

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
3 July 2008 (03.07.2008)

PCT

(10) International Publication Number
WO 2008/078142 A1

(51) International Patent Classification:
H01Q 1/24 (2006.01)

(74) Agents: HIGGIN, Paul et al.; Swindell & Pearson, 48
Friar Gate, Derby DE1 1GY (GB).

(21) International Application Number:
PCT/IB2006/004177

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS,
JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS,
LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY,
MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS,
RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
22 December 2006 (22.12.2006)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): NOKIA
CORPORATION [FI/FI]; Keilalahdentie 4, FIN-02150
Espoo (FI).

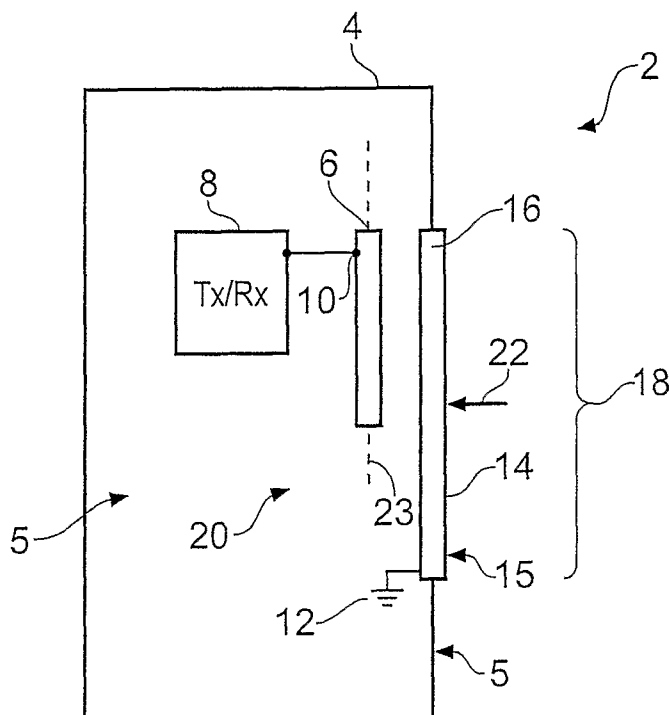
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT,
RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA,
GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(72) Inventors; and

(75) Inventors/Applicants (for US only): HUI, Ping [CA/CA];
420 Livingstone Place, Richmond, BC V7C 5N1 (CA).
IRAJI, Sassan [FI/FI]; Huovitie 7 A 12, FIN-00400
Helsinki (FI). JANTUNEN, Joni, Jorma, Marius [FI/FI];
Eerikinkatu 26 B 34, FIN-00100 Helsinki (FI).

Published:
— with international search report

(54) Title: AN APPARATUS COMPRISING A RADIO ANTENNA ELEMENT AND A GROUNDED CONDUCTOR



(57) Abstract: An apparatus comprising: an exterior housing; a radio antenna element within the exterior housing; and a grounded conductor extending adjacent the antenna element and having a first area that is physically associated with a portion of the exterior housing.

WO 2008/078142 A1

TITLE

An apparatus comprising a radio antenna element and a grounded conductor

5 FIELD OF THE INVENTION

Embodiments of the present invention relate to a radio apparatus.

BACKGROUND TO THE INVENTION

10

Some radio apparatuses have an antenna element and a grounded conductor that operates as a ground plane for the grounded conductor.

15

The ground plane is an important component of such apparatus. To maximize the efficiency of the antenna element the ground plane must be sufficiently large. This constraint on the size of the ground plane may make it difficult to reduce the size of such radio apparatus.

BRIEF DESCRIPTION OF THE INVENTION

20

According to some embodiments of the invention there is provided an apparatus comprising: an exterior housing; a radio antenna element within the exterior housing; and a grounded conductor extending adjacent the antenna element and having a first area that is physically associated with a portion of the exterior housing.

25

30

In use, a user's hand may touch or come close to the first area because of the physical association between the first area of the grounded conductor and the exterior housing. The user's hand, in use, increases the size of the grounded conductor improving antenna radiation efficiency.

2

According to some embodiments of the invention there is provided a portable apparatus comprising: an exterior housing; and an antenna arrangement comprising a radio antenna element within the exterior housing and a grounded conductor extending adjacent the antenna element and having a first area that is arranged such that it is coupled to the exterior housing to a significantly greater degree than the radio antenna element such that when the apparatus is held in a hand of a user the electrical length of the grounded conductor is significantly extended improving the efficiency of the antenna arrangement.

10

In some embodiments, the presence of the user's hand does not significantly change the impedance of the antenna element so that the antenna element is operable in the same communications band with or without the presence of the hand, although it is more efficient with the presence of the hand.

15

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention reference will now be made by way of example only to the accompanying drawings in which:

- 20 Figure 1 schematically illustrates a first embodiment of an apparatus;
Figure 2 schematically illustrates a second embodiment of an apparatus;
Figure 3 schematically illustrates a third embodiment of an apparatus;
Figure 4 schematically illustrates a fourth embodiment of an apparatus; and
25 Figure 5 schematically illustrates the effect of a user's hand on the efficiency of the apparatus.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

30 Figures 1, 2, 3 and 4 schematically illustrate an apparatus 2 comprising: an exterior housing 4; an antenna arrangement 20 comprising a radio antenna

3

element 6 and a grounded conductor 14 and RF circuitry 8 connected to the radio antenna element 6.

5 The RF circuitry 8 may be a receiver, a transmitter or a transceiver depending upon implementation.

10 The radio antenna element 6 is positioned within a volume 5 enclosed by the exterior housing 4. It has a feed point 10 connected to the RF circuitry 8. It is not, in this example, in physical or electrical contact with exterior housing 4.

15 The exterior housing 4 has a portion 18 that typically makes contact with a user's hand when the apparatus 4 is in use. The portion 18 of the exterior housing 4 is coupled to ground in each of the embodiments illustrated in Figs 1 to 4. In Figs 1 and 3, a dc current path to ground is provided via the grounded conductor as the grounded conductor 14 provides the portion 18 of the exterior housing. In Figs 2 and 4, an ac current path to ground is provided via a capacitor formed by the grounded conductor 14, the dielectric portion 18 and the user's hand 22.

20 The grounded conductor 14 operates as a ground plane for the antenna element 6 and extends adjacent at least the feed point 10 of the radio antenna element 6. In some embodiments, the antenna element 6 may extend substantially in a first plane 23 from the feed point with the separate grounded conductor 14 running in parallel.

25 A first area 16 of the grounded conductor 14 is arranged such that it is electrically coupled to an exterior of the housing 4 to a significantly greater degree than the radio antenna element 6. The grounded conductor 14 is positioned closer to an exterior of the apparatus 2 than the radio antenna
30 element 6.

4

When a hand 22 of a user contacts the portion 18 of the exterior housing 4, in use, the electrical length of the grounded conductor 6 is significantly increased. This increase in the ground plane of the antenna element 6 improves the efficiency of the antenna arrangement 20 at its lowest resonant
5 frequency whereas the impedance of the antenna element 6 is not significantly changed at this frequency.

As illustrated in Fig 5, the insertion loss S_{11} is more negative when a hand is in contact with the portion 18 of the exterior housing 4. As is well known to a
10 person skilled in the art, a more negative insertion loss S_{11} corresponds to an improved efficiency. Thus the antenna arrangement 20 is more efficient when a user's hand is touching the portion 18 of the exterior housing 4.

It can also be seen from the Figure that, in this particular example, the
15 resonant frequency of the antenna arrangement does not change or change significantly because the radio antenna element 6 is positioned and arranged such that coupling, in use, to a user's hand 22 is small or minimal. The presence of the user's hand does not significantly affect the electrical length or impedance of the antenna element 6 so that the antenna arrangement is
20 operable in the same communications band with or without the presence of the user's hand but is more efficient with the presence of the user's hand..

In other embodiments the presence of a user's hand may significantly affect the electrical length or impedance of the antenna element 6. In these
25 circumstances, the antenna arrangement may only be operable in a communications band with the presence of the user's hand.

In some embodiments, the grounded conductor 14 may operate as a separate antenna element particularly at lower frequencies. It is possible that the
30 ground plane is effectively operating as a planar inverted F antenna that is capacitively fed from the antenna element 6.

5

In Figs 1 and 3, the grounded conductor 14 is associated with the exterior housing 14 by incorporation therein. The grounded conductor 14 is incorporated within the exterior housing 4 such that an exterior surface 15 of the grounded conductor 14 is an exterior surface 5 of the exterior housing 4. It is an integral and exposed part of the exterior housing 4. The grounded conductor 14 is galvanically connected to ground 12. When a user 22 touches the grounded conductor 14 the user is connected to ground via a galvanic (dc) current path that includes the grounded conductor 14. The user thus becomes part of the grounded conductor 14 extending the ground plane of the antenna element 6.

In Figs 2 and 4, the grounded conductor 14 is associated with the exterior housing 14 by being positioned very close to the portion 18 of the exterior housing 4. The grounded conductor 14 forms one plate of a capacitor, the other plate being formed by the user's hand 22 and the exterior housing providing the capacitor dielectric. The grounded conductor 14 may be attached or bonded to the interior surface 7 of the exterior housing 4 so that it is an integral but not exposed part of the exterior housing 4 or there may be a small air gap between them. When a user 22 touches the portion 18 of the exterior housing 4, the user is connected to ground via an ac current path that includes the capacitor. The user thus becomes part of the grounded conductor 14 for higher frequencies.

In Figs 1 and 2, the grounded conductor 14 is a single element. It may, for example, be a sheet of metal lying in a single plane.

In Figs 3 and 4, the grounded conductor 14 is a multi-part element. Each part is a separate element and the elements are electrically connected. In the illustrated examples, two parts are shown but there may be additional parts in other implementations. One or more of the interconnected parts may be electrically connected to ground 12.

6

The grounded conductor 14 comprises a first portion 14B that is associated with the exterior housing 4 in one of the manners described above and a second portion 14A that is associated with the antenna element 6 and electrically connected to the first portion 14A.

5

Typically the first portion 14B of the grounded conductor 14 is positioned closer to an exterior of the apparatus than the antenna element 6 to ensure that when a user touches the apparatus 2 the coupling between user and grounded conductor 14 is significantly greater than any coupling between the user and the antenna element 6.

10

The second portion 14A may be a printed wiring board (PWB). If the ground plane of the antenna element 6 has $\lambda/4$ resonant modes then one would expect its lowest resonant frequency mode to be defined by $L = \lambda/4$, where L is the electrical length of the ground plane which we shall approximate to the physical length. If the electrical length of the ground plane in the absence of a user's hand is L_1 and the extension to the ground plane provided by the presence of a user's hand is L_2 then $L_1 + L_2 = \lambda/4$ or $4L_1 + 4L_2 = \lambda$. Thus the lowest resonant frequency mode has an equivalent wavelength that is significantly greater than four times the electrical length L_1 of the grounded conductor 14.

15

20

It will be appreciated from the foregoing that embodiments of the invention enable the electrical length of a ground plane for an antenna element to be extended in use. This enables the apparatus 2 to have a shorter than ideal ground plane because its length will be extended in use.

25

The apparatus 2 is typically a hand-portable device that is held in the palm of the hand when in use.

30

7

The apparatus 2 may, for example, be an RFID reader. Such readers are operable to receive radio communications for a range of frequencies between 800MHz and 1GHz e.g. at 868MHz or 915MHz.

5 The apparatus 2 may, for example, be a mobile cellular telephone, a wireless local area network (WLAN) terminal, a Digital Video Broadcasting- Handled (DVB-H) mobile TV receiver, a Frequency Modulation (FM) radio receiver etc. DVB-H typically uses the frequency range 470 to 830 MHz. A FM radio receiver typically uses the frequency range 88-108 MHz.

10

The device dimensions of a DVB-H device or FM radio device are typically much smaller than the operating wavelength and the antenna element is of small dimension compared to wavelength.

15 Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

20 Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

25

I/we claim:

CLAIMS

1. An apparatus comprising
an exterior housing;
5 a radio antenna element within the exterior housing; and
a grounded conductor extending adjacent the antenna element and having a
first area that is physically associated with a portion of the exterior housing.

2. An apparatus as claimed in claim 1, comprising an antenna arrangement
10 that comprises the radio antenna element and the grounded conductor,
wherein the first area of the grounded conductor is arranged such that it is
electrically coupled to the exterior housing to a significantly greater degree
that the radio antenna element such that when a hand of a user contacts the
portion of the exterior housing the electrical length of the grounded conductor
15 is significantly increased improving the efficiency of the antenna arrangement
at a first frequency whereas the impedance of the antenna element is not
significantly changed at the first frequency.

3. An apparatus as claimed in claim 1 or 2, wherein the grounded conductor
20 operates as a ground plane for the antenna element and increasing the
electrical length of the grounded conductor extends the ground plane thereby
increasing the efficiency of the antenna element.

4. An apparatus as claimed in claim 1, 2 or 3, wherein the grounded
25 conductor, in use, operates as a planar inverted F antenna that is capacitively
fed from the antenna element.

5. An apparatus as claimed in any preceding claim, wherein the radio antenna
30 element has a feed point and the grounded conductor extends adjacent at
least the feed point of the radio antenna element.

6. An apparatus as claimed in any preceding claim, having a first operational frequency that has an equivalent wavelength that is significantly greater than four times the length of the grounded conductor.

5 7. An apparatus as claimed in any preceding claim, wherein the radio antenna element is positioned and arranged such that coupling, in use, to a user's hand does not affect the electrical length of the antenna element.

10 8. An apparatus as claimed in any preceding claim, wherein the grounded conductor is positioned closer to the exterior of the apparatus than the radio antenna element.

9. An apparatus as claimed in any preceding claim, wherein the grounded conductor is physically attached to the exterior housing.

15

10. An apparatus as claimed in any preceding claim, wherein the grounded conductor is integrated within the exterior housing.

20 11. An apparatus as claimed in any preceding claim, wherein the grounded conductor comprises a first portion that is associated with the exterior housing and a second portion that is associated with the antenna element and electrically connected to the first portion.

25 12. An apparatus as claimed in claim 11, wherein the first portion of the grounded conductor is positioned closer to an exterior of the apparatus than the antenna element.

13. An apparatus as claimed in any preceding claim, wherein the radio antenna element extends substantially in a first plane and the first area of the grounded conductor extends substantially parallel to the first plane.

30

14. An apparatus as claimed in claim 13, wherein

the radio antenna element extends from a feed point substantially in the first plane and the first area extends adjacent to, but separated from, at least the feed point of the antenna element.

5 15. An apparatus as claimed in any preceding claim, wherein at least a portion of the exterior housing is coupled to ground.

16. An apparatus as claimed in claim 15, wherein the coupling to ground is provided by capacitive coupling that involves the grounded conductor.

10

17. An apparatus as claimed in claim 15 or 16, wherein the exterior housing forms a dielectric for a capacitor formed in use between the grounded conductor and the user's hand.

15 18. An apparatus as claimed in claim 15, wherein the coupling to ground is provided by a galvanic connection that comprises the grounded conductor.

19. An apparatus as claimed in any one of claims 1 to 15 or claim 18, wherein a surface portion of the exterior housing provides the grounded conductor.

20

20. An apparatus as claimed in any preceding claim that is hand-portable.

21. An apparatus as claimed in any preceding claim that is arranged for use as a RFID reader.

25

22. An apparatus as claimed in any preceding claim that is arranged for DVB-H communication.

23. An apparatus as claimed in any preceding claim that is arranged for FM
30 radio communication.

24. An apparatus as claimed in any preceding claim that is operable to receive radio communications for a range of frequencies between 800MHz and 1GHz.

5 25. A portable apparatus comprising:

an exterior housing; and

an antenna arrangement comprising a radio antenna element within the exterior housing and

10 a grounded conductor extending adjacent the antenna element and having a first area that is arranged such that it is coupled to the exterior housing to a significantly greater degree than the radio antenna element such that when the apparatus is held in a hand of a user the electrical length of the grounded conductor is significantly extended improving the efficiency of the antenna arrangement

15

26. A portable apparatus as claimed in claim 25, wherein, when the apparatus is held in a hand of a user, the impedance of the antenna element is not significantly changed.

20 27. A portable apparatus as claimed in claim 25 or 26, wherein at least a portion of the exterior housing is coupled to ground.

28. A portable apparatus as claimed in claim 27, wherein the coupling is via a galvanic connection.

25

29. A portable apparatus as claimed in claim 27, wherein the coupling is capacitive coupling.

30

1/3

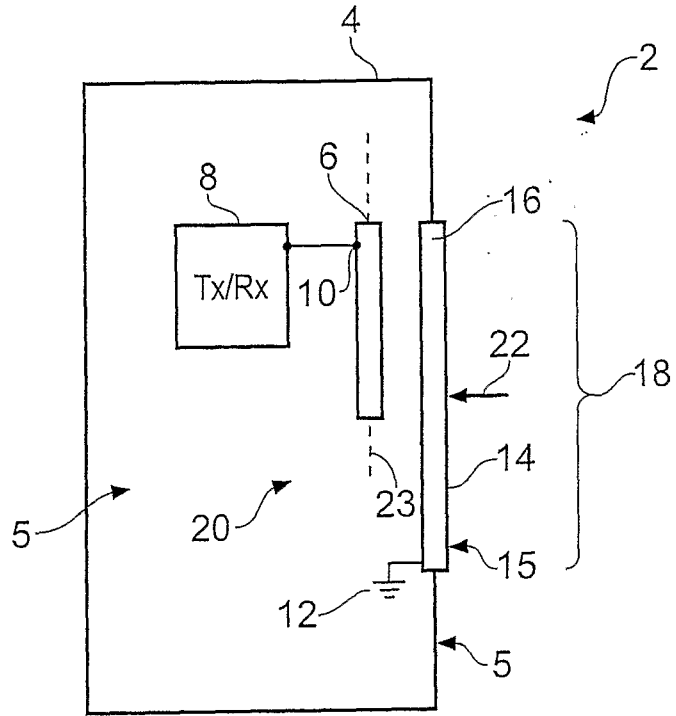


Fig. 1

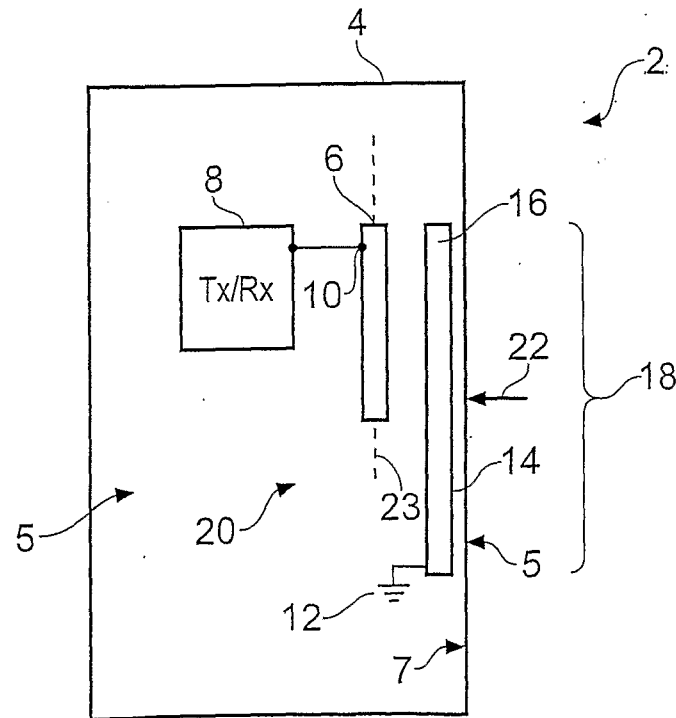


Fig. 2

2/3

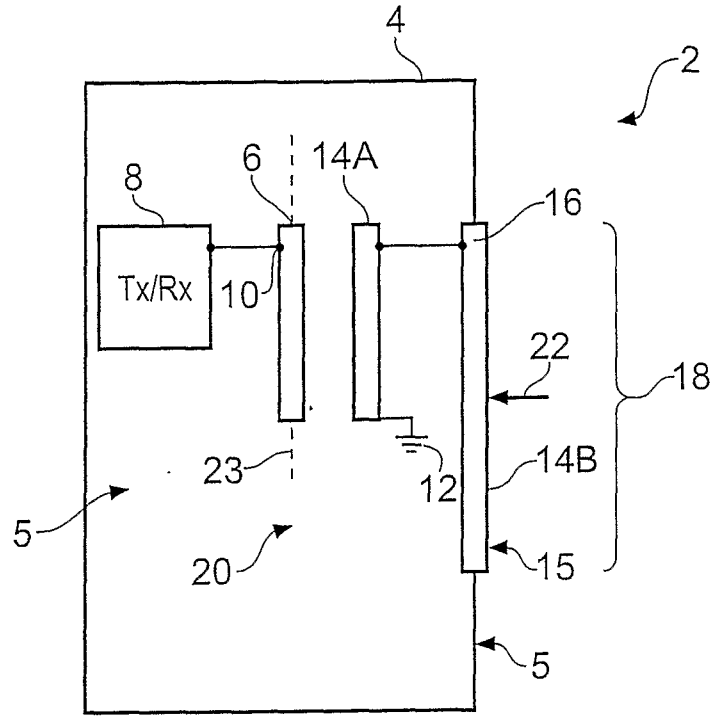


Fig. 3

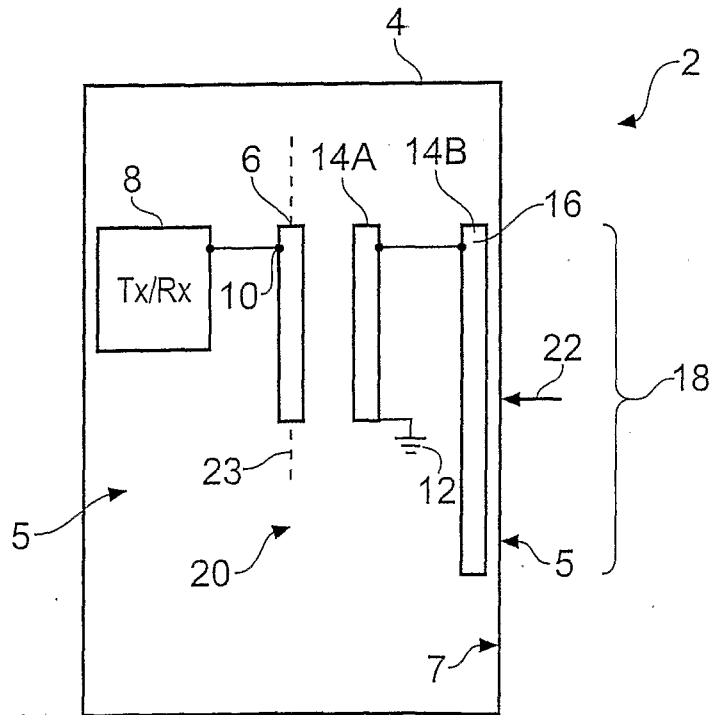


Fig. 4

3/3

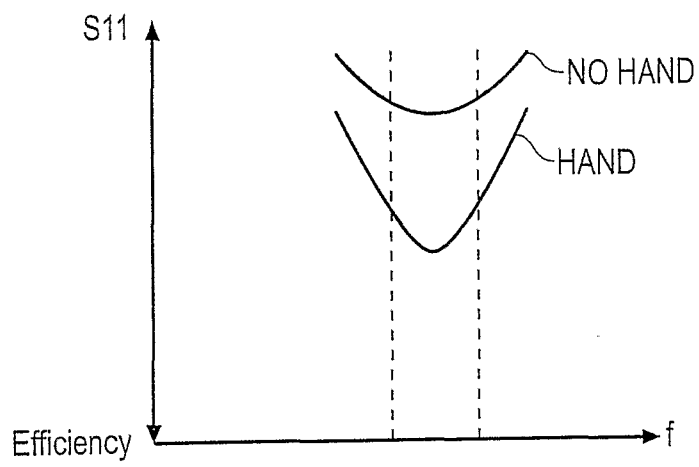


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2006/004177

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5969685 A (G.J.HAYES ET AL), 19 October 1999 (19.10.1999), column 4, line 11 - line 32, figure 3 --	1-29
A	US 20020094789 A1 (N.HARANO), 18 July 2002 (18.07.2002), abstract --	1-29
A	US 20060192724 A1 (V.KEZYS ET AL), 31 August 2006 (31.08.2006), abstract --	1-29
A	US 20040164910 A1 (M.KURODA), 26 August 2004 (26.08.2004), abstract --	1-29

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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

"&" document member of the same patent family

Date of the actual completion of the international search

15 October 2007

Date of mailing of the international search report

18-10-2007

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Rune Bengtsson /itw
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2006/004177

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20060025185 A (H.SHOJI ET AL), 2 February 2006 (02.02.2006), [0062], fig.6 -----	1-29

International patent classification (IPC)
H01Q 1/24 (2006.01)

Download your patent documents at www.prv.se

The cited patent documents can be downloaded at www.prv.se by following the links:

- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument (service in Swedish).

Use the application number as username.

The password is **PLMYAIFHQW**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/09/2007

International application No.

PCT/IB2006/004177

US	5969685	A	19/10/1999	AU	4702699	A	06/03/2000
				CN	1312963	A,T	12/09/2001
				EP	1118135	A	25/07/2001
				JP	2002523003	T	23/07/2002
				TW	457743	B	00/00/0000
				WO	0010222	A	24/02/2000

US	20020094789	A1	18/07/2002	JP	2002217803	A	02/08/2002

US	20060192724	A1	31/08/2006	CA	2584375	A	27/04/2006
				EP	1803233	A	04/07/2007
				US	7187332	B	06/03/2007
				US	20060084395	A	20/04/2006
				US	20070132647	A	14/06/2007
				WO	2006042399	A	27/04/2006

US	20040164910	A1	26/08/2004	JP	2002051125	A	15/02/2002
				US	6725070	B	20/04/2004
				US	20020019252	A	14/02/2002

US	20060025185	A	02/02/2006	CN	1231995	C	14/12/2005
				CN	1437778	A	20/08/2003
				EP	1271687	A	02/01/2003
				EP	1443590	A	04/08/2004
				US	7031762	B	18/04/2006
				US	7225003	B	29/05/2007
				US	20030013490	A	16/01/2003
				WO	02054532	A	11/07/2002
				US	D535400	S	16/01/2007
