

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
6 July 2006 (06.07.2006)

PCT

(10) International Publication Number  
**WO 2006/071168 A1**

(51) International Patent Classification:  
**G01S 13/87** (2006.01) **G01S 13/78** (2006.01)

(21) International Application Number:  
PCT/SE2005/001843

(22) International Filing Date:  
6 December 2005 (06.12.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
0403200-9 30 December 2004 (30.12.2004) SE

(71) Applicant (for all designated States except US): **TAG-MASTER AB** [SE/SE]; Kronborgsgränd 1, S-164 87 Kista (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **WILLGERT, Mikael** [SE/SE]; Skiljevägen 23, S-163 54 Spånga (SE).

(74) Agents: **ÖRTENBLAD, Bertil** et al.; Noréns Patentbyrå AB, Box 10198, S-100 55 Stockholm (SE).

(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, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

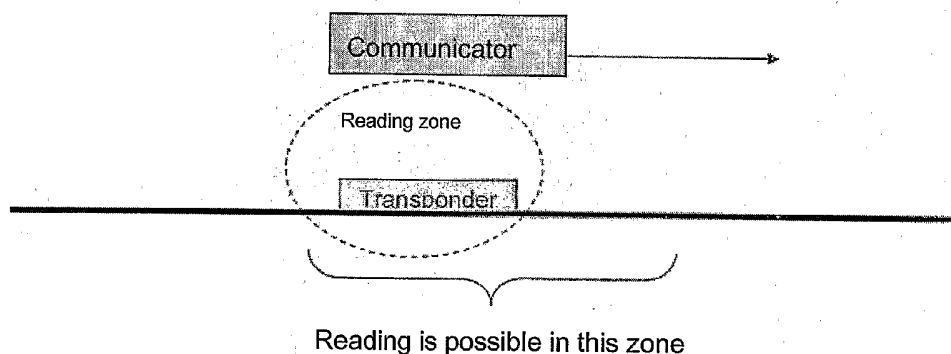
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, 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).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD OF DETERMINING THE POSITION OF A TRANSPONDER IN RELATION TO A COMMUNICATOR



(57) Abstract: A method of determining the position of a transponder in relation to a communicator, wherein the transponder (9) can be read by means of a communicator (11) which is adapted to send an inquiry signal to the transponder, wherein the transponder (9) is adapted to answer the inquiry signal and therewith transfer information from a memory in the transponder and wherein the communicator (11) is connected to a principal data system (16) and is adapted to receive said information. The method is characterized by connecting the communicator (11) to an envelope detector (15) which is caused to detect the envelope of the signal received from the transponder (9); and by determining the relative position between the transponder (9) and the communicator (11) from said envelope.

WO 2006/071168 A1

## A METHOD OF DETERMINING THE POSITION OF A TRANSPONDER IN RELATION TO A COMMUNICATOR

The present invention relates to a method of determining a position of a transponder in relation to a communicator.

Known automatic identification systems normally include person-carried identification tags and equipment for reading the tags.

Known automatic identification systems that use radio frequencies, so-called RFID (Radio Frequency Identification), include at least one transponder and at least one communicator. A known type of transponder includes an antenna, a modulator, a memory and a modulator controlling logic circuit. This known transponder is designed to receive a signal sent by the communicator and reflect this signal in a modulate state. The communicator is designed to receive and read the modulated signal reflected by the transponder.

The system also includes ID-tags for sending information to a communicator.

One area of use of such a system resides in a train position determining system, which is used in regard of braking the speed of the train and therewith controlling its stop position, for instance relative to a railway platform. A desired accuracy with respect to this stop position is +/- 5 – 10 cm.

In this respect, a train is provided with a communicator and transponders are placed along the railroad track.

One problem with this known system is that the positions at which the transponders are read is, among other things, dependent on the antenna lobes of the transponder and the communicator, and the distance between these antennas. With regard to positioning, the detected position between the transponder and the communicator concerned is influenced when reading of the transponder takes place at an early stage or at a late stage in the time slot in which reading is possible.

This problem is solved by means of the present invention.

The present invention relates to a method of determining the position of a transponder in relation to a communicator, wherein the transponder can be read by means of a communicator which is adapted to send an inquiry signal to the transponder, wherein the transponder is adapted to answer the inquiry signal, and therewith transfer information from a memory in the transponder, and wherein the communicator is connected to a principal data system, and is adapted to receive said information and wherein the method is characterized by connecting the communicator to an envelope detector which is caused to detect the envelope of the signal received from the transponder, and by causing the relative position between the transponder and the communicator to be determined from said envelope.

The invention will now be described in more detail partly with reference to an exemplifying embodiment of the invention illustrated in the accompanying drawing, of which

- Fig. 1 is a diagrammatic illustration of a transponder and a communicator;
- Fig. 2 illustrates a communicator that has moved along a railroad track, said figure illustrating the position at which the first reading takes place at a varying instance, and wherein the figure illustrates the signal that is received in a communicator that moves along a railroad track relative to a transponder, where parameters such as distance above the track, speed, etc., vary;
- Fig. 3 illustrates the principle appearance of the envelope of a received signal as the communicator passes a transponder;
- Fig. 4 shows the principle appearance of the envelope of a received signal, dependent on the height above the track, damping caused by water and snow etc.; and
- Fig. 5 illustrates an example of how the time point relating to passage of a reference point can be achieved.

Figure 1 illustrates a system for identifying objects or people. The system comprises a transponder 9, which includes an antenna 10, and a communicator in the form of a transceiver unit 11, which includes an antenna 12. The communicator 11 is designed to send an inquiry signal 13 to the transponder 9. The transponder is designed to receive the inquiry signal and therewith reflect and modulate said signal. The communicator 11 is designed to receive the reflected signal 14 and to decode the information content of the signal. The communicator 11 is connected to a principal data system 16 of some appropriate kind, such as a cable, radio, W-Lan, GSM/GPRS/G3 system or some like system.

The transponder 9 may, instead, be of a type where the transponder receives the inquiry signal 13 and then actively sends a response signal 14 back to the communicator 11 with a built-in transmitter.

5

The invention thus relates to a method of determining the position of a transponder in relation to a communicator.

10

The communicator 11 is designed to receive this information and is connected to a principal or super ordinate data system 16. Naturally, many transponders may be placed along a track or passageway. The principal data system is designed to control, for instance, railroad traffic, the stopping positions of trains at respective stations, to control unmanned trains, to calculate initiation of a braking or slow-down sequence, etc., and to forward such information to the trainset and to the station equipment.

15

According to the present invention, the communicator 11 is connected to an envelope detector 15 which is caused to detect the envelope of the signal received from the transponder 9, wherewith the relative position between the transponder 9 and the communicator 11 is determined from said envelope.

20

In one highly preferred embodiment of the invention, there is determined a maximum value of the envelope or a value above a pre-determined envelope threshold value. The relative position between the transponder and the communicator at said pre-determined envelope value is also determined.

25

Figure 3 shows the principle appearance of the envelope of a received signal as the communicator passes a transponder.

30

As the communicator approaches the transponder, damping of the transferred signal decreases in relation to the shorter distance. Damping of the reflected signal also decreases, meaning that the strength of the signal will increase rapidly as the communicator comes closer to the transponder and then decreases strongly subsequent to passing the transponder. This characteristic is amplified by the shape of the antenna lobes.

Figure 4 illustrates an example of the appearance of the envelope of a received signal, depending on the height above the track, damping caused by water and snow, etc..

According to one preferred embodiment there is determined the time point of a first threshold value as the envelope rises and the time point of a second threshold value as the envelope drops after having passed said maximum, wherein the time point of said maximum is calculated to have occurred at a time point midway of said two time points.

The envelope detector 15 is thus designed to determine the time point at which the amplitude of the received signal is at its maximum. The physical point corresponding to this time point can be calculated from the physical position of the transponder.

The first and the second time points are determined by sampling the received signal and thereafter determine the time point of the maximum amplitude from the formula  $t_m = t_1 + (t_2 - t_1) / 2$ , where  $t_1$  is the first time point and  $t_2$  is the second time point.

Although said parameters may vary on different occasions, it has been found that the maximum of the envelope is situated at the same physical positions along the track to a high degree of accuracy.

The reference point sought may also be calculated as the centre-of-gravity of the envelope or by some other mathematical process of the envelope that is deemed beneficial with respect to the configuration and mutual angle of the antennas.

This enables the position of the communicator relative to the position of the transponder to be read to a high degree of accuracy.

For example, when the invention is applied with respect to a train, the principal data system is provided with information concerning the trainset that shall stop at a railroad platform for instance. This information can be utilised to cause the train to stop at a platform at a position that, for instance, depends on the number of carriages in the trainset.

According to a preferred embodiment of the invention, in the event of a delay from the time point of the envelope maximum to the time at which a signal to this effect reaches the

principal data system, the principal data system is caused to subtract this time delay when calculating the physical position at which said maximum is measured.

5 The present invention, however, can be used in all manner of applications, particularly in applications where both identification and accurate positioning are concerned.

The invention thus solves the problem mentioned in the introduction.

10 Although the invention has been described with reference to a number of exemplifying embodiments, it will be understood that the detailed design of the electronic components included may be varied. For example, the envelope detector may be integrated with the communicator, or with the principal data system.

15 Consequently, the present invention shall not be considered to be limited by the disclosed embodiments, since these embodiments may be varied within the scope of the accompanying claims.

## CLAIMS

1. A method of determining the position of a transponder in relation to a communicator,  
wherein the transponder (9) can be read by means of a communicator (11) which is  
5 adapted to send an inquiry signal to the transponder, wherein the transponder (9) is  
adapted to answer the inquiry signal and therewith transfer information from a  
memory in the transponder and wherein the communicator (11) is connected to a  
principal data system (16) and is adapted to receive said information, and wherein the  
method is characterized by connecting the communicator (11) to an envelope detector  
10 (15) which is caused to detect the envelope of the signal received from the transponder  
(9); and by causing the relative position between the transponder (9) and the  
communicator (11) to be determined from said envelope.
2. A method according to claim 1, characterized by determining the maximum of the  
15 envelope or a value above a pre-determined threshold value; and by determining the  
relative position between the transponder (9) and the communicator (11) at said pre-  
determined value of said envelope.
3. A method according to claim 1 or 2, characterized by determining a time point (t1) for  
20 a first threshold value as the envelope rises and the time point (t2) of a second  
threshold as the envelope falls after having passed said maximum; and by calculating  
that the time point (tm) of said maximum will have occurred midway between said  
two time points (t1, t2).
4. A method according to claim 1, 2 or 3, wherein in the event of a delay from the time  
25 (tm) of the envelope maximum is detected and a signal to this effect reaches the  
principal data system, the principal data system (16) is caused to subtract this delay  
when calculating the physical position when said maximum is measured.

1 / 2

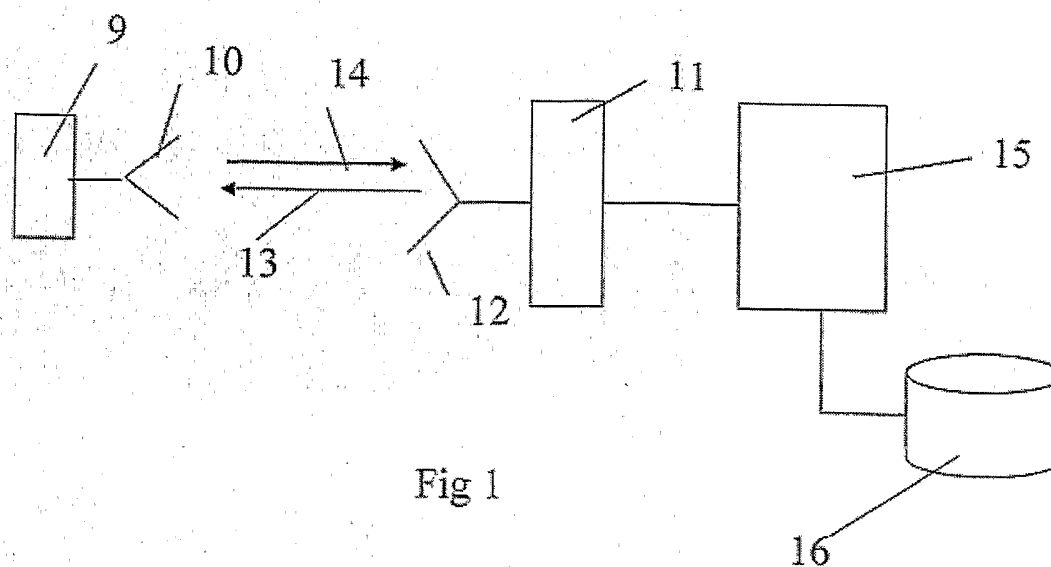


Fig 1

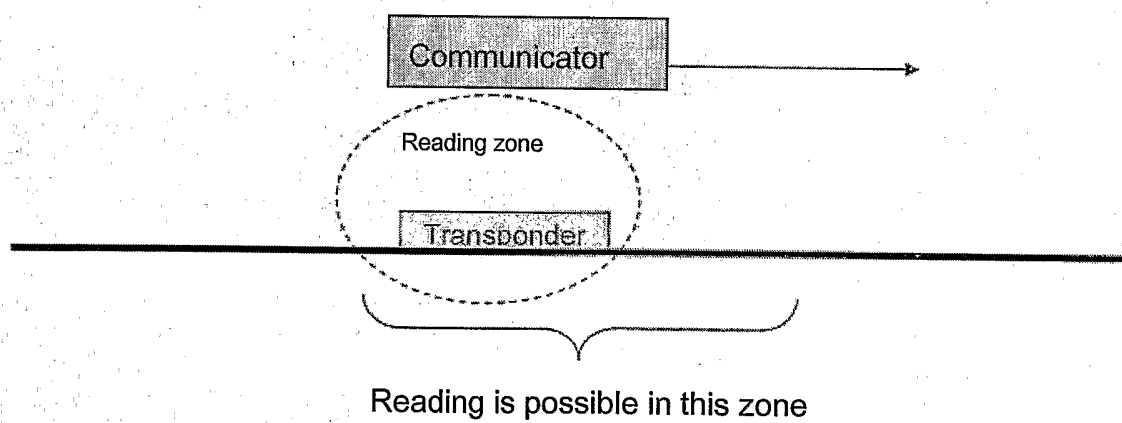
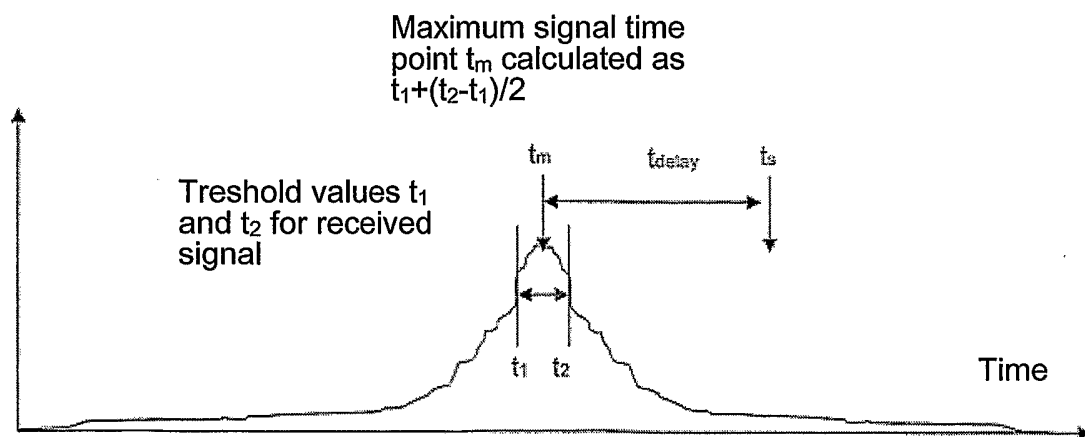
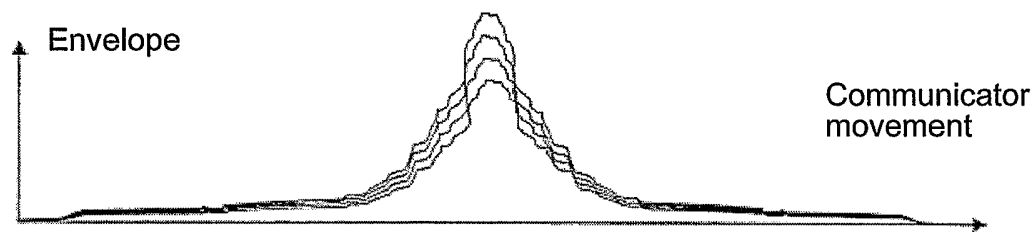
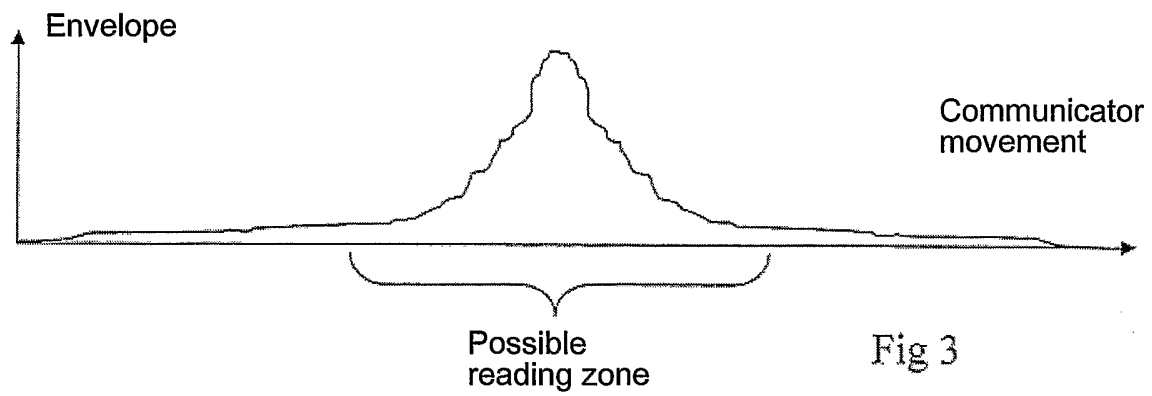


Fig 2



2 / 2



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/001843

## 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: G01S, H04B, G06K, G07C

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. |
|-----------|---|-----------------------|
| X         | US 5317318 A (GERARD THOMAS ET AL), 31 May 1994<br>(31.05.1994), column 2, line 21 - line 44;<br>column 6, line 4 - line 55, figure 2<br><br>--                           | 1-4                   |
| X         | US 6362738 B1 (VICTOR VEGA), 26 March 2002<br>(26.03.2002), column 3, line 3 - line 27; column 8,<br>line 8 - line 25; column 3, line 33 - column 8,<br>line 35<br><br>-- | 1-4                   |
| X         | US 5365516 A (LOUIS H.M. JANDRELL),<br>15 November 1994 (15.11.1994), abstract,<br>see figure 32,33,34 with associated text<br><br>--                                     | 1-4                   |

☒ 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

27 February 2006

Date of mailing of the international search report

01-03-2006

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

Gordana Ninkovic/MN

Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2005/001843

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
|-----------|---|-----------------------|
| X         | GB 2062395 A (INTERNATIONAL STANDARD ELECTRIC CORPORATION), 20 May 1981 (20.05.1981), page 6, line 3 - line 17, figure 4, abstract<br>--          | 1-4                   |
| X         | US 3984835 A (GERALD STANLEY KAPLAN ET AL), 5 October 1976 (05.10.1976), column 7, line 43 - line 66; column 8, line 39 - line 56, figure 5<br>-- | 1-4                   |
| A         | US 6437740 B1 (BRIAN DE CHAMPLAIN ET AL), 20 August 2002 (20.08.2002), abstract<br>--   | 1-4                   |
| A         | DE 19946168 A1 (SIEMENS AG), 26 April 2001 (26.04.2001), abstract<br>--<br>-----  | 1-4                   |

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/ SE2005/001843

INTERNATIONAL PATENT CLASSIFICATION (IPC):

*G01S 13/87* (2006.01)

*G01S 13/78* (2006.01)

## INTERNATIONAL SEARCH REPORT

Information on patent family members

31/12/2005

International application No.

PCT/SE 2005/001843

|       |          |    |            |      |             |       |            |
|-------|----------|----|------------|------|-------------|-------|------------|
| US    | 5317318  | A  | 31/05/1994 | AU   | 648092      | B     | 14/04/1994 |
|       |          |    |            | AU   | 8123791     | A     | 30/01/1992 |
|       |          |    |            | CA   | 2047522     | A     | 24/01/1992 |
|       |          |    |            | EP   | 0468366     | A     | 29/01/1992 |
|       |          |    |            | FR   | 2665038     | A,B   | 24/01/1992 |
|       |          |    |            | JP   | 4242188     | A     | 28/08/1992 |
| <hr/> |          |    |            |      |             |       |            |
| US    | 6362738  | B1 | 26/03/2002 | US   | 6107921     | A     | 22/08/2000 |
|       |          |    |            | US   | 6157300     | A     | 05/12/2000 |
|       |          |    |            | US   | 6275681     | B     | 14/08/2001 |
|       |          |    |            | US   | 6282407     | B     | 28/08/2001 |
|       |          |    |            | US   | 6580369     | B     | 17/06/2003 |
|       |          |    |            | US   | 6611199     | B     | 26/08/2003 |
|       |          |    |            | US   | 6879809     | B     | 12/04/2005 |
|       |          |    |            | US   | 20020093426 | A     | 18/07/2002 |
|       |          |    |            | AU   | 6245899     | A     | 03/04/2000 |
|       |          |    |            | WO   | 0016283     | A     | 23/03/2000 |
| <hr/> |          |    |            |      |             |       |            |
| US    | 5365516  | A  | 15/11/1994 | AU   | 659869      | B     | 01/06/1995 |
|       |          |    |            | AU   | 2466792     | A     | 16/03/1993 |
|       |          |    |            | AU   | 3032295     | A     | 30/05/1996 |
|       |          |    |            | BR   | 9206372     | A     | 30/05/1995 |
|       |          |    |            | CA   | 2115251     | A     | 17/02/1993 |
|       |          |    |            | EP   | 0677198     | A     | 18/10/1995 |
|       |          |    |            | JP   | 7502153     | T     | 02/03/1995 |
|       |          |    |            | US   | 5526357     | A     | 11/06/1996 |
|       |          |    |            | WO   | 9304453     | A     | 04/03/1993 |
| <hr/> |          |    |            |      |             |       |            |
| GB    | 2062395  | A  | 20/05/1981 | BR   | 8006331     | A     | 14/04/1981 |
|       |          |    |            | DE   | 3036071     | A     | 16/04/1981 |
|       |          |    |            | IT   | 1123407     | B     | 30/04/1986 |
|       |          |    |            | IT   | 7926179     | D     | 00/00/0000 |
|       |          |    |            | JP   | 56100373    | A     | 12/08/1981 |
| <hr/> |          |    |            |      |             |       |            |
| US    | 3984835  | A  | 05/10/1976 | CA   | 1041199     | A     | 24/10/1978 |
|       |          |    |            | DE   | 2524571     | A,B,C | 11/12/1975 |
|       |          |    |            | FR   | 2275783     | A,B   | 16/01/1976 |
|       |          |    |            | GB   | 1500289     | A     | 08/02/1978 |
|       |          |    |            | JP   | 51006498    | A     | 20/01/1976 |
|       |          |    |            | JP   | 55040832    | B     | 20/10/1980 |
| <hr/> |          |    |            |      |             |       |            |
| US    | 6437740  | B1 | 20/08/2002 | AU   | 4278600     | A     | 10/11/2000 |
|       |          |    |            | US   | 6590535     | B     | 08/07/2003 |
|       |          |    |            | US   | 6774845     | B     | 10/08/2004 |
|       |          |    |            | US   | 20040130488 | A     | 08/07/2004 |
|       |          |    |            | US   | 6587080     | B     | 01/07/2003 |
|       |          |    |            | US   | 20040033714 | A     | 19/02/2004 |
|       |          |    |            | WO   | 0065372     | A     | 02/11/2000 |
| <hr/> |          |    |            |      |             |       |            |
| DE    | 19946168 | A1 | 26/04/2001 | NONE |             |       |            |