



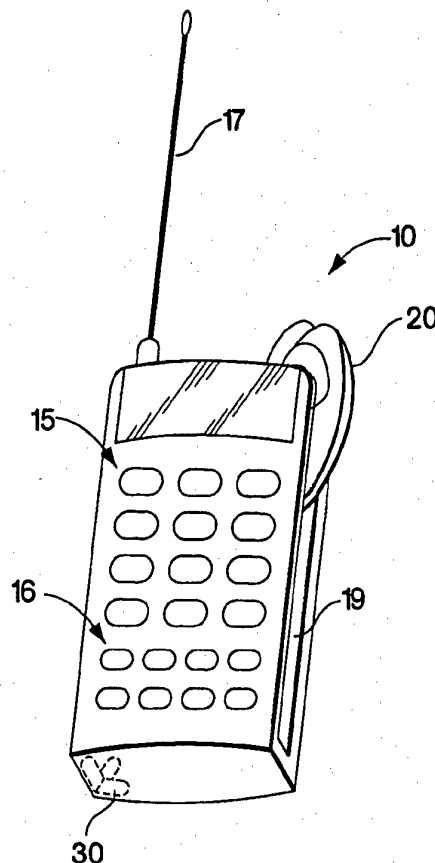
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <p>(51) International Patent Classification ⁶ : H04B 5/02, H04M 1/60</p> | <p>A1</p> | <p>(11) International Publication Number: WO 96/37052 (43) International Publication Date: 21 November 1996 (21.11.96)</p> |
| <p>(21) International Application Number: PCT/US96/07144 (22) International Filing Date: 17 May 1996 (17.05.96) (30) Priority Data: 08/444,017 18 May 1995 (18.05.95) US (71) Applicant: AURA COMMUNICATIONS, INC. [US/US]; 33 Nagog Park, Acton, MA 01720 (US). (72) Inventors: PALMERO, Vincent; 13 Stony Brook Road, Westford, MA 01886 (US). COBLER, Patrick, J.; 105 Concord Avenue, Belmont, MA 02178 (US). BUTLER, Neal, R.; 144 School Street, Acton, MA 01720 (US). (74) Agent: DORNY, Brett, N.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, MA 02210 (US).</p> | <p>(81) Designated States: CA, CN, FI, JP, KR, MX, SG, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p> | |

(54) Title: SHORT-RANGE MAGNETIC COMMUNICATION SYSTEM

(57) Abstract

A system and method communicate signals between a portable unit and a communications system. The portable device communicates with a base unit using inductive coupling. The base unit is further connected to a wider communication system such as a telephone network. Multiple, orthogonally arranged transducers are used in the base unit to provide a more complete magnetic field and to prevent mutual inductance nulls which are otherwise present in a magnetic field. The use of short-range inductive coupling minimizes the power requirements and limits interference with other sources. The inductive coupling may also be used to recharge a battery in the portable device.



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SHORT-RANGE MAGNETIC COMMUNICATION SYSTEM

Background of the Invention

1. Field of the Invention

5 The present invention relates to short-range wireless communication systems, and more particularly to systems utilizing inductive coupling.

2. Discussion of the Related Art

 When using a telephone, continually holding the handset to one's ear can be awkward.
10 Also, holding the telephone interferes with the use of both hands for other work while trying to talk. In particular, the use of cellular telephones, which has increased dramatically, can interfere with the user's proper operation of an automobile. Various techniques have been used to overcome these difficulties.

 Speakerphones allow one to talk while roaming around a room and using one's hands.
15 However, speaker volume can disturb others around the user. They also cannot be used in close proximity to other speakerphones due to interference. They have limited privacy since the speaker broadcasts the conversation to all within earshot. Typically, the user must speak more loudly than normal to have proper reception at the microphone. Also, they tend to have poor sound quality because the user is not near the microphone and acoustics in the room are poor.

20 Headsets have been another way to free up the hands of a telephone user. Typically, the headset includes an adjustable strap extending across the user's head to hold the headset in place, at least one headphone located by the user's ear, and a microphone which extends from the headset along and around the user's face to be positioned in front of the user's mouth. The headset is attached by a wire to the telephone. Headsets have the disadvantages of being bulky
25 and somewhat awkward to use. Although they permit hands free use of the telephone, the user has limited mobility due to the connecting wire.

 Wireless headsets have also been developed which eliminate the connecting wire to the telephone. The wireless headset uses radio frequency (RF) technology or infrared technology for communicating between the headset and a base unit connected to the telephone. The need for
30 communications circuitry and sufficient power to communicate with the base unit increases the bulk and weight of the headset. This increased weight can become tiresome for the user. One alternative has been to attach the headset by a wire to a transmitting unit worn on the belt of the

user. As with wired headsets, the wire can become inconvenient and interfere with other actions by the user. Significant interference rejection circuitry is also needed when multiple wireless headsets are used in close proximity.

Therefore, a wireless communication system for telephones is desired with will provide
5 greater convenience and comfort for the user.

Summary of The Invention

The deficiencies of prior art systems are overcome by the present invention which, in one aspect, includes a short-range, wireless communication system including a miniaturized portable
10 transceiver and a base unit transceiver. The miniaturized portable transceiver sends and receives information through magnetic induction to the base unit, which may also be portable. Similarly, the base unit sends and receives information through magnetic induction to the portable transceiver. The information can be voice, data, music, or video. Use of magnetic induction fields reduces the power requirements and thus allows a smaller size and greater convenience.

15 In another aspect of the present invention, the base unit may include multiple, orthogonally arranged transducers for generating multiple magnetic fields. The multiple fields substantially eliminates mutual inductance nulls between the base unit and portable unit which result at certain positions in a generated field. In another aspect of the present invention, the multiple transducers may be selectively operated based upon a strongest signal, in order to limit
20 power consumption.

In another aspect of the present invention, a headset contains the miniaturized transceiver which communicates with the base unit through magnetic induction fields. The information sent between the headset and the base unit may be voice or data. In another aspect of the present invention, the headset may be of the concha type in which the speaker fits into the user's ear
25 without a strap across the head and the transceiving transducer is encapsulated into the microphone boom which is short and straight along the user's cheek. In another aspect of the invention, the base unit may be a portable telephone, which can be attached to the user, to further transmit communications from the wireless communication system to a cellular telephone network or a cordless telephone unit.

30 In another aspect of the invention, the headset may fit in a receptacle in the portable base unit in order to recharge the battery in the headset. In another aspect of the invention, the battery may be recharged via the magnetic inductive link between the base unit and the headset.

With these and other objects, advantages and features of the invention that may become apparent, the nature of the invention may be more clearly understood by reference to the following detailed description of the invention, the appended claims and the several drawings attached hereto.

5

Brief Description of The Drawings

Fig. 1 illustrates schematically the wireless communication system of the present invention.

Fig. 2 illustrates a telephone handset as the base unit in the communication system of Fig. 1.

Fig. 3 illustrates a headset that is utilized as the portable device in the communication system of Fig. 1.

Fig. 4 illustrates schematically the transducer and electronics of the portable device.

Fig. 5 illustrates schematically the transducer and electronics of the base unit.

Fig. 6 illustrates an alternative transducer configuration for the base unit.

15

Detailed Description

Fig. 1 illustrates schematically a short-range magnetic communication system 1 including a portable device 2 and a base unit 1, which connects to a long-range communication network 14. Contained within each of the base unit 1 and the portable device 2 is a short-range miniaturized magnetic induction transceiver 11, 12, which can simultaneously transmit and receive communications signals 13. These signals may be voice, audio, data, or video. The communications network 14 may be any network in which it would be desirable for these signals to be communicated over a terminal link without wires, such as a telephone network, personal communications (PCS) network, special mobile radio (SMR) network, computer system or network, and video conferencing systems. The base unit 1 may any part of the communications network 14 from which it would be desirable to communicate to another device without wires; for example, it may be a telephone handset, PCS handset, SMR handset, walkie-talkie, computer or computer peripheral devices, personal digital assistant (PDA), or video game controller. The portable device 2 may be any device from which it would be desirable to communicate without wires to a communications network; for example, it may be a telephone headset or handset, portable computer or computer peripheral device, headphone, or video input device.

30

As illustrated in Fig. 2, one example of the base unit 1 is a portable telephone 10 having a plurality of number buttons 15 and a plurality of function buttons 16. A retractable antenna 17 communicates with a cellular telephone network or a cordless telephone base unit. The portable telephone 10 operates in a manner similar to that of an ordinary cellular or cordless telephone handset. Signals are sent to and received from the telephone network in an ordinary manner. The portable telephone 10 includes a transducer system 30 which communicates by magnetic induction with headset 20, which operates as the portable device 2, to provide the outputs and inputs to the portable telephone 10. The portable telephone 10 may also include a mouthpiece or earpiece (not shown) as in a regular telephone handset, allowing the user to choose between a conventional method of operation and a hands-free use afforded by the headset 20.

The portable device 2 as a headset 20 is illustrated more fully in Fig. 3. It includes a body portion 23 which houses a transducer 40 and processing circuitry. A speaker 22 is connected to the circuitry within the body 23. An earpiece 21 next to the speaker 22 fits in the user's ear to hold the unit in place and to allow the user to hear sounds from the speaker. A microphone boom 24 extends from the body 23 several inches in order to place a microphone 25, located at the end of the boom 24, close to the user's mouth. Alternatively the transducer 40 may be housed in the boom 24. A rechargeable battery 51 is also housed in the body 23 of the headset 20 to provide power to the headset. Other features may be optionally included in the headset 20, such as switcher or buttons for manually activating different modes. For example, a capacitive switch or push-button could be used to cause the headset 20 to transmit a control signal to the portable phone 10 to activate muting of the microphone. The portable phone 10 may include a receptacle 19 for receiving and holding the headset 20. Depositing the headset in the receptacle can provide a variety of functions, in addition to maintaining the headset 20 and portable phone 10 together. A switch can be disposed in the receptacle to terminate the telecommunication when the headset 20 is inserted or initiate the telecommunication when it is removed. The receptacle may also include connections to recharge the battery 51 in the headset 20.

The base unit 1 and portable device 2 communicate through amplitude modulation of inductive fields, although other modulation methods such as frequency or phase modulation could be employed. During use, the distance between the portable device 2 and the base unit 1 typically is short. Since the distance is short, only an inductive field is necessary, and little or no radiation occurs. This limits the operating power, which allows a smaller size and weight for the

rechargeable battery 51 and, thus, the portable device 2. Furthermore, it limits interference between systems operating in close proximity. Therefore, interference rejection circuitry may be limited or not necessary in the portable device 2.

The transducer system in the portable device 2 is illustrated schematically in Fig. 4. The transducer 40 preferably includes a ferrite rod transducer having a ferrite rod 41 within a wire coil 42. The wires from the transducer 40 are connected to a transceiver 27 having transmitter electronics 28 and receiver electronics 29. The transceiver 27 connects to the portable device electronics 26, the nature of which is dependent upon the function of the portable device 2. In the example of the portable device as a headset 20, the portable device electronics would connect to a speaker 22 and a microphone 25. Transmission and reception can occur at different frequencies, which permits full duplex operation. Alternatively, separate transmitting and receiving transducers can be used.

The base unit 1 configuration is illustrated schematically in Fig. 5. The transducer system 30 includes three orthogonally disposed ferrite rod transducers, each including a ferrite rod 31, 32, 33 and a respective coil 34, 35 and 36. The use of the orthogonally disposed transducers overcomes the occurrence of mutual inductance nulls in the resulting inductive fields. The three transducers are connected to multiplexer electronics 60 for selecting one or more of the transducers for transmission and reception. Circuitry may be used to select the transducer or transducers having the strongest signal for transmission and reception to reduce the total power consumption of the device. The transmitter electronics 61 and receiver electronics 62 provide for processing of the communications signals from the base unit electronics 70 and the portable device 2. As discussed above, for a portable telephone 10, the conventional telephone speaker 71 and mouthpiece 72 may be eliminated so that the portable telephone 10 solely uses the headset 20 through the transducer system for communicating to the user. Switching circuitry (not shown) would be included to select between the speaker 71 and microphone 72, and the headset 20. The switching circuitry could be included in the receptacle 19 so that the speaker 71 and microphone 72 are disconnected when the headset 20 is removed.

Fig. 6 illustrates a second embodiment of the transducer system for the base unit 1. In the transducer 30 of Fig. 6, one of the ferrite rod transducers is replaced with a loop coil transducer 37. A loop coil transducer can replace any or all of the ferrite rod transducers. The loop coil transducer 37 is disposed in the plane of the remaining ferrite rod transducers. This creates a transducer system having a decreased depth. As illustrated in Fig. 2, the three orthogonal

transducers can be placed in a corner along the sides of the portable telephone 10. Alternatively, the loop coil transducer 37 could be placed along the back of the portable phone 10, so that it could be made thinner.

Additionally, the transmission system can be used for charging the battery 51 of the portable device 2. The base unit 1 includes a battery charger signal generator 52 connected to the transmitter 61. This generator 52 produces a recharging signal which is sent through one of the ferrite rod transducers in the base unit 1 to the ferrite rod transducer 40 of the portable device 2. Since in the telephone embodiment of Fig. 2, the headset 20 and transducer 40 have a known orientation when in the receptacle 19, only one transducer in the portable telephone 10 needs to be energized to inductively transmit the recharging signal. As illustrated in Fig. 3, the wires from the transducer 40 in the portable device 2 are connected to a battery charger 50 which is used to charge the battery 51.

Although the communication system of the present invention has been illustrated in connection with a concha type headset 20 and a cellular or cordless telephone handset 10 as a base unit 1, it is readily adaptable for other types of headsets and uses. The headset can be of the over-the-head type, over-the-ear type, or binaural type. The system can be used as a wireless connection to a conventional desktop telephone. Such a system would operate in the manner discussed above with the cordless handset. Since several such units may be used in close proximity, interference may become more of a problem. Therefore, the system can be designed to operate on various frequencies and can select frequencies for the transmission and reception which are unlikely to have significant interference. Similarly, the system can be used with a computer, either stationary or portable, for voice data entry, sound transmission, and telephone functions. The system can also be used with other types of communication systems, including personal digital assistants (PDA's), cordless phones, PCS and SMR cellular phones, two way (video games), two-way half duplex (walkie-talkies, CBs), or two-way full duplex (phones). When the base unit is stationary and the user is likely to be at certain locations relative to the base unit, fewer transducers may be used in the base unit without encountering mutual inductance nulls. Alternative transducer systems may also be used for generating the inductive fields. Specifically, rather than a single transducer for transmission and reception on different frequencies, separate transducers may be used.

Having thus described one illustrative embodiment of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations,

modifications, and improvements are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only and is not intended as limiting. The invention is limited only as defined in the following claims and equivalent thereto.

CLAIMS

1. A communications system comprising:
a base unit, including:
a base unit input for inputting first signals,
5 a base unit output for outputting second signals, and
a base unit transducer system connected to said input for generating a first
inductive field based upon said first signals and connected to said output for converting a second
inductive field into said second signals;
a portable unit including:
10 a portable unit input for inputting third signals,
a portable unit output for outputting fourth signals, and
a portable unit transducer system connected to said portable unit input for
generating said second inductive field based upon said third signals, and connected to said
portable unit output for converting said first inductive field into said fourth signals; and
15 wherein the base unit transducer system and the portable unit transducer system operate
so that said first inductive field and said second inductive field may be concurrently generated
and converted.
2. The communications system of claim 1, wherein said base unit is connected to a
20 communications network for inputting said first signals from and outputting said second signals
to said communications network.
3. The communications system of claim 1, wherein said portable unit is a headpiece,
wherein said portable unit input is a microphone, and wherein said portable unit output is a
25 speaker.
4. The communications system of claim 1, wherein said base unit transducer system
includes:
a plurality of orthogonal transducers; and
30 selection means for selectively energizing at least one of said plurality of orthogonal
transducers.

5. The communications system of claim 1, wherein said first inductive field includes a first carrier frequency, and wherein said second inductive field includes a second carrier frequency having a different frequency than said first carrier frequency.

5 6. The communications system of claim 1, wherein said base unit transducer system includes a transmitter transducer for generating said first inductive field and a receiver transducer for converting said second inductive field into said second signals.

7. The communications system of claim 1, wherein said portable transducer system
10 includes a transmitter transducer for generating said second inductive field and a receiver transducer for converting said first inductive field into said fourth signals.

8. A communications system comprising:
a base unit communicating with a communications network, including:
15 a base unit input for inputting first signals from the communications network, and
a base unit transducer system connected to said input for generating a first inductive field based upon said first signals; and
a portable unit including:
a portable unit transducer system for converting said first inductive field into fourth
20 signals, and
a portable unit output connected to the portable unit transducer system for outputting said fourth signals.

9. The communications system of claim 8, wherein the portable unit further includes
25 a portable unit input for inputting third signals; wherein said portable unit transducer is connected to the portable unit input for generating a second inductive field based upon said third signals; wherein said base unit further includes a base unit output for outputting second signals to said communications network, and wherein the base unit transducer is connected to the base unit output for converting said second inductive field into said second signals.

30 10. The communications system of claim 8, wherein said communications network is a telephone system.

11. The communications system of claim 8, wherein said communications network is a cellular telephone system.

12. The communications system of claim 8, wherein said base transducer system includes at least one ferrite rod transducer.

13. The communications system of claim 8, wherein said base transducer system includes at least one loop transducer.

14. The communications system of claim 8, wherein said headpiece transducer system includes at least one ferrite rod transducer.

15. The communications system of claim 8, wherein said base unit further includes a receptacle for attaching said portable unit to said base unit.

16. The communications system of claim 15, wherein said receptacle includes means for disconnecting said base unit from said communications network when said portable unit is attached to said base unit.

17. The communications system of claim 15, further comprising charging means for charging a battery in said portable unit when said portable unit is attached to said base unit.

18. The communications system of claim 8, further comprising charging means for charging a battery in said portable unit.

19. The communications system of claim 18, wherein said charging means includes: generation signal means in said base unit for generating a third inductive field; and charging signal means in said portable unit for converting said third inductive field into a signal for charging said battery.

20. The communications system of claim 8, wherein said base unit transducer system includes:

a plurality of orthogonal transducers; and
selection means for selectively energizing at least one of said plurality of orthogonal transducers.

5 21. The communications system of claim 9, wherein said first inductive field includes a first carrier frequency, and wherein said second inductive field includes a second carrier frequency having a different frequency than said first carrier frequency.

 22. The communications system of claim 9, wherein said base unit transducer system
10 includes a transmitter transducer for generating said first inductive field and a receiver transducer for converting said second inductive field into said transmitted communications signals.

 23. The communications system of claim 9, wherein said portable unit transducer system includes a transmitter transducer for generating said second inductive field and a receiver
15 transducer for converting said first inductive field into said received audio signals.

 24. A method for communicating with a communications network, said method comprising the steps of:

 inputting first signals from said communications network;
20 generating a first inductive field based upon said first signals; and
 converting said first inductive field into fourth signals.

 25. The method of claim 24, further comprising the steps of:
 receiving third signals;
25 generating a second inductive field based upon said third signals;
 converting said second inductive field into second signals; and
 outputting said second signals to said communications network.

 26. The method of claim 24, wherein said fourth signals are sounds.

30 27. The method of claim 25, wherein said third signals are sounds.

28. The method of claim 24, wherein said communications network is a telephone system.

29. The method of claim 24, wherein said communications network is a cellular
5 telephone system.

30. A method for communicating comprising the steps of:
inputting first signals;
generating a first inductive field based upon said first signals; and
10 converting said first inductive field into fourth signals.
receiving third signals;
generating a second inductive field based upon said third signals;
converting said second inductive field into second signals;
outputting said second signals; and
15 wherein said first inductive field and second inductive field may be generated
concurrently.

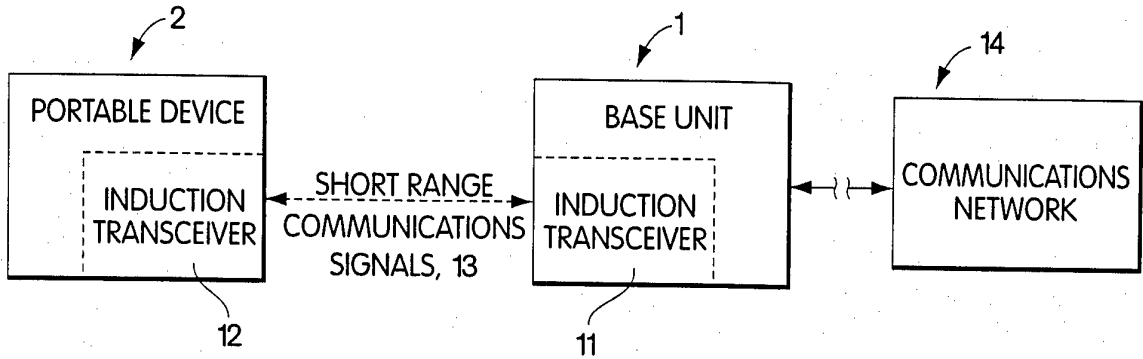


Fig. 1

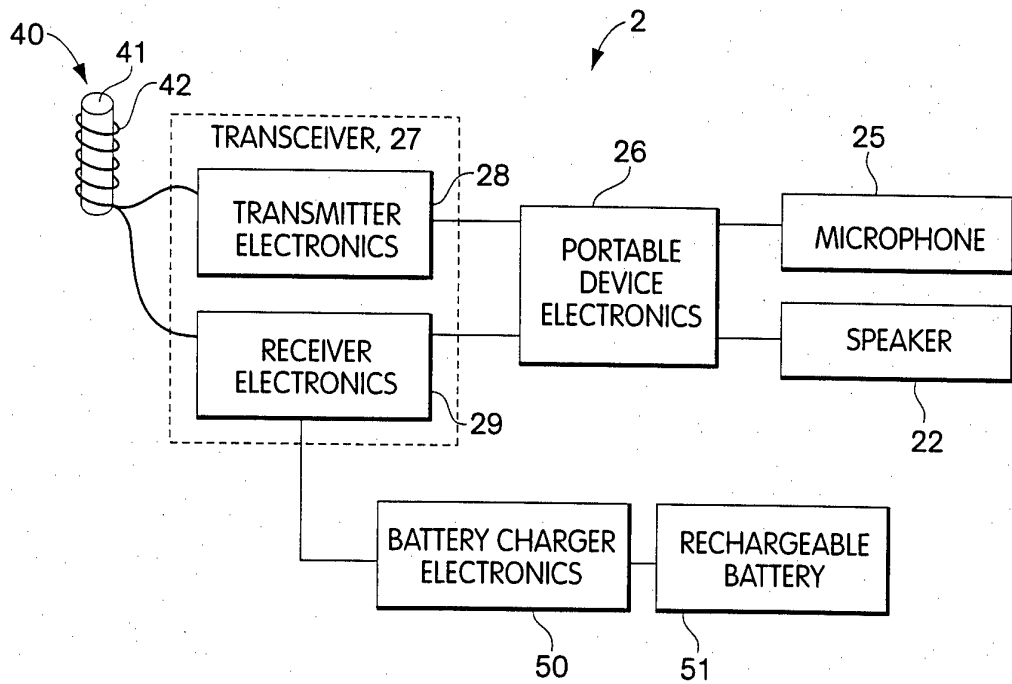


Fig. 4

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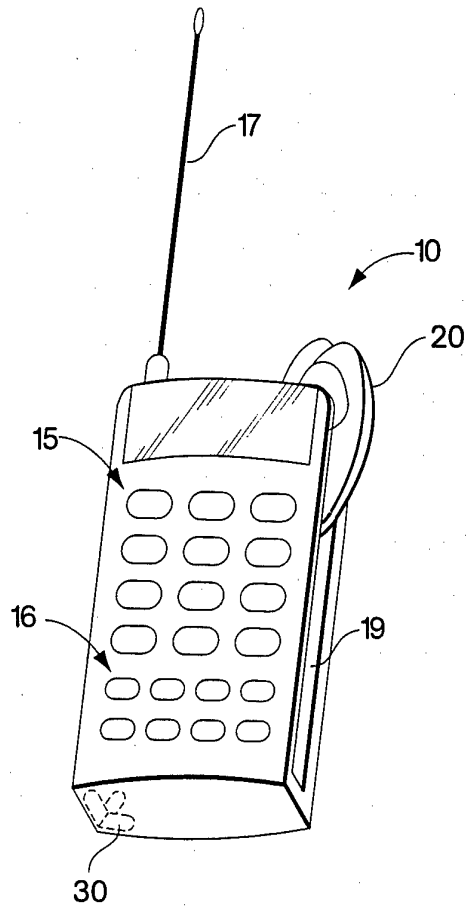


Fig. 2

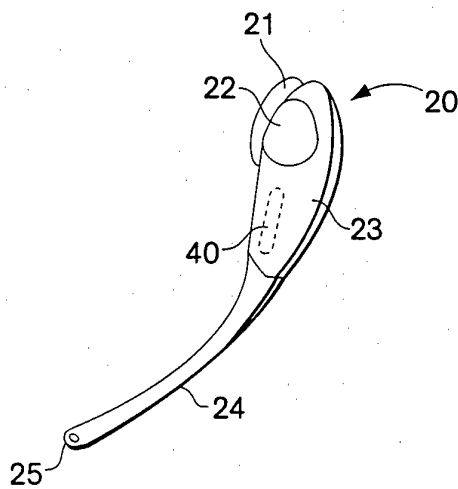


Fig. 3

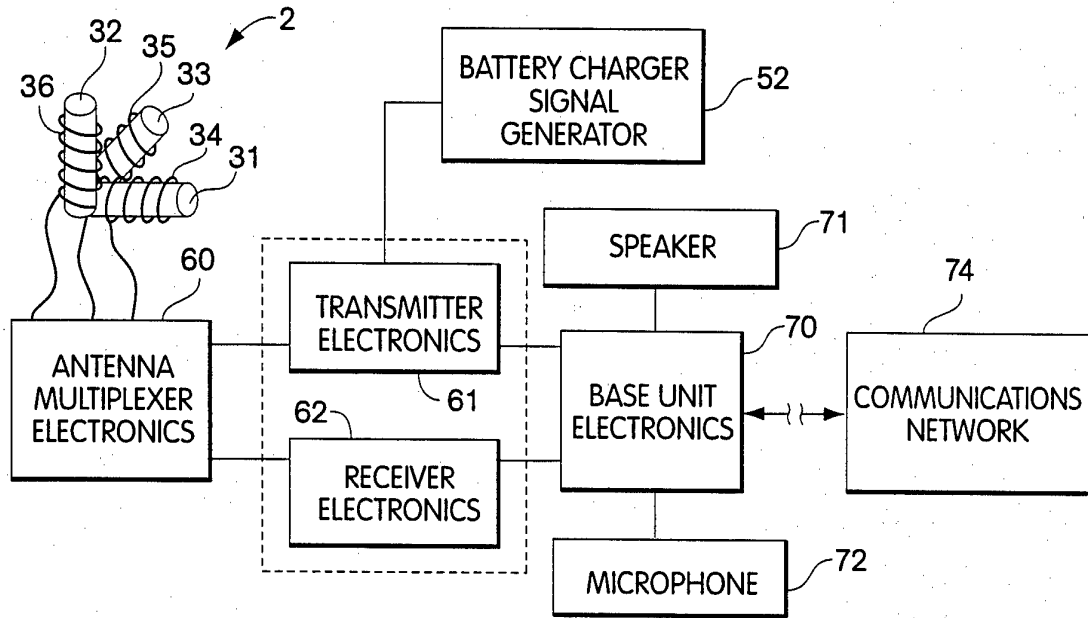


Fig. 5

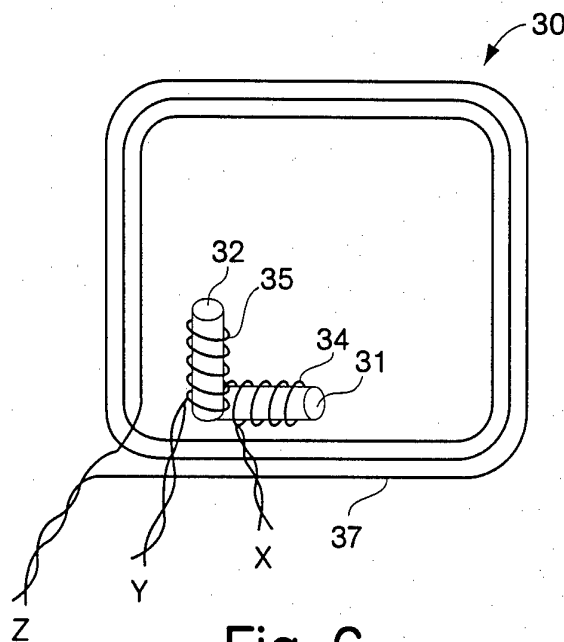


Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 96/07144

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B5/02 H04M1/60

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B. FIELDS SEARCHED

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IPC 6 H04B H04M

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| X | GB,A,1 164 281 (EMI) 17 September 1969 see page 1, line 37 - line 47 see page 2, line 46 - line 83 see page 3, line 75 - line 86 see page 3, line 114 - page 4, line 19 see page 5, line 67 - line 72 --- | 1,2,5, 7-10, 13-15, 17-19, 21, 23-28,30 |
| X | GB,A,2 197 160 (DATAPRODUCTS) 11 May 1988 see page 2, line 11 - line 121 --- -/-- | 1,3,5,6, 8,9,13, 30 |

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Date of the actual completion of the international search

4 September 1996

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Holper, G

INTERNATIONAL SEARCH REPORT

International Application No
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| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT | | |
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| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| A | DE,A,36 03 098 (RADAKOVIC) 8 January 1987 see column 6, line 36 - line 59 --- | 4,12,14, 20 |
| A | FR,A,2 431 227 (ELECTRONIQUE MARCEL DASSAULT) 8 February 1980 see page 2, line 20 - line 40 --- | 19 |
| A | GB,A,2 277 422 (UNIVERSAL EXCHANGE LIMITED) 26 October 1994 see page 2, line 1 - line 6 see page 4, line 5 - line 9 see page 2, paragraph 4 --- | 3,15 |
| A | DE,U,93 09 032 (LACHNITT) 3 November 1994 see figure 4 ----- | 3,10 |

INTERNATIONAL SEARCH REPORT

Information on patent family members

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|--|
| Intern: <small>al</small> Application No PCT/US 96/07144 |
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| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|------------------|
| GB-A-1164281 | 17-09-69 | NONE | |
| GB-A-2197160 | 11-05-88 | US-A- 4747158 | 24-05-88 |
| DE-A-3603098 | 08-01-87 | NONE | |
| FR-A-2431227 | 08-02-80 | NONE | |
| GB-A-2277422 | 26-10-94 | NONE | |
| DE-U-9309032 | 03-11-94 | NONE | |