of these solutions are shown in U.S. Patent Nos.: D297,735, D297,734, D326,091, D326,451, D326,452, D298,244, D305,427, D300,827, D300,742, D304,189 and D297,736. However, as the devices become even smaller, the distance between the earpiece and microphone becomes even shorter and the  
10 acceptable acoustic coupling is even more difficult to maintain.

- Secondly, smaller devices have less space for display and data input devices, such as keypads. The smaller devices  
15 have compromised these functions by making display characters and input keys smaller and thus harder to use. Additionally, the market for advanced communication devices is requiring more capability from the display and data input devices which is contradictory to the trend of providing less  
20 capability for the sake of miniaturization.

- Thirdly, smaller devices have less space for an antenna thereby degrading transmission and/or reception performance. Smaller devices, having smaller antennas, are  
25 more susceptible to the well known shadowing phenomenon produced by the position of the human head between the communication device and the nearest base site when the device is held against the head during use.

- 30 Thus, there is a need to maintain acceptable acoustic coupling, increase display and data input device capability and increase antenna performance as wireless communication devices are made smaller.

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## Brief Description of the Drawings

FIG. 1 is a perspective view of a radiotelephone in an open position constructed in accordance with a first preferred embodiment of the present invention.

FIG. 2 is a perspective view of the radiotelephone of FIG. 1 in a closed position.

FIG. 3 is a perspective view of a radiotelephone in an open position constructed in accordance with a second preferred embodiment of the present invention.

FIG. 4 is a perspective view of the radiotelephone of FIG. 3 in a closed position.

FIG. 5 is a perspective view of a radiotelephone in an open position constructed in accordance with a third preferred embodiment of the present invention.

FIG. 6 is a perspective view of the radiotelephone of FIG. 5 in a closed position.

FIG. 7 is a block diagram of the radiotelephone of FIGs. 1-6 and including an optional pager.

## Detailed Description of the Preferred Embodiments

Referring now to FIGs. 1 and 2, there are shown perspective views of a radiotelephone 10 in an open and closed position, respectively, constructed in accordance with a first preferred embodiment of the present invention.

Radiotelephones that may advantageously utilize the present invention include, among others, cellular radiotelephones, and cordless radiotelephones such as cordless radiotelephone one (CT-1) and cordless radiotelephone two (CT-2). The radiotelephone 10 is similar to that of a portable cellular radiotelephone model no. F09HYD8363BG, manufactured and available from Motorola Inc., 600 North U.S. Highway 45, Libertyville, IL 60048. Wireless communication devices, such as the radiotelephone 10, are well known in the art and will not be described in detail except to distinguish what is well known and what is described in the preferred embodiments of the present invention.

The radiotelephone 10 comprises a housing assembly having first 12, second 14 and third 16 housing portions. The first 12 and second 14 housing portions are each coupled to the third 16 housing portion. The third housing portion includes a side 32. The first 12 and second 14 housing portions are each moveable between a first, closed position, designated by reference numeral 18 in FIG. 1 and shown in FIG. 2, and a second, open position, designated by reference numeral 20 in FIG. 1 and shown in FIG. 1. The first housing portion 12 is moveable between a first housing position 18 at least partially covering the side 32 of the third housing portion 16 and a second housing position 20 at least partially exposing the side 32 of the third housing portion 16. The second housing portion 14 is moveable between a first housing position 18 at least partially covering the side 32 of the third housing portion 16

and a second housing position 20 at least partially exposing the side 32 of the third housing portion 16.

5 A unique feature of the radiotelephone 10 is readily apparent from viewing both FIGs. 1 and 2. The first housing portion 12 has an end portion 22. The second housing portion 14 has an end portion 24 extending beyond the end portion 22 of the first housing portion 12 when the first 12 and the second 14 housing portions are moved to their first respective housing  
10 position 18 at least partially covering the side 32 of the third housing portion 16. Preferably, the length of the first 12 housing portion and the length of the second 14 housing portion are each greater than one-half the length of the third housing portion 16.

15 A conventional earpiece transducer 26 is coupled to the first housing portion 12 and a conventional microphone transducer 28 is coupled to the second housing portion 14. The earpiece 26 and microphone 28 transducers are substantially  
20 aligned with a center axis 30 of the third housing portion 16. Conventional transceiving means (see FIG. 7), coupled to the earpiece 26 and microphone 28 transducers, is preferably disposed in the third housing portion 16.

25 In the closed housing position 18, the first 12 and second 14 housing portions are substantially disposed in the same plane and preferably adjacent to the side 32 of the third housing portion 16. Preferably, a side 34 of the first housing portion 12 is shaped to matively engage with a side 36 of the  
30 second housing portion 14. Such engagement permits the positioning of the first 12 and second 14 housing portions in the same plane adjacent to the side 32 of the third housing portion 16 while permitting the earpiece 26 and microphone 28 transducers to align with the center axis 30.

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Note that in the closed position 18, the holes in the earpiece 26 and microphone 28 transducers are facing towards the side 32 of the third housing portion 16. This produces a very clean appearance on the outside of the radiotelephone 10 when in its closed position 18.

In the open housing position 20, the first housing portion 12 is disposed at an obtuse angle relative to the third housing portion 16, preferably  $180^\circ$ , permitting alignment of the earpiece transducer 26 with a human ear. Similarly, the second housing portion 14 is also disposed at an obtuse angle relative to the third housing portion 16, although preferably  $135^\circ$ , permitting alignment of the microphone transducer 28 with a human mouth. Both the earpiece 26 and microphone 28 transducers remain aligned with the center axis 30 when the first 12 and second 14 housing portions are in the open housing position 20.

Although it would be less desirable than the preferred embodiment, one of the first 12 and second 14 housing portions may overlap the other such that the first 12 and second 14 housing portions are disposed in different but preferably substantially parallel planes.

In the preferred embodiment of the present invention, the first 12 and second 14 housing portions are rotatably coupled to the third housing portion 16 between the closed 18 and open 20 housing positions via hinge mechanisms 38 and 40, respectively. The first 12 and second 14 housing portions are manually rotated between the open 18 and closed 20 positions, one at a time. The hinge mechanisms also retain each of the first 12 and second 14 housing portions in both the closed 18 and open 20 housing positions. A variety of conventional hinge mechanisms are acceptable for use with the present invention.



The movement of the first housing portion 12 between the closed 18 and open 20 housing positions can be coupled to the movement of the second housing portion 14 between the closed 18 and open 20 housing positions. Due to the sculptured shape of the first 12 and second 14 housing portions, one of the housing portions must rotate a predetermined number of degrees relative to the third housing portion 16 before the other housing portion can rotate so that the first and second housing portions do not interfere with each other. The first housing portion 12 is retained in the closed position 18 using the hinge mechanism 38. The second housing portion 14 includes a conventional spring member as shown in U.S. Patent No. 4,471,493 coupled to the hinge mechanism 40. The spring member generates a biasing force to urge the second housing portion 14 to its open position 20. A tab 42 coupled to the end portion 24 of the second housing portion 14 is adapted to fit within a recess 44 in the area of the hinged mechanism 38 of the first housing portion 12 to maintain the second housing portion 14 in its closed position 18 when the first housing portion 12 is in its closed position 18. When the first housing portion 12 is manually moved to the open position 20, the tab 42 clears the recess 44 permitting the biasing force exerted by the spring member to urge the second housing portion 14 to its open position 20. The radiotelephone 10 may be thereafter closed by closing the first housing portion 12 after the second housing portion 14. Of course, more elaborate coupling mechanisms may be employed to automatically open each of the first 12 and the second 14 housing portions.

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The radiotelephone 10 is advantageous in that is contracted to approximately one third of its useable length when in its closed position 18 while providing only one additional layer of housing material. This results in a reduction in thickness of the device and a weight reduction

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approximately equal to that of one moveable housing portion. Furthermore, when the radiotelephone 10 is expanded to its open position 20, the earpiece 26 and microphone 28 transducers remain on the center axis 30 of the third housing portion 10 permitting convenient and comfortable alignment with a human ear and mouth.

The radiotelephone 10 further includes a display 46 and a data input device, such as a keypad 48, preferably coupled to the side 32 of the third housing portion 16. As the radiotelephone 10 becomes smaller, less space is available for the display 46 and keypad 48. However, radiotelephones are being designed with more capability to provide a greater range of services and thus need additional display 46 and keypad 48 resources to support the expanded capability. One such example of added capability is the addition of a selective call receiver functions, such as a conventional pager, to the functionality of the radiotelephone 10. A conventional pager may be of the type model number A04JRC5661A, manufactured and available from Motorola Inc. 1500 N.W. 22nd Avenue, Boynton Beach, Fl 33426-8292. The combination of a pager and a radiotelephone is already well known in the art.

Such expanded capability problems are overcome by relating paging and radiotelephone modes associated with the wireless communication device 10 to at least one of the first 12 and second 14 housing portions being moved between the closed 18 and open 20 positions. The movement of one housing portion actuates a switch (see FIG. 7) to prompt the device to change a portion of the communication device between paging and radiotelephone functions. A switch actuated responsive to the movement of a housing portion is well known as taught, by example, in U.S. Patent No. 5,117,073.

For example, display functionality is expanded by displaying paging information when the first housing portion 12 is moved to the closed position 18 and radiotelephone  
5 information when the first housing portion 12 is moved to the open housing position 20.

For example, keypad functionality is expanded by having paging functions associated therewith when the first  
10 housing portion 12 is in the closed position 18 and radiotelephone functions associated therewith when the first housing portion 12 is moved to the open housing position 20.

The dual modes of the device are not limited to only  
15 radiotelephone and paging functions. This feature of the present invention is intended to include any two modes of the wireless communication device. For example, the dual modes alternatively include: radiotelephone vs. notebook functions, private vs. hands-free conversation and cellular vs. cordless  
20 functions.

The display 46 and keypad 48 are preferably covered by the moveable housing portions as shown in FIGs. 1 and 2, but do not necessarily need to be covered to gain the expanded  
25 functionality provided by the moveable housing portion. An example of a radiotelephone that has a moveable housing portion and does not fully cover the keypad is cordless radiotelephone model number 34986, manufactured and available from Motorola Inc., 600 North U.S. Highway 45,  
30 Libertyville, IL 60048.

Another unique feature of the wireless communication device 10 as shown in FIGs. 1 and 2 is a substantially transparent portion 50, hereinafter called a lens, coupled to  
35 the first 12 and second 14 housing portions. Since the display

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46 is at least partially covered by the first housing portion 12 when the first housing portion 12 is moved to the closed housing position 18, the display traditionally becomes of little use. However, the lens 50 is coupled to the first 12 and second 5 14 housing portions such that the lens is disposed essentially opposite at least a portion of the display 46 when the first 12 and second 14 housing portions are moved to the closed housing position 18. Thus, the display capability is expanded since it can now be used when the housing portions are in 10 their closed position 18. Of course, the lens may optionally be coupled to only one of the moveable housing portions if so desired. In accordance with the previously taught expanded keypad feature, the covered display 46 provides paging information when the housing portions are moved to their 15 respective closed housing position 18 and radiotelephone information when the housing portions are moved to their respective open 20 housing position.

Still another unique feature of the wireless 20 communication device 10 as shown in FIGs. 1 and 2 is keycap means 52 coupled to the second housing portion 14. Since the keypad 48 is at least partially covered by the second housing portion 14 when the second housing portion 14 is moved to the closed housing position 18, the keypad 48 traditionally becomes 25 of little use. However, the keycaps 52 are coupled to the second housing portion 14 such that the keycaps 52 are disposed essentially opposite at least a portion of the keypad 54 when the second housing portion 14 is moved to the closed housing position 18. The keycaps 52 are comprised of conventional 30 elastomeric material and protrude through the thickness of the second housing portion 14. The keycaps 52 are coupled to the second housing portion 14 by sandwiching webbing interconnecting individual keycaps between layers of the second housing portion 14. Thus, the keypad capability is 35 expanded since it can now be used when the second housing

portion 14 is in its closed position 18. Of course, additional keycaps may also be coupled to the first housing portion 12 if so desired. In accordance with the previously taught expanded keypad feature, the covered portion of the keypad 54 provides paging functions when the second housing portion 14 is moved to its closed housing position 18 and radiotelephone functions when the second housing portion 14 is moved to its open housing position 20.

Yet, still another unique feature of the wireless communication device 10 as shown in FIGs. 1 and 2 is an antenna 56 coupled to the first housing portion 12. A transceiver (FIG. 7) is substantially disposed in the third housing portion 16. The antenna 56 is coupled to the transceiver and the first housing portion 12. The antenna 56 is moveable between a first, closed, antenna position designated by reference numeral 60 at pocket 58 and a second, open, antenna position designated by reference numeral 62 extended beyond the first housing portion 12. The antenna 56 is shown to be rotatably coupled to the first housing portion 12 between antenna positions 60 and 62. The antenna preferably extends beyond the housing portion having the earpiece transducer 26 such that the antenna extends above a human head.

For the radiotelephone 10 having the length of the first housing portion 12 approximately equal to the length of the third housing portion 16, a conventional antenna extending beyond the third housing portion 16 would not reach beyond the length of the first housing portion 12. In this position a shadowing phenomenon reduces the performance of the conventional antenna. However, extending the antenna 56 beyond the first, moveable housing portion 12 raises the antenna 56 to an even further extended position away from the radiotelephone 10 and therefore overcomes the shadowing problem resulting in improved antenna performance.

Referring now to FIGs. 3 and 4, there are shown perspective views of the radiotelephone 10 in an open and closed position, respectively, constructed in accordance with a second preferred embodiment of the present invention. The radiotelephone 10 is the same as the radiotelephone 10 shown in in FIGs. 1 and 2 and described in the associated text with the following two exceptions. Firstly, the first 12 and second 14 housing portions are slidably coupled to the third housing portion 16 rather than being rotatably coupled. Secondly, the antenna 56 is slidably coupled to the first housing portion 12 rather than being rotatably coupled.

The radiotelephone 10 comprises a housing assembly having first 12, second 14 and third 16 housing portions. The first 12 and second 14 housing portions are each coupled to the third 16 housing portion. The third housing portion includes a side 32. The first 12 and second 14 housing portions are each moveable between a first, closed position, designated by reference numeral 18 in FIG. 3 as shown in FIG. 4, and a second, open position, designated by reference numeral 20 in FIG. 3 as shown in FIG. 3. The first housing portion 12 is moveable between a first housing position 18 at least partially covering the side 32 of the third housing portion 16 and a second housing position 20 at least partially exposing the side 32 of the third housing portion 16. The second housing portion 14 is moveable between a first housing position 18 at least partially covering the side 32 of the third housing portion 16 and a second housing position 20 at least partially exposing the side 32 of the third housing portion 16.

A unique feature of the radiotelephone 10 is readily apparent from viewing both FIGs. 3 and 4. The first housing portion 12 has an end portion 22. The second housing portion 14 has an end portion 24 extending beyond the end portion 22 of

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the first housing portion 12 when the first 12 and the second 14 housing portions are moved to their first respective housing positions 18 at least partially covering the side 32 of the third housing portion 16. Preferably, the length of the first 12  
5 housing portion and the length of the second 14 housing portion are each greater than one-half the length of the third housing portion 16.

Opposing sides 64 and 66 of the first housing portion 12  
10 each slide and are thereby captured by opposing guide rails 72 and 74 on the side 32 of the third housing portion 16.

Similarly, opposing sides 68 and 70 of the second housing portion 14 each slide and are thereby captured by opposing guide rails 72 and 74 on the side 32 of the third housing portion  
15 16. The first and second housing portions 12 and 14 are raised above the side 32 of the third housing portion 16 to permit the first 12 and the second 14 housing portions to at least partially cover the side 32 when the housing portions 12 and 14 are in their closed housing position 18.

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When the housing portions 12 and 14 are in their closed housing position 18, the side 64 of the first housing portion 12 slides past and over the side 68 of the second housing portion 14. Likewise, the side 66 of the first housing portion 12 slides  
25 past and over the side 70 of the second housing portion 14. The end portion 22 at the opposing sides 64 and 66 of the first housing portion 12 are disposed in grooves 76 and 78, respectively, when the housing portions 12 and 14 are in their respective closed positions.

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When the housing portions 12 and 14 are in their open housing position 20, conventional stops (not shown) at the end portion 22 of the first housing position 12 and the end portion 24 of the second housing portion 14 keep the housing portions  
35 12 and 14 from separating from the third housing portion 16.

The conventional stops also retain the housing portions 12 and 14 when the housing portions 12 and 14 are in their closed housing position 18.

5           The first and second housing portions 12 and 14 are shown to be slidably coupled to opposing guide rails 72 and 74 on the third housing portion 16. Alternatively, only one side of the first and second housing portions 12 and 14 need be  
10           slidably coupled to the third housing portion 16, given a robust design. For example, the side 64 of the first housing portion 12 slidably engages with guide rail 72 of the third housing  
portion 16 and the side 70 of the second housing portion 14 slidably engages with guide rail 74 of the third housing  
15           portion 16. Thus, absolutely, no overlap occurs between any part of the sides of first and second housing portions 12 and 14.

          A conventional earpiece transducer 26 is coupled to the first housing portion 12 and a conventional microphone  
20           transducer 28 is coupled to the second housing portion 14. The earpiece 26 and microphone 28 transducers are substantially aligned with a center axis 30 of the third housing portion 16. Conventional transceiving means (see FIG. 7), coupled to the  
earpiece 26 and microphone 28 transducers, is preferably  
25           disposed in the third housing portion 16.

          In the closed housing position 18, the major surfaces of first 12 and second 14 housing portions are substantially  
30           disposed in the same plane, and preferably, adjacent to the side 32 of the third housing portion 16. Preferably, a side 34 of the first housing portion 12 is shaped to matively engage with  
a side 36 of the second housing portion 14. Such engagement  
permits the positioning of the first 12 and second 14 housing  
portions in the same plane adjacent to the side 32 of the third  
housing portion 16 while permitting the earpiece 26 and  
35           microphone 28 transducers to align with the center axis 30.



Note that in the closed position 18, the holes in the earpiece 26 and microphone 28 transducers are facing away from the side 32 of the third housing portion 16. This produces an opportunity for the user to use the earpiece and microphone transducers of the radiotelephone 10 when in its closed position 18. One such use includes a hands-free operation enabling the user to answer a call without opening the radiotelephone 10.

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In the open housing position 20, the first housing portion 22 is disposed at an obtuse angle relative to the third housing portion 16, preferably 180°, permitting alignment of the earpiece transducer 26 with a human ear. Similarly, the second housing portion 14 is also disposed at an obtuse angle relative to the third housing portion 16, although preferably 180°, permitting alignment of the microphone transducer 28 with a human mouth. Both the earpiece 26 and microphone 28 transducers remain aligned with the center axis 30 when the first 12 and second 14 housing portions are in the open housing position 20.

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Although it would be less desirable than the preferred embodiment, one of the first 12 and second 14 housing portions may overlap the other such that the first 12 and second 14 housing portions are disposed in different but preferably substantially parallel planes.

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The movement of the first housing portion 12 between the closed 18 and open 20 housing positions can be coupled to the movement of the second housing portion 14 between the closed 18 and open 20 housing positions. Contrary to the rotating housing portions 12 and 14 of FIGs. 1 and 2, the sliding housing portions 12 and 14 of FIGs. 3 and 4 do not interfere with each other and thus can be moved at the same

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time. Of course, elaborate coupling mechanisms may be employed to automatically open each of the first 12 and the second 14 housing portions.

5           The radiotelephone 10 is advantageous in that is contracted to approximately one third of its useable length when in its closed position 18 while providing only one additional layer of housing material. This results in a reduction in thickness of the device and a weight reduction  
10 approximately equal to that of one moveable housing portion. Furthermore, when the radiotelephone 10 is expanded to its open position 20, the earpiece 26 and microphone 28 transducers remain on the center axis 30 of the third housing portion 10 permitting convenient and comfortable alignment  
15 with a human ear and mouth.

          The radiotelephone 10 further includes a display 46 and a data input device, such as a keypad 48, preferably coupled to the side 32 of the third housing portion 16. As the  
20 radiotelephone 10 becomes smaller, less space is available for the display 46 and keypad 48. However, radiotelephones are being designed with more capability to provide a greater range of services and thus need additional display 46 and keypad 48 resources to support the expanded capability. One such  
25 example of added capability is the addition of a selective call receiver functions, such as a conventional pager, to the functionality of the radiotelephone 10. Such expanded capability problems are overcome by relating paging and radiotelephone modes associated with the wireless  
30 communication device 10 to at least one of the first 12 and second 14 housing portions being moved between the closed 18 and open 20 positions.

          The display functionality is expanded by displaying  
35 paging information when the first housing portion 12 is

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moved to the closed position 18 and radiotelephone information when the first housing portion 12 is moved to the open housing position 20.

5           The keypad functionality is expanded by having paging functions associated therewith when the first housing portion 12 is in the closed position 18 and radiotelephone functions associated therewith when the first housing portion 12 is moved to the open housing position 20.

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          As with FIGs. 1 and 2, the dual modes of the device 10 are not limited to only radiotelephone and paging functions. This feature of the present invention is intended to include any two modes of the wireless communication device. For  
15       example, the dual modes alternatively include:  
radiotelephone vs. notebook functions, private vs. hands-free conversation and cellular vs. cordless functions.

          The display 46 and keypad 48 are preferably covered by  
20       the moveable housing portions as shown in FIGs. 3 and 4, but do not necessarily need to be covered to gain the expanded functionality provided by the moveable housing portion as discussed with FIGs. 1 and 2.

25           Another unique feature of the wireless communication device 10 as shown in FIGs. 3 and 4 is a substantially transparent portion 50, hereinafter called a lens, coupled to the second housing portion 14. As similarly discussed with FIGs. 1 and 2, the lens 50 is coupled to the second 14 housing  
30       portion such that the lens is disposed essentially opposite at least a portion of the display 46 when the second 14 housing portion is moved to the closed housing position 18. Thus, the display capability is expanded since it can now be used when the second housing portion is in its closed position 18. Of  
35       course, the lens may optionally be coupled to both of the

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moveable housing portions 12 and 14 if so desired. In accordance with the previously taught expanded keypad feature, the covered display 46 provides paging information when the housing portions are moved to their closed housing position 18 and radiotelephone information when the housing portions are moved to their open 20 housing position.

Still another unique feature of the wireless communication device 10 as shown in FIGs. 3 and 4 is keycap means 52 coupled to the second housing portion 14. As discussed with FIGs. 1 and 2, the keycaps 52 are coupled to the second housing portion 14 such that the keycaps 52 are disposed essentially opposite at least a portion of the keypad 54 when the second housing portion 14 is moved to the closed housing position 18. The keycaps 52 are comprised of conventional elastomeric material and protrude through the thickness of the second housing portion 14. The keycaps 52 are coupled to the second housing portion 14 by sandwiching webbing interconnecting individual keycaps between layers of the second housing portion 14. Thus, the keypad capability is expanded since it can now be used when the second housing portion 14 is in its closed position 18. Of course, additional keycaps may also be coupled to the first housing portion 12 if so desired. In accordance with the previously taught expanded keypad feature, the covered portion of the keypad 54 provides paging functions when the second housing portion 14 is moved to its closed housing position 18 and radiotelephone functions when the second housing portion 14 is moved to its open 20 housing position.

Yet, still another unique feature of the wireless communication device 10 as shown in FIGs. 3 and 4 is an antenna 56 coupled to the first housing portion 12. A transceiver (FIG. 7) is substantially disposed in the third housing portion 16. The antenna 56 is coupled to the

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transceiver and the first housing portion 12. The antenna 56 is moveable between a first, closed, antenna position designated by reference numeral 60 at pocket 58 and a second, open, antenna position designated by reference numeral 62 extended  
5 beyond the first housing portion 12. The antenna 56 is shown to be slidably coupled to the first housing portion 12 between antenna positions 60 and 62. The antenna preferably extends beyond the housing portion having the earpiece transducer 26 such that the antenna extends above a human head.

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For the radiotelephone 10 having the length of the first housing portion 12 approximately equal to the length of the third housing portion 16, a conventional antenna extending beyond the third housing portion 16 would not reach beyond  
15 the length of the first housing portion 12. In this position the shadowing phenomenon reduces the performance of the conventional antenna. However, extending the antenna 56 beyond the first, moveable housing portion 12 raises the antenna 56 to an even further extended position away from the  
20 radiotelephone 10 and therefore overcomes the shadowing problem resulting in improved antenna performance.

Referring now to FIGs. 5 and 6, there are shown perspective views of the radiotelephone 10 in an open and  
25 closed position, respectively, constructed in accordance with a third preferred embodiment of the present invention. The radiotelephone 10 is the same as the radiotelephone 10 shown in FIGs. 3 and 4 and described in the associated text with the following one exception. The second housing portion 14 is  
30 rotatably coupled to the third housing portion 16 rather than being slidably coupled. Therefore, a combination of sliding and rotating moveable housing portions is shown.

The radiotelephone 10 comprises a housing assembly  
35 having first 12, second 14 and third 16 housing portions. The

first 12 and second 14 housing portions are each coupled to the third 16 housing portion. The third housing portion includes a side 32. The first 12 and second 14 housing portions are each moveable between a first, closed position, designated by  
5 reference numeral 18 in FIG. 5 as shown in FIG. 6, and a second, open position, designated by reference numeral 20 in FIG. 5 as shown in FIG. 5. The first housing portion 12 is moveable between a first housing position 18 at least partially covering the side 32 of the third housing portion 16 and a  
10 second housing position 20 at least partially exposing the side 32 of the third housing portion 16. The second housing portion 14 is moveable between a first housing position 18 at least partially covering the side 32 of the third housing portion 16 and a second housing position 20 at least partially exposing  
15 the side 32 of the third housing portion 16.

A unique feature of the radiotelephone 10 is readily apparent from viewing both FIGs. 5 and 6. The first housing portion 12 has an end portion 22. The second housing portion  
20 14 has an end portion 24 extending beyond the end portion 22 of the first housing portion 12 when the first 12 and the second 14 housing portions are moved to their first respective housing positions 18 and at least partially covering the side 32 of the third housing portion 16. Preferably, the length of the first 12  
25 housing portion and the length of the second 14 housing portion are each greater than one-half the length of the third housing portion 16.

Opposing sides 64 and 66 of the first housing portion 12  
30 each slide and are thereby captured by opposing guide rails 72 and 74 on the side 32 of the third housing portion 16. The first and second housing portions 12 and 14 are raised above the side 32 of the third housing portion 16 to permit the first 12 housing portion to at least partially cover the side 32 when the  
35 first housing portions 12 is in its closed housing position 18.

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The second housing portion 14 is rotatably coupled to the third housing portion 16 between the closed 18 and open 20 housing positions via hinge mechanism 40. The second housing portion 14 is manually rotated between the open 18 and closed 20 position. The hinge mechanism 40 also retains second housing portion 14 the closed 18 and open 20 housing positions. Conventional hinge mechanisms are acceptable for use with the present invention.

When the housing portions 12 and 14 are in their closed housing position 18, the side 64 of the first housing portion 12 slides under the side 68 of the second housing portion 14. Likewise, the side 66 of the first housing portion 12 slides under the side 70 of the second housing portion 14.

When the first housing portion 12 is in its open housing position 20, conventional stops (not shown) at the end portion 22 of the first housing position 12 keep the first housing portion 12 from separating from the third housing portion 16. The conventional stops also retain the first housing portion 12 when the first housing portion 12 is in its closed housing position 18.

The first housing portion 12 is shown to be slidably coupled to opposing guide rails 72 and 74 on the third housing portion 16. Alternatively, only one side of the first housing portion 12 need be slidably coupled to the third housing portion 16 given a robust design. For example, the side 64 of the first housing portion 12 slidably engages with guide rail 72 of the third housing portion 16.

A conventional earpiece transducer 26 is coupled to the first housing portion 12 and a conventional microphone transducer 28 is coupled to the second housing portion 14. The

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earpiece 26 and microphone 28 transducers are substantially aligned with a center axis 30 of the third housing portion 16. Conventional transceiving means (see FIG. 7), coupled to the earpiece 26 and microphone 28 transducers, is preferably  
5 disposed in the third housing portion 16.

In the closed housing position 18, the major surfaces of first 12 and second 14 housing portions are substantially disposed in the same plane, and preferably, adjacent to the  
10 side 32 of the third housing portion 16. Preferably, a side 34 of the first housing portion 12 is shaped to matively engage with a side 36 of the second housing portion 14. Such engagement permits the positioning of the first 12 and second 14 housing portions in the same plane adjacent to the side 32 of the third  
15 housing portion 216 while permitting the earpiece 26 and microphone 28 transducers to align with the center axis 30.

Note that in the closed position 18, the holes in the earpiece transducer 26 is facing away from the side 32 of the  
20 third housing portion 16 and microphone transducer 28 is facing towards the side 32 of the third housing portion 16.

In the open housing position 20, the first housing portion 22 is disposed at an obtuse angle relative to the third  
25 housing portion 16, preferably 180°, permitting alignment of the earpiece transducer 26 with a human ear. Similarly, the second housing portion 14 is also disposed at an obtuse angle relative to the third housing portion 16, although preferably 135°, permitting alignment of the microphone transducer 28  
30 with a human mouth. Both the earpiece 26 and microphone 28 transducers remain aligned with the center axis 30 when the first 12 and second 14 housing portions are in the open housing position 20.



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Although it would be less desirable than the preferred embodiment, one of the first 12 and second 14 housing portions may overlap the other such that the first 12 and second 14 housing portions are disposed in different but preferably substantially parallel planes.

The movement of the first housing portion 12 between the closed 18 and open 20 housing positions can be coupled to the movement of the second housing portion 14 between the closed 18 and open 20 housing positions. Contrary to the rotating housing portions 12 and 14 of FIGs. 1 and 2, the movement of the housing portions 12 and 14 of FIGs. 5 and 6 do not interfere with each other and thus can be moved at the same time. Of course, elaborate coupling mechanisms may be employed to automatically open each of the first 12 and the second 14 housing portions.

The radiotelephone 10 is advantageous in that is contracted to approximately one third of its useable length when in its closed position 18 while providing only one additional layer of housing material. This results in a reduction in thickness of the device and a weight reduction approximately equal to that of one moveable housing portion. Furthermore, when the radiotelephone 10 is expanded to its open position 20, the earpiece 26 and microphone 28 transducers remain on the center axis 30 of the third housing portion 10 permitting convenient and comfortable alignment with a human ear and mouth.

The radiotelephone 10 further includes a display 46 and a data input device, such as a keypad 48, preferably coupled to the side 32 of the third housing portion 16. As the radiotelephone 10 becomes smaller, less space is available for the display 46 and keypad 48. However, radiotelephones are being designed with more capability to provide a greater range

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of services and thus need additional display 46 and keypad 48 resources to support the expanded capability. One such example of added capability is the addition of a selective call receiver functions, such as a conventional pager, to the functionality of the radiotelephone 10. Such expanded capability problems are overcome by relating paging and radiotelephone modes associated with the wireless communication device 10 to at least one of the first 12 and second 14 housing portions being moved between the closed 18 and open 20 positions.

The display functionality is expanded by displaying paging information when the second housing portion 14 is moved to the closed position 18 and radiotelephone information when the second housing portion 14 is moved to the open housing position 20.

The keypad functionality is expanded by having paging functions associated therewith when the second housing portion 14 is in the closed position 18 and radiotelephone functions associated therewith when the second housing portion 14 is moved to the open housing position 20.

As with FIGs. 1 and 2, the dual modes of the device are not limited to only radiotelephone and paging functions. This feature of the present invention is intended to include any two modes of the wireless communication device. For example, the dual modes alternatively include: radiotelephone vs. notebook functions, private vs. hands-free conversation and cellular vs. cordless functions.

The display 46 and keypad 48 are preferably covered by the moveable housing portions as shown in FIGs. 5 and 6, but do not necessarily need to be covered to gain the expanded

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functionality provided by the moveable housing portion as discussed with FIGs. 1 and 2.

Another unique feature of the wireless communication device 10 as shown in FIGs. 5 and 6 is a substantially transparent portion 50, hereinafter called a lens, coupled to the second housing portion 14. As similarly discussed with FIGs. 1 and 2, the lens 50 is coupled to the second 14 housing portion such that the lens is disposed essentially opposite at least a portion of the display 46 when the second 14 housing portion is moved to the closed housing position 18. Thus, the display capability is expanded since it can now be used when the second housing portion is in its closed position 18. Of course, the lens may optionally be coupled to both of the moveable housing portions 12 and 14 if so desired. In accordance with the previously taught expanded keypad feature, the covered display 46 provides paging information when the housing portions are moved to their closed housing position 28 and radiotelephone information when the housing portions are moved to their open 20 housing position.

Still another unique feature of the wireless communication device 10 as shown in FIGs. 5 and 6 is keycap means 52 coupled to the second housing portion 14. As discussed with FIGs. 1 and 2, the keycaps 52 are coupled to the second housing portion 14 such that the keycaps 52 are disposed essentially opposite at least a portion of the keypad 54 when the second housing portion 14 is moved to the closed housing position 18. The keycaps 52 are comprised of conventional elastomeric material and protrude through the thickness of the second housing portion 14. The keycaps 52 are coupled to the second housing portion 14 by sandwiching webbing interconnecting individual keycaps between layers of the second housing portion 14. Thus, the keypad capability is expanded since it can now be used when the second housing

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portion 14 is in its closed position 18. Of course, additional keycaps may also be coupled to the first housing portion 12 if so desired. In accordance with the previously taught expanded keypad feature, the covered portion of the keypad 54 provides paging functions when the second housing portion 14 is moved to its closed housing position 18 and radiotelephone functions when the second housing portion 14 is moved to its open 20 housing position.

10 Yet, still another unique feature of the wireless communication device 10 as shown in FIGs. 3 and 4 is an antenna 56 coupled to the first housing portion 12. A transceiver (FIG. 7) is substantially disposed in the third housing portion 16. The antenna 56 is coupled to the  
15 transceiver and the first housing portion 12. The antenna 56 is moveable between a first, closed, antenna position designated by reference numeral 60 at pocket 58 and a second, open, antenna position designated by reference numeral 62 extended beyond the first housing portion 12. The antenna 56 is shown  
20 to be slidably coupled to the first housing portion 12 between antenna positions 60 and 62. The antenna preferably extends beyond the housing portion having the earpiece transducer 26 such that the antenna extends above a human head.

25 For the radiotelephone 10 having the length of the first housing portion 12 approximately equal to the length of the third housing portion 16, a conventional antenna extending beyond the third housing portion 16 would not reach beyond the length of the first housing portion 12. In this position the  
30 shadowing phenomenon reduces the performance of the antenna 56. However, extending the antenna 56 beyond the first, moveable housing portion 12 raises the antenna 56 to an even further extended position away from the radiotelephone 10 and therefore overcomes the shadowing problem resulting  
35 in improved antenna performance.

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Referring now to FIG. 7, there is shown a block diagram of the radiotelephone 10 of FIGs. 1-6. The block diagram of the radiotelephone 10 generally includes an antenna 56, a receiver 702, memory 703, a display 46, a keypad 48, a processor 706, an earpiece 26, a microphone 28, a transmitter 709, an alert transducer 710, a switch 711 and a power supply 712. The memory 703 includes conventional read only memory (ROM), random access memory (RAM) and electrically erasable programmable read only memory (EEPROM), and may be external or internal to the processor 706. The radiotelephone 10 is of a cellular portable type such as model number F09HYD8363BG manufactured and available from Motorola Inc. 600 North U.S. Highway 45, Libertyville, Il 60048.

15

Optionally, the radiotelephone 10 is coupled to a selective call receiver unit, or pager 713. The selective call receiver 713 is of the type such as model number A04JRC5661A, manufactured and available from Motorola Inc. 1500 N.W. 22nd Avenue, Boynton Beach, Fl 33426-8292.

20

The details in FIG. 7 either represented as a radiotelephone 10 in blocks 701-712 or in combination with a pager 713 and their functional relationship therebetween are well known in the art and will not be described further except to distinguish between what is well known and that described in the preferred embodiments of the present invention.

25

As discussed with FIGs. 1-6, the radiotelephone 10 performs certain tasks responsive to the position of the moveable housing portions. This is accomplished using the switch 711. When one of the housing portions is in its closed position, the switch is closed circuited and thereby sends a control signal 704 of a logic low to the processor. Likewise, when the one housing portion is in its open position, the

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switch 711 is open circuited and thereby sends a control signal 704 of a logic high to the processor 706.

5       The processor 706 is programmed with a predetermined  
set of instructions which control the functions of the shown  
blocks of the radiotelephone 10 based on the control signal 704  
sent to the processor 706 from the switch 711. Thus, for  
example, the processor 706 can adaptively reconfigure the  
keypad 48 and display 46 for either radiotelephone or paging  
10   modes depending upon the state of the switch 711.

What is claimed is:

## Claims

1. A housing assembly, comprising:  
first, second and third housing portions, the first and  
5 the second housing portions each coupled to the third housing  
portion;  
a side on the third housing portion, the first housing  
portion moveable between a first housing position at least  
partially covering the side of the third housing portion and a  
10 second housing position at least partially exposing the side of  
the third housing portion, the second housing portion  
moveable between a first housing position at least partially  
covering the side of the third housing portion and a second  
housing position at least partially exposing the side of the  
15 third housing portion;  
an end portion of the first housing portion; and  
an end portion of the second housing portion extending  
beyond the end portion of the first housing portion when the  
first and the second housing portions are moved to their first  
20 respective housing positions at least partially covering the side  
of the third housing portion.
2. A housing assembly according to claim 1 wherein the  
first and second housing portions are substantially disposed  
25 in the same plane when moved to the first housing position.
3. A housing assembly according to claim 1 wherein at  
least one of the first and second housing portions is rotatably  
coupled to the third housing portion.
- 30 4. A housing assembly according to claim 1 wherein at  
least one of the first and second housing portions is slidably  
coupled to the third housing portion.

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5. A housing assembly according to claim 1 wherein at least one of the first and second housing portions further comprises a transducer.
- 5 6. A housing assembly according to claim 5 wherein the first and second housing portions further comprise an earpiece transducer and a microphone transducer, respectively.
- 10 7. A housing assembly according to claim 5 wherein the transducer is substantially aligned with a center axis of the third housing portion.
8. A housing assembly according to claim 1 wherein the  
15 third housing portion further comprises at least one of display means and data input means.
9. A housing assembly according to claim 1 wherein at least one of the first, second and third housing portions  
20 further comprises radiotelephone means.
10. A wireless communication device comprising:  
first and second housing portions, the first housing portion coupled to the second housing portion and moveable  
25 between a first and a second housing position; and  
paging and radiotelephone modes associated with the device when the first housing portion is moved to the first and the second housing position, respectively.
- 30 11. A wireless communication device according to claim 10 further comprising display means for displaying paging and radiotelephone information when the first housing portion is moved to the first and the second housing position, respectively.

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12. A wireless communication device according to claim 10 further comprising data input means having paging and radiotelephone functions associated therewith when the first housing portion is moved to the first and the second housing position, respectively.

13. A wireless communication device comprising:  
a first and a second housing portion, the first housing portion coupled to the second housing portion and moveable between a first and a second housing position;  
display means coupled to the second housing portion and at least partially covered by the first housing portion when the first housing portion is moved to the first housing position; and  
lens means forming a substantially transparent portion of the first housing portion and disposed essentially opposite at least a portion of the display means when the first housing portion is moved to the first housing position.

14. A wireless communication device according to claim 13 further comprising first and second information sets displayed by the display means when the first housing portion is moved to the first and the second housing position, respectively.

15. A wireless communication device according to claim 14 wherein the first and second information sets further comprise paging and radiotelephone information sets, respectively.

16. A wireless communication device comprising:  
a first and a second housing portion, the first housing portion coupled to the second housing portion and moveable between a first and a second housing position;

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data input means coupled to the second housing portion and at least partially covered by the first housing portion when the first housing portion is moved to the first housing position; and

5           keycap means coupled to the first housing portion and disposed essentially opposite at least a portion of the data input means when the first housing portion is moved to the first housing position.

10   17.   A wireless communication device according to claim 16 further comprising first and second functions of the data input means when the first housing portion is moved to the first and the second housing position, respectively.

15   18.   A wireless communication device according to claim 17 wherein the first and second functions further comprise paging and radiotelephone functions, respectively.

19.   A wireless communication device comprising:  
20           a first housing portion coupled to a second housing portion and moveable between a first and a second housing position;

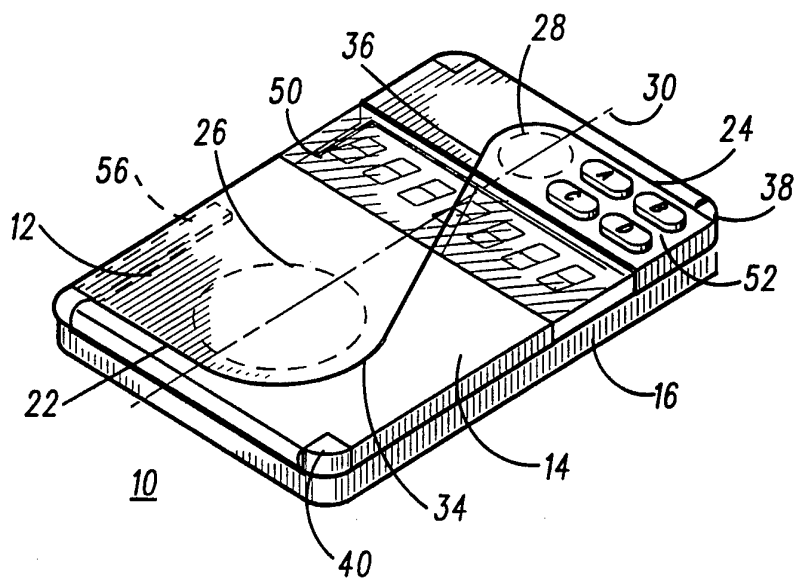
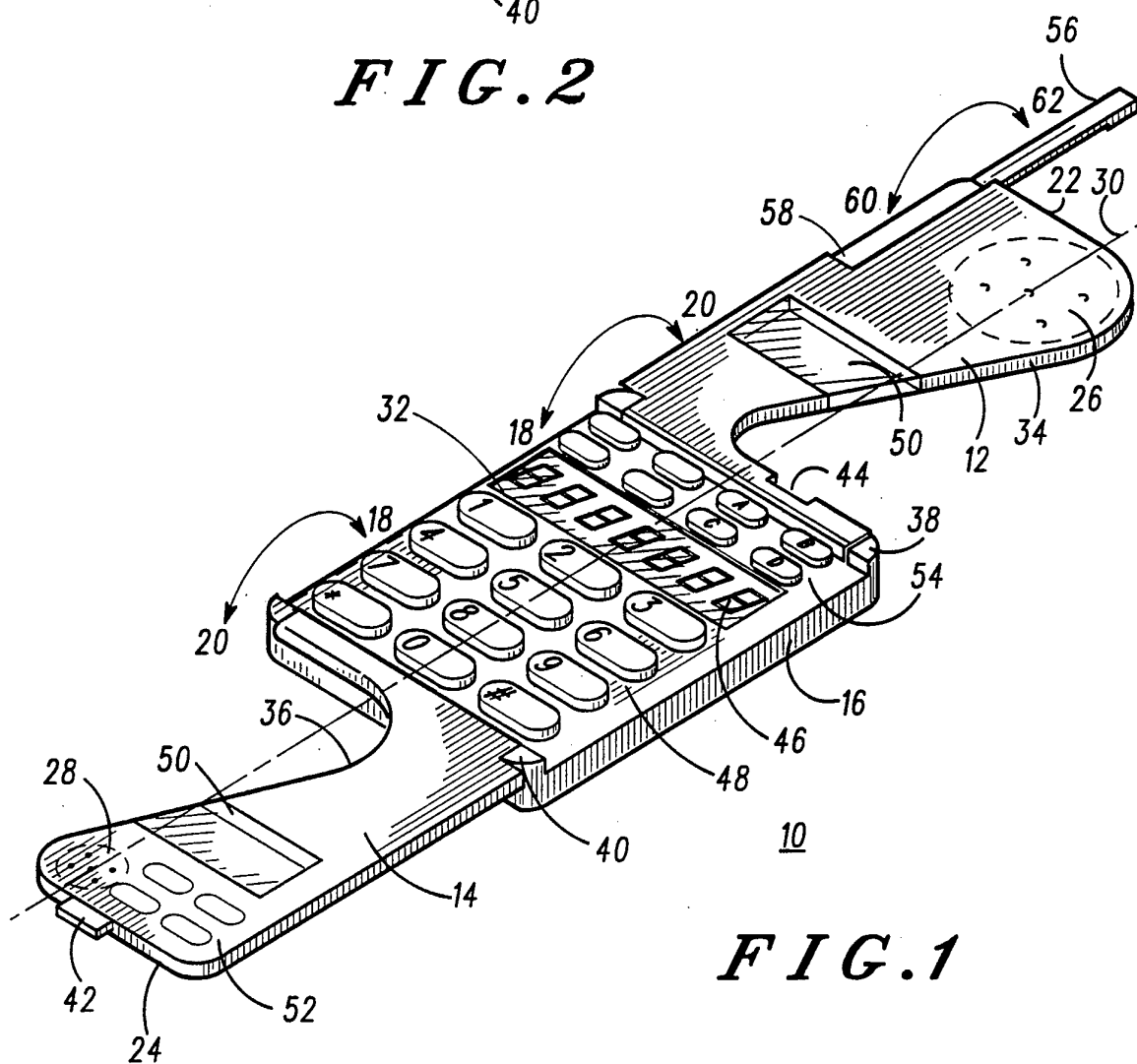
          transceiving means substantially disposed in the second housing portion; and

25           antenna means coupled to the transceiving means and the first housing portion, and moveable between a first and a second antenna position.

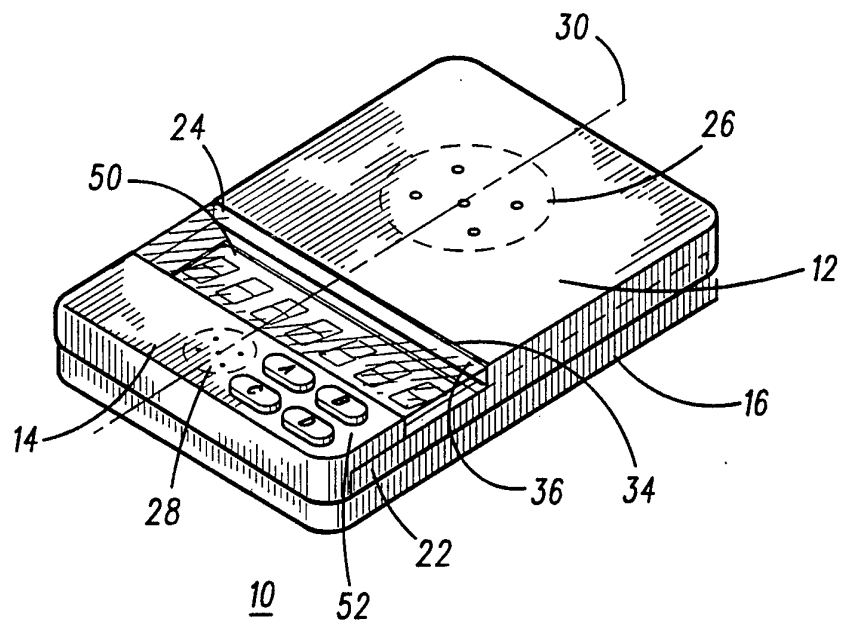
20.   A wireless communication device, comprising:  
30           first, second and third housing portions, the first and second housing portions each coupled to the third housing portion and each moveable between a first and a second housing position; and

          antenna means coupled to the first housing portion and  
35           moveable between a first and a second antenna position.

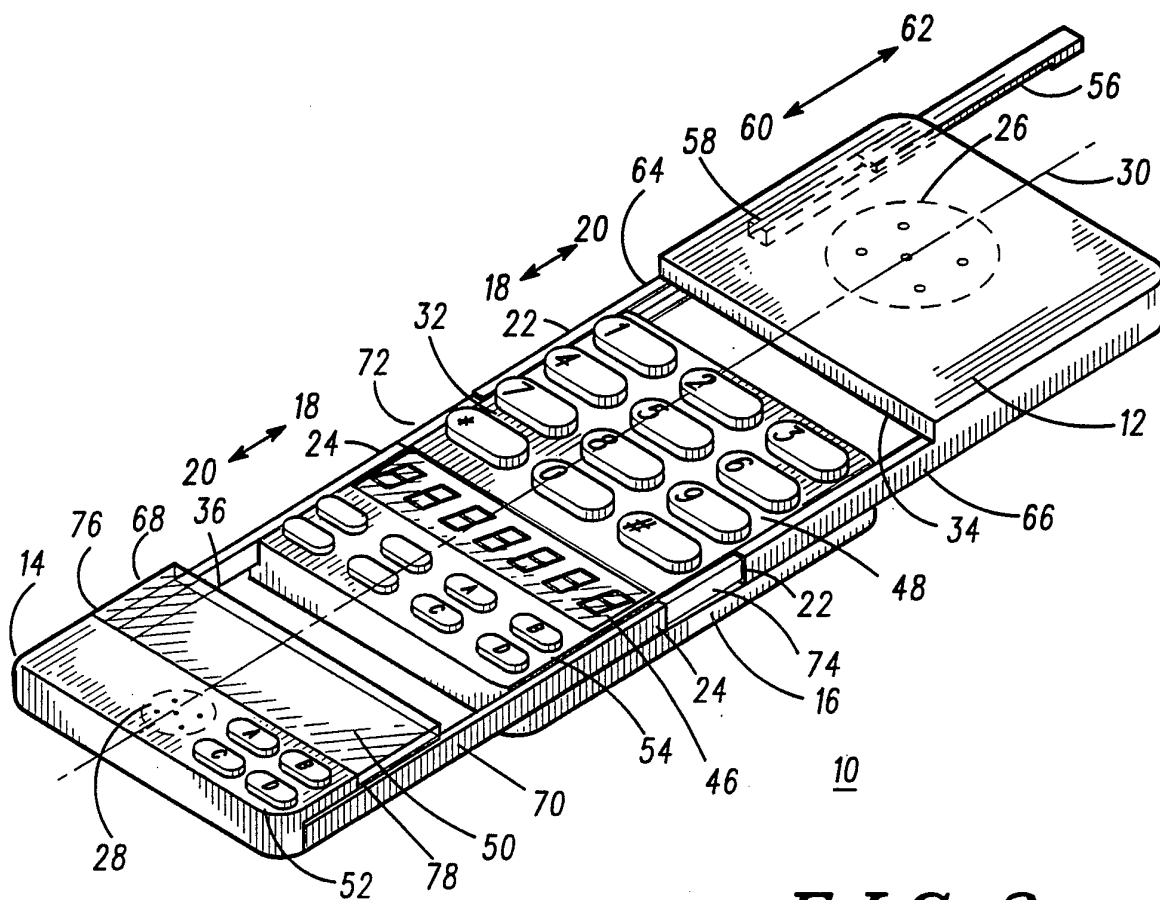
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**FIG. 2****FIG. 1**

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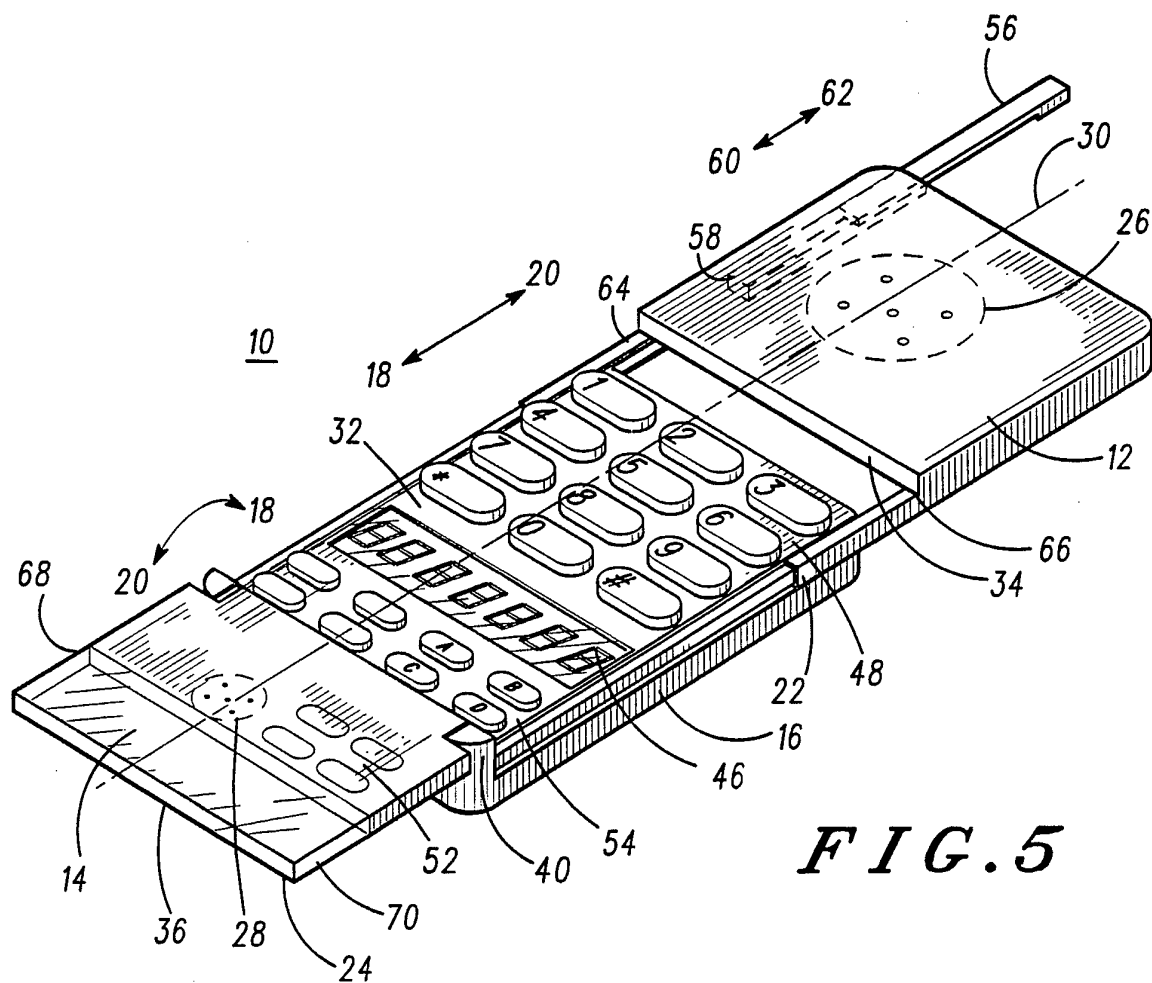
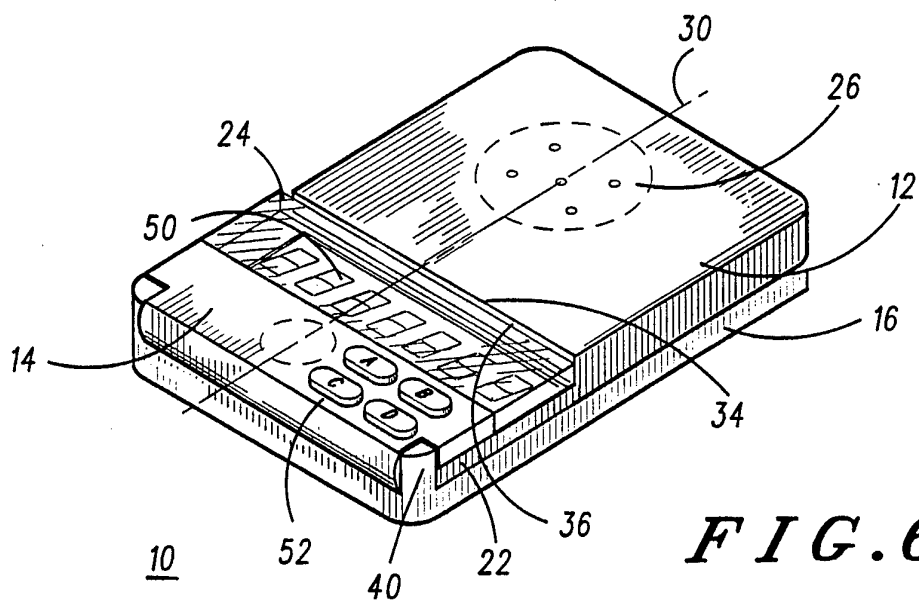


**FIG. 4**



**FIG. 3**

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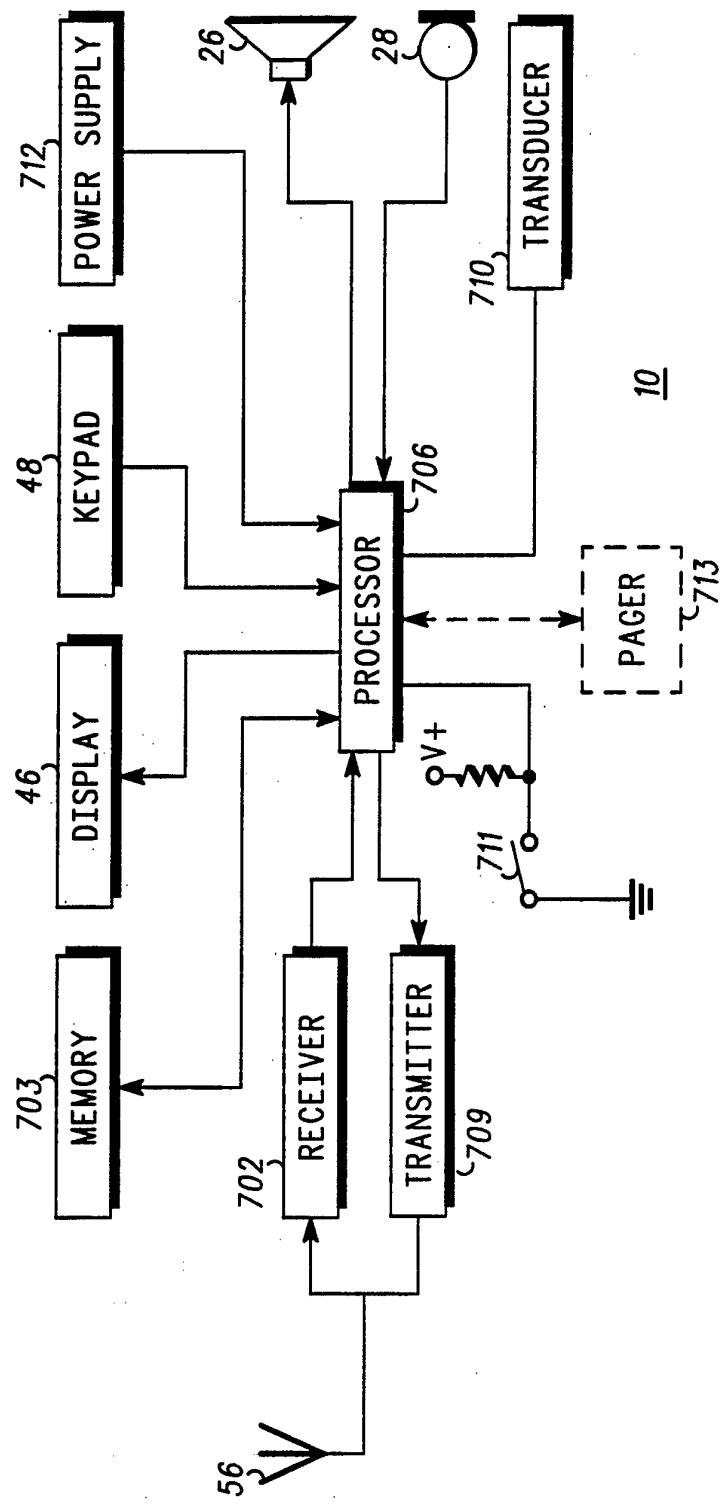


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US93/11291

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H04M 1/00, 9/00

US CL :379/433, 59, 58, 368, 434

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 379/433, 59, 58, 368, 434

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
noneElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
none

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,260,998 (Takagi) 09 November 1993, Figs. 1-3, 9 and 15, col. 4, lines 26-27, col. 6, lines 54-56, 66-68, col. 7, 1-2.	1-9, 19-20
Y	US, A, 5,109,539 (Inubushi et al) 28 April 1992, col. 5, lines 39-44	10-12
A	US, A, 4,063,046 (Schiffman et al) 13 December 1977, col. 2, lines 23-28, 47-49.	13-18
A	GB, A, 2 186 15.3 (Eden) 05 August 1987, page 1, lines 66-68	13-15

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	*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
*A document defining the general state of the art which is not considered to be part of particular relevance	*X	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E earlier document published on or after the international filing date	*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
*L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z	document member of the same patent family
*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		


Date of the actual completion of the international search

02 February 1994

Date of mailing of the international search report

MAR 22 1994

 Name and mailing address of the ISA/US  
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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US93/11291

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.



# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US93/11291

## BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

Group 1, claims 1-9, drawn to handset structure, classified in class 379, subclass 433;

Group 2, claims 10-12, drawn to a communication device which has paging and radiotelephone mode, and housing structure, classified in class 379, subclass 59;

Group 3, claims 13-15, drawn to a combination of lens and display in a communication device, classified in class in 379, subclass 58;

Group 4, claims 16-18, drawn to a combination of keycap and keypad in a communication device, classified in class 379, subclass 368;

Group 5, claims 19-20, drawn to an antenna mounting in a communication device, classified in class 379, subclass 434.

This international application lacks unity because Group 1 (claims 1-9) is a handset structure which does not have the paging mode, the len, the keycap , and the antenna as required in Groups 2-5 respectively; Group 2 (claims 10-12) involves the paging and radiotelephone modes, it does not require the specific handset structure, the len, the keycap, and the antenna as required in Groups 1 and 3-5 respectively; Group 3 (claims 13-15) involves a transparent len which Groups 1-2 and 4-5 are not required; Group 4 (claims 16-18) involves a keypad which Groups 1-3 and 5 are not required; Group 5 (claims 19-20) involves an antenna which Groups 1-4 are not required.