Title: GENERAL INDUCTIVE HANDPIECE FOR ACTIVE DEVICES

Abstract: A handpiece (32) defines a bore (62) in which a proximal end (56) of a catheter or other interventional instrument (30) is received. An insulating support (70) supports an interventional instrument which carries an interventional instrument winding (54) in, but spaced from, the internal bore (62). A handpiece winding (64) disposed along the bore interacts with the transmission line winding (54) to form an inductive coupling with the transmission line. After the handpiece is slid axially to adjust the inductive coupling between the windings (54, 64), a locking mechanism functions in such a manner that the interventional instrument is inhibited from axial sliding motion relative to the handpiece while permitting rotation of the interventional instrument relative to the handpiece thus maintaining the inductive coupling while allowing optimal handling of the device.
GENERAL INDUCTIVE HANDPIECE FOR ACTIVE DEVICES

DESCRIPTION

The present application relates to the magnetic resonance arts, more particularly to a handpiece for receiving signals of at least one electrical interventional accessory suitable for use in a magnetic resonance system.

A magnetic resonance (MR) imaging system is used for the examination and treatment of patients. By such a system, the nuclear spins of the body tissue to be examined are aligned by a static main magnetic field \( B_0 \) and are excited by transverse magnetic fields \( B_i \) oscillating in the radiofrequency band to induce resonance. The resulting resonance relaxation signals are exposed to gradient magnetic fields to localize the resultant resonance relaxation signals. The resonance relaxation signals are received and reconstructed into a single or multiple dimension image, for example.

A whole-body radiofrequency (RF) coil system provides the transmission of the \( B_i \) RF signals and the reception of the resonances signals. In addition to the whole-body RF coil system which is permanently built into the imaging apparatus, use is also made of local or surface coils which can be flexibly arranged, for example, as a sleeve or pad around or in a specific region to be examined.

In some applications, interventional accessories, e.g., a catheter, are introduced into the patient during imaging. Catheters often have one or more RF coil elements which can be used for locating the catheter within the patient, receiving resonance signals from adjacent tissue, and the like.

Transmission lines or paths connect accessory devices like catheters, needles, imaging coils, guidewires, and the like with an active unit, such as a power supply, a receiving/transmission device, a control unit, or the like. Active units send RF pulses to the inserted device coils and/or receive RF signals from the inserted device coils. Typically, electrical connections to an active unit are required. To avoid the potential risk of electric currents unintentionally flowing into the patient and/or the operator, additional measures to ensure patient and operator safety are generally required.
When the interventional devices are guided through MR fields, particularly the $B_1$ RF fields can introduce common mode signals (currents) in the transmission line and in the surrounding body tissue. These currents involve not only the risk of disturbances or destruction of the interventional device and/or the active unit, but also these currents can give rise to substantial heating of the directly adjacent tissue resulting in potentially severe burns for the patient. A second major concern is that a malfunction in the active unit or an unintentional static build-up and discharge by the operator could send currents through the transmission lines into the subject.

The present application provides a new and improved MR inductive handpiece (holder) for active devices which overcomes the above-referenced problems and others.

In accordance with one aspect, a handpiece is configured to receive any of a variety of catheters or other interventional instruments. The handpiece includes an insulating support which supports a portion of the interventional instrument which carries a transmission line in, but spaced from, an internal bore of the handpiece. A handpiece winding is disposed along the bore and interacts with the transmission line to form an inductive coupling therebetween.

In accordance with another aspect, a magnetic resonance system includes a magnet which generates a static magnetic field in an examination region, a radio frequency transmit coil configured to induce magnetic resonance in the examination region, a radio frequency receive coil configured to acquire magnetic resonance data from the examination region, and a handpiece as discussed above.

In accordance with another aspect, a method of operating a catheter or other interventional instrument is provided. The interventional instrument is connected with the handpiece such that a transmission line extending through the interventional instrument is supported in and spaced from a bore of the handpiece and axially slidable relative to the bore and rotatable relative to the bore. The interventional instrument is slid axially relative to the bore to adjust an inductive coupling between an interventional instrument inductive winding connected to the transmission line and a handpiece inductive winding to adjust a coupling strength. The interventional instrument can be locked to inhibit axially sliding movement relative to the handpiece while permitting rotation of the interventional
instrument relative to the handpiece, thus maintaining the coupling state and allowing free rotational movement of the device.

One advantage resides in reduced complexity and cost of the disposable part of the active interventional device (catheter, needle, guidewire).

Another advantage resides in possible use of a generic handpiece for multiple devices. The generic handpiece can be reusable further reducing cost.

Another advantage resides in manual control of coupling strength yielding improved signal strength and signal-to-noise ratio.

Another advantage resides in improved rotational handling of the active device compared to devices with standard fixed handpieces.

Another advantage resides in improved patient safety due to the inductive (i.e. non-contact) connection.

Still further advantages of the present invention will be appreciated by those of ordinary skill in the art upon reading and understand the following detailed description.

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 is a diagrammatic side view in partial section of an MR apparatus along with an inductive handpiece inductively couple to an interventional device;

FIGURE 2 is a diagrammatic side sectional view of an inductive handpiece inductively coupled to an interventional device;

FIGURE 3 is a diagrammatic side sectional view of an inductive handpiece inductively coupled to an interventional device employing an alternate locking mechanism;

FIGURE 4 is a diagrammatic side sectional view of an inductive handpiece inductively coupled to a catheter and then to a guide wire via a cascaded inductive coupling.

With reference to FIGURE 1, a magnetic resonance imaging system includes a main magnet which generates a temporally uniform field through an examination region. The main magnet can be an annular or bore-type magnet, a
C-shaped open magnet, other designs of open magnets, or the like. Gradient magnetic field coils 16 are disposed adjacent the B₀ magnet in order to generate magnetic field gradients in the examination region along selected axes relative to the B₀ magnetic field. A radio frequency (RF) coil, such as a whole-body radio frequency coil 18 is disposed adjacent the examination region. Optionally, local or surface RF coils 18' are provided in addition to or instead of the whole-body RF coil 18.

A scan controller 20 controls a gradient controller 22 which causes the gradient coils to apply selected magnetic field gradient pulses across the imaging region, as may be appropriate to a selected magnetic resonance imaging or spectroscopy sequence.

The scan controller 20 also controls an RF transmitter 24 which causes the whole-body or local RF coils to generate magnetic resonance excitation and manipulation Bi pulses. The scan controller also controls an RF receiver 26 which is connected to the whole-body or local RF coils to receive magnetic resonance signals therefrom.

An interventional instrument, such as a catheter 30, is removably connected with a handpiece 32 which is held by the surgeon or clinician. Various other types of interventional instruments and catheters are contemplated. For example, the catheter may include a guide wire, a stent, an injector, a needle, a passage for introducing contrast agents or other fluids, etc. The catheter or other interventional instrument, in the illustrated embodiment, has a coil 34 disposed at a distal end thereof. Optionally, additional coils may be disposed along the length of the catheter. Optionally, other electrical equipment such as an amplifier, matching and tuning circuitry, or other circuitry, may be disposed in the tip of the catheter adjacent the coil 34. The catheter, particularly electrical conductors therein, are inductively coupled, but not directly connected by electrical wires, via the handpiece 32 with the RF receiver 26 and/or an RF transmitter 24'. The RF transmitter 24' can be the same as the RF transmitter 24. Alternately, as illustrated in FIGURE 1, the RF transmitters 24 and 24' can be different transmitters to facilitate the significantly different transmit power levels.

The interventional instrument coil 34 can be used in various ways. In one embodiment, RF resonance excitation and manipulation signals are applied via the RF transmitter 24' to the coil 34 to induce resonance in tissue closely adjacent the coil. In other embodiments, resonance is induced in the adjacent tissue by the whole-body RF coil 18 or a local RF coil 18' on the exterior of the patient. The coil 34 can also be used in a
receive mode to receive resonance signals from resonating tissue adjacent the coil. Such resonance signals are sent to the RF receiver 26 to be processed analogous to other received magnetic resonance signals. In another mode, the coil 34 is used for locating the interventional instrument, particularly the distal tip of the catheter. Various localization techniques are known. Most commonly, MR sequences comprising one or more projection measurements in one or multiple linear independent directions are performed, which exploit the point-like signal distribution of coil 34 to reconstruct its position in one or more dimensions. In some localization techniques, the coil 34 is caused to switch between resonant and non-resonant configurations. In others, an RF signal at a different frequency from the Larmor frequency is applied to the coil 34. This locator RF signal can be received by the whole-body coil 18 or a local coil 18'. The magnetic field gradients can be applied for spatially localizing the locator RF signal in a separate location process or the localization of the coil can be processed concurrently with processing of the magnetic resonance signals. Various other electrical functions can also be performed in the interventional instrument.

The received data from the receiver 26 is temporarily stored in a data buffer 40 and processed by a magnetic resonance data processor 42. The magnetic resonance data processor can perform various functions as are known in the art, including image reconstruction, magnetic resonance spectroscopy, catheter or interventional instrument localization, and the like. Reconstructed magnetic resonance images, spectroscopy readouts, interventional instrument location information, and other processed MR data are displayed on a graphic user interface 44. The graphic user interface 44 also includes a user input device which a clinician can use for controlling the scan controller 20 to select scanning sequences and protocols, and the like.

With reference to FIGURE 2, the RF coil 34 is connected with a transmission line 50 which extends the length of the catheter or other interventional instrument 30 from a distal end 52 to an interventional instrument inductive winding 54 disposed adjacent a proximal end 56. Optionally, the transmission line can include inductive couplings, e.g., at quarter wavelength intervals, to block the transfer of direct currents, off-resonance frequency currents, and common-mode resonance. Additionally the interventional instrument maybe hermetically sealed.
The handpiece 32 includes a body portion 60 which defines a bore 62. The bore 62 is larger in diameter than at least the portion of the catheter or interventional instrument adjacent the proximal end 56 that includes the coil 54. In this manner, the proximal end of the catheter can be received in, but spaced from the bore 62. A handpiece inductive coil 64 is disposed along the bore, e.g., wrapped annularly around it in a helical or sinusoidal manner. The interventional instrument transformer winding 54 and the handpiece inductive winding 64 define a transformer which is tuned to pass appropriate frequency RF signals, e.g., resonance frequency signals, therebetween but are configured to block the passage of direct current and other frequencies. Optionally, electrical circuitry 66 is mounted in the handpiece body, e.g., hermetically sealed into the handpiece body for easy cleaning and sterilization. The circuitry 66 may include matching circuitry, tuning circuitry, analog-to-digital converters, amplifiers, and the like.

The interventional instrument is supported in an insulating support mechanism 70. The insulating support mechanism includes a bushing or bearing race 72 whose interior is sized such that the interventional instrument can be slid relative to the bushing 72 and can be rotated therein. By moving the interventional instrument axially, the relative position of the interventional instrument inductive winding 54 and the handpiece inductive winding 64 is selectively adjusted, which adjusts the coupling between these two windings of the transformer. By adjusting the coupling, the coupling strength, and hence the amplitude of the output signals from the coil 34, when it is functioning as an antenna, can be adjusted. Adjusting the coupling strength can make signals from the coil 34 adjacent the distal end of the interventional element brighter or less bright. The bushing 72, in turn, is supported by a bearing element 74, such as PTFE or rubber rolling bearings or an annular low friction ring. The bearing element 74, in turn, is supported by a compressible annular support element 76 such as a soft rubber ring.

A locking mechanism 80 which locks the interventional instrument against rotation includes a compression element 82 that selectively compresses the compressible, soft rubber ring 76 of the insulating support mechanism 70, squeezing the bearing elements 74 against the bushing 72. As the bushing 72 is compressed, it grips the interventional instrument to inhibit its axial sliding, while permitting rotation of the bushing 72 relative to the bearing element 74, i.e., rotation of the interventional instrument relative to the handpiece. In this manner, the interventional radiologist or other user can hold the
handpiece body 32 in one hand and rotate and otherwise manipulate the interventional instrument 30 with the other hand.

The locking mechanism 80 further includes a ratchet mechanism 84 for holding the compressible element 76 in a selected state of compression. More specifically, pawls 86 on spring elements 88 extend outward to engage annular ratchet elements or teeth 90 on the compression element 82. Pressing the compression element 82 toward the handpiece body snaps the ratchet elements 90 progressively over the pawls 86, locking the interventional instrument progressively tighter. To release the locking mechanism, release elements 92 are compressed to bias the spring elements 88 and their pawls 86 away from the ratchet elements 90, allowing the compression element 82 to move axially as the compressible element 76 expands.

With reference to FIGURE 3, an alternate locking mechanism 80' includes an annular locking ring 94 within the bore 62' of the insulating support mechanism 70'. The locking ring is configured to resiliently engage an array of adjacent annular channels 96 of the interventional instrument. It should be appreciated that either the locking ring 94 or the channels 96 or both are made of a resilient material that allows the locking ring 94 to traverse the raised edges between adjacent channels 96. As the locking ring engages a channel, it rests in one of the channels inhibiting axial sliding while permitting rotation relative to the handpiece. In this manner, the interventional radiologist, technician or other user can hold the handpiece body 32' in one hand and rotate and otherwise manipulate the interventional instrument 30' with the other hand.

With reference to FIGURE 4, an alternate configuration includes at least two cascaded inductive couplings which are incorporated into an interventional instrument comprising of a catheter and guidewire arrangement or a needle and needle-guide arrangement. An RF coil 98, disposed adjacent a distal end 100 is connected with a transmission line 102 which extends the length of the interventional accessory or device 104 to an interventional accessory inductive winding 106. A first interventional instrument winding 108 is along an interventional instrument 112. The first interventional instrument winding 108 and the accessory winding 106 define a transformer which is tuned to pass RF signals at a particular frequency or band of frequencies. The first interventional instrument winding 108 is connected with a transmission line 112 which extends the length of the interventional instrument 110 to second interventional instrument inductive winding 114.
disposed near a proximal end 116 of the interventional instrument 110. A handpiece inductive coil 118 is disposed annularly along bore 120. The handpiece inductive coil 118 and the second interventional instrument inductive winding 114 define a second transformer which is tuned to pass RF signals at a particular frequency or band of frequencies. In this manner, the handpiece is inductively coupled to interventional accessory 104 via a series of inductive couplings in order to block the passage of direct current and other frequencies while permitting imaging, spectroscopy, localization, and the like. The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.
Having thus described the preferred embodiments, the invention is now claimed to be:

1. A handpiece (32) which is configured to receive any of a variety of catheters or other interventional instruments (30,110), the handpiece comprising:
   an insulating support (70) which supports a portion of the interventional instrument which carries a transmission line (50,112) in, but spaced from, an internal bore (62); and
   a handpiece winding (64,118) disposed along the bore which handpiece winding interacts with the transmission line to form an inductive coupling to the transmission line.

2. The handpiece according to claim 1, wherein the transmission line (50) is connected with an interventional instrument inductive winding (54) which is positioned in the bore (62), an axial position of the interventional instrument inductive winding (54) being selectively positionable by sliding the interventional instrument axially relative to the handpiece.

3. The handpiece according to claim 1, wherein:
   a first transmission line (102) is connected with an accessory winding (106) extends the length of an interventional accessory (104), an axial position of the accessory winding (106) being selectively positionable by sliding the accessory axially relative to a first interventional instrument winding (108) of interventional instrument (110); and
   a second transmission line (112) is connected with a second interventional instrument winding (114) extends the length of the interventional instrument (110), an axial position of the second interventional instrument winding (114) being selectively positionable by sliding the interventional instrument axially relative to the handpiece inductive coil (118) of handpiece (32).
4. The handpiece according to either one of claims 2 and 3, wherein the transmission line (50,104) is connected with a coil (34,98) adjacent a distal tip of the interventional instrument, and preferably the handpiece further including matching, amplification, and tuning circuitry (66).

5. The handpiece according to any one of claims 1-4, wherein the transmission line is rotatable and axially translatable with respect to the internal bore; and further including:

   a locking mechanism (80,80') that selectively inhibits axial translation of the interventional instrument relative to the handpiece.

6. The handpiece according to any one of claims 1-5, wherein:

   the interventional instrument and the transmission line are hermetically sealed; and

   the transmission line is flexible.

7. The handpiece according to claim 1, wherein the insulating support (70') includes:

   a locking ring (94) configured to resiliently engage an array of adjacent annular channels (96) of the interventional instrument (30).

8. The handpiece according to claim 1, wherein the insulating support (70) includes:

   a bushing (72) in which the transmission line is slidably received;

   a compressible element (76), which under the action of a compression element (82), selectively presses the bushing (72) into tighter frictional engagement with the portion of the interventional instrument that is received in the handpiece bore (62);

   bearing elements (74) between the compressible element (76) and the bushing (72) to facilitate rotation of the bushing element and the interventional instrument relative to the handpiece when the compressible element (76) has urged the bushing (72) into tight engagement with the interventional instrument.
9. A magnetic resonance system (10) comprising:
   a magnet (12) which generates a static magnetic field in an examination region (14);
   a radio frequency transmit coil (18, 18') configured to induce magnetic resonance of a subject in the examination region;
   a radio frequency receive coil (18, 18') configured to acquire magnetic resonance data from the examination region; and
   the handpiece (32) according to any one of claims 1-7, with which the interventional instrument (30) is adjustably positioned in the examination region (14).

10. The magnetic resonance system according to claim 9, wherein the interventional instrument includes:
    an interventional instrument coil (34,98) connected with the transmission line and wherein the handpiece inductive winding (64,118) is electrically connected with at least one of a radio frequency transmitter (24, 24') and a radio frequency receiver (26).

11. The magnetic resonance system according to claim 9, further including:
    an MR data processor (42) which processes data from the interventional instrument coil (34,98) to produce one of magnetic resonance imaging data, magnetic resonance spectroscopy data, or interventional instrument coil locating information.

12. A method of operating a catheter or other interventional instrument (30) comprising:
    connecting the interventional instrument (30,110) with a handpiece (32) such that a transmission line (50,112) extending through the interventional instrument is supported in and spaced from a bore (62) of the handpiece (32) and axially slidable relative to the bore and rotatable relative to the bore;
    sliding the interventional instrument (30) axially relative to the bore to adjust the inductive coupling between an interventional instrument inductive winding (54)
connected with the transmission line and a handpiece inductive winding (64) to adjust coupling strength; and

locking the interventional instrument to inhibit axially sliding movement relative to the handpiece while permitting rotation of the interventional instrument relative to the handpiece.

13. The method according to claim 12, further including:
inserting the interventional instrument into a subject disposed in an examination region (14) of a magnetic resonance system (10);
during insertion of the interventional instrument, manually rotating the interventional instrument relative to the handpiece.

14. The method according to either one of claims 12 and 13, wherein the interventional instrument includes at least one interventional instrument RF coil (34,98) which is connected with the transmission line and the handpiece inductive winding (64,118) is connected with at least one of a radio frequency transmitter (24, 24') and a radio frequency receiver (26), the method further including:
at least one of transmitting radio frequency signals with the interventional instrument RF coil (34,98) and receiving radio frequency signals with the interventional instrument RF coil (34,98).

15. The method according to claim 14, further including:
processing signals received from the interventional instrument RF coil (34,98) to generate at least one of magnetic resonance image data, magnetic resonance spectroscopy data, and interventional instrument coil localization data.
## INTERNATIONAL SEARCH REPORT

**International application No**

PCT/IB2009/055294

### A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B5/055 G01R33/36

ADD.

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

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B GO1R

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

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

EPO-Internal

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>DE 37 08 801 A1 (MEDTRONIC MEDIZINISCH ELEKTRON [DE]) 29 September 1988 (1988-09-29) page 4, line 32 - page 5, line 58; figures 1,4</td>
<td>1-3,5,7,8</td>
</tr>
<tr>
<td>X</td>
<td>US 5 849 020 A (LONG GARY L [US] ET AL) 15 December 1998 (1998-12-15) column 4, line 7 - line 41; figures 2,2a</td>
<td>1,2,8</td>
</tr>
<tr>
<td>Y</td>
<td>US 5 807 253 A (DUMOULIN CHARLES LUCIAN [US] ET AL) 15 September 1998 (1998-09-15) column 4, line 48 - column 5, line 15; figures 1,2</td>
<td>4,6,9-11</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C

See patent family annex

- **X** Special categories of cited documents
  - **X** document defining the general state of the art which is not considered to be of particular relevance
  - **X** 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)
  - **X** document referring to an oral disclosure, use, exhibition or other means
  - **X** document published prior to the international filing date and later than the priority date claimed

TT 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

IX 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

YY 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

SA document member of the same patent family

**Date of the actual completion of the international search**

30 March 2010

**Date of mailing of the international search report**

08/04/2010

**Name and mailing address of the ISA/Authorized officer**

European Patent Office, P B 5818 Patentlaan 2
NL - 2280 HV RIJSWIJK
Tel (+31-70) 340-2040, Fax (+31-70) 340-3016

Mayer-Martenson, E
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>
**INTERNATIONAL SEARCH REPORT**

**Box No. K** Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

1. **X** Claims Nos.: 12-15 because they relate to subject matter not required to be searched by this Authority, namely:
   - Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. **x** 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. **x** 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 No. III** Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

1. **x** As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. **x** As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. **x** 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. | 1 | 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**

1. The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

2. The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

3. No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 3708801 A1</td>
<td>29-09-1988</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2242070 A1</td>
<td>30-12-1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69819972 D1 08-01-2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69819972 T2 22-07-2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0894476 A1 03-02-1999</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2212225 T3 16-07-2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 4145395 B2 03-09-2008</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 11128242 A 18-05-1999</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6371967 B1 16-04-2002</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 11230705 A 27-08-1999</td>
<td></td>
</tr>
<tr>
<td>US 6246896 B1</td>
<td>12-06-2001</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>EP 0850595 A1</td>
<td>01-07-1998</td>
<td>DE 69734500 D1 08-12-2005</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5876338 A 02-03-1999</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1708695 A 14-12-2005</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 10249239 A1 06-05-2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1556710 A1 27-07-2005</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2004038443 A1 06-05-2004</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2006503634 T 02-02-2006</td>
<td></td>
</tr>
</tbody>
</table>

Form PCT/IS/V21 (patent family annex) (April 2005)