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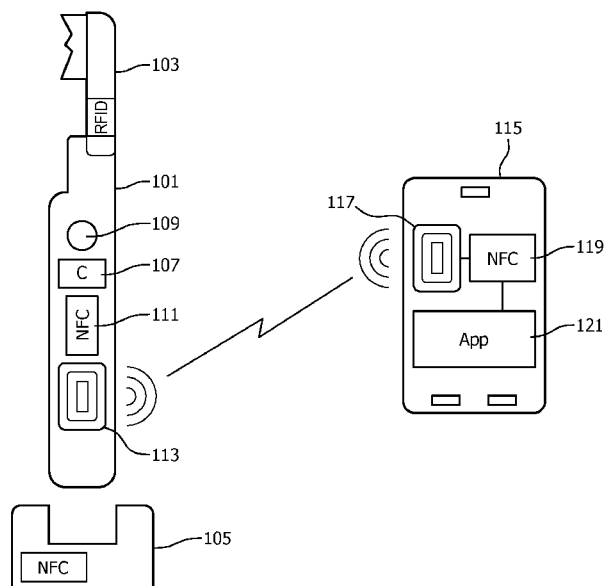
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[Continued on next page]

(54) **Title:** TOOTH CLEANING DEVICE AND METHOD OF OPERATION THEREFOR**FIG. 1**

(57) **Abstract:** A tooth cleaning device, such as a toothbrush, comprises a communication element (205) for supporting a bi-directional short range communication with a wireless range of no more than 50 cm. A communication controller (203) comprises a connection controller (209) which automatically establishes a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the communication element. A data communication controller (207) communicates data to the external communication entity over the short range communication link where the data includes usage data for the tooth cleaning device. The approach may provide an improved user experience, and e.g. facilitate or improve configuration of the tooth cleaning device, or analysis and user feedback on the tooth cleaning activity. Exchanged usage data may e.g. include duration of cleaning.



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Tooth cleaning device and method of operation therefor

FIELD OF THE INVENTION

The invention relates to a tooth cleaning device, and a method of operation therefor, and in particular but not exclusively to a toothbrush capable of communicating data using Near Field Communication.

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BACKGROUND OF THE INVENTION

Dental cleaning is of the utmost importance to maintain a high level of oral hygiene and accordingly the number, functionality and complexity of tooth cleaning devices is increasing, especially in the consumer market segment.

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Toothbrushes are designed to clean teeth by removing bio-films and food debris from teeth surfaces and interproximal regions to improve oral health. A wide variety of electric toothbrush designs have been created to provide improved brushing performance by increasing the speed of the brush head and using sonic, and in some cases ultrasonic, vibration. Some of these electric toothbrushes now provide feedback methods to help guide the user to evenly brush all teeth and to use feedback to get good practices to improve overall brushing performance. Generally electric toothbrushes contain a timer to ensure brushing takes a minimum period of time (typically 2-3 minutes), regardless of the state of the teeth. An improvement on this method is when the user is guided to divide the brushing time equally over the 4 quadrants of the teeth (front/top front/bottom back/top back/bottom) by pausing the brushing cycle briefly.

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Handheld floss devices, such as the Philips AirflossTM floss device, have been developed for home use. Such devices provide an easy and practical means for cleaning gaps between teeth.

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According to Adult Dental Health Survey 2012 in the United Kingdom, less than 50% of adults are following an acceptable oral hygiene routine. The average time spent brushing is just 45 seconds, while a quarter of adults skip brushing at least once a day. The same data also showed 42 per cent of adults only use a toothbrush and toothpaste, with only 27 per cent saying they use an electric brush. Furthermore, about 24% of people do not use toothpastes with high levels of fluoride. The data also indicates that well known dental care

products, such as mouthwash and floss, are not usually used in general oral care routines. Instead, only 31% of people use mouthwash and 22%, use floss. The need to encourage better oral hygiene is well established.

Some coaching toothbrushes sense the pressure applied in order to warn if it is too strong, others sense the orientation of the toothbrush and change mode based on the sensed angle. United States patent application US-20080109973 discloses a system using a display separated from the toothbrush with wireless communication of brushing parameters such a brush head speed, type of cleaning elements, pressure, and power status.

There is a general desire to provide processes and means for improving oral care, and especially for improving a user's cleaning of teeth. However, at the same time it is important that the user is presented with an easy and practical experience. Indeed, the user scenario for the activity is characterized by requiring a very high degree of ease and practicability. This is in particular important as any inconvenience will tend to bias users away from the improved oral care. At the same time, it is often desirable to reduce cost and maintain low complexity.

Hence, an improved approach would be advantageous and in particular an approach allowing increased flexibility, reliable operation, reduced cost, reduced complexity, improved performance, improved interoperability, improved oral hygiene, improved adaptability and/or an improved user experience would be advantageous.

SUMMARY OF THE INVENTION

Accordingly, the Invention seeks to preferably mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination.

According to an aspect of the invention there is provided a tooth cleaning device comprising: a communication element for supporting a bi-directional short range communication, the short range communication having a wireless range of no more than 50 cm; and a communication controller comprising: a connection controller for automatically establishing a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the communication element, and a data communication controller for communicating data to the external communication entity over the short range communication link, the data including usage data for the tooth cleaning device.

The invention may allow an improved user experience. In particular, the system may allow for the tooth cleaning to be supported by external devices that may for

example analyze the experience to provide feedback, encouragement or monitoring of the process. The approach of using short range communication and automatic connection establishment may in particular allow a very convenient yet flexible user experience.

For example, an external device may be used to monitor the tooth cleaning performance (e.g. to provide feedback to the user). The external device can simply be coupled to the tooth cleaning device by bringing the tooth cleaning device and the external device sufficiently close together and without requiring any other user input or activity. The tooth cleaning device can easily be used with a plurality of external devices, with the pairing being changeable simply by moving the tooth cleaning device to be next to a given device.

Similarly, one external device can be used with a plurality of tooth cleaning devices, and the coupling of the external device to one specific tooth cleaning device can simply be achieved by bringing this tooth cleaning device into proximity with the tooth cleaning device.

The approach may allow the user data to be used by an external device to improve the tooth cleaning experience or performance, e.g. by analyzing the data and providing feedback.

The short-range communication link may specifically be a wireless communication link.

In accordance with an optional feature of the invention, the tooth cleaning device comprises: a communication element for supporting a bi-directional short range communication, the short range communication having a wireless range of no more than 50 cm; and a communication controller comprising: a connection controller for automatically establishing a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the communication element, and a data communication controller for communicating data to the external communication entity over the short range communication link, the data including usage data for the tooth cleaning device.

This may provide improved flexibility. For example, it may allow the tooth cleaning device to connect to both complex communication entities as well as to passive entities. Thus, the tooth cleaning device may provide sufficient control to establish and maintain the communication link, or it may operate in a passive mode wherein the communication is controlled by an external device.

In accordance with an optional feature of the invention, the short range communication link includes a Near Field Communication link.

This may provide a particularly advantageous approach for many embodiments. In particular, it may allow low cost, low complexity yet highly reliable communication which is particularly suitable for providing a desirable user experience for a tooth cleaning activity. The approach may allow compatibility with a range of different external devices and in particular may allow facilitated interaction with a number of devices not dedicated to the tooth cleaning activity.

In accordance with an optional feature of the invention, the short range communication link includes a Body Coupled Communications link.

This may provide an improved user experience and/or improved operation in many embodiments.

In some embodiments, the short range communication link may include a communication path formed by the skin of a user.

This may provide an improved user experience and/or improved operation in many embodiments.

In accordance with an optional feature of the invention, the data communication controller is arranged to receive suggested usage data from the external communication entity over the short range communication link, and the tooth cleaning device further comprises a user feedback controller for generating a user feedback in response to an evaluation of usage of the tooth cleaning device relative to the suggested usage data.

This may provide an improved user experience in many embodiments, and may in particular result in improved tooth cleaning in many embodiments. For example, based on a complex analysis in a remote device, desired changes to the tooth cleaning may be detected. These can be communicated to the toothbrush which may accordingly provide feedback that biases the user towards a desired behavior. For example, the tooth cleaning device may indicate when brushing of a section should be terminated (e.g. by an audio signal). The timing of this cleaning may be determined by the external device but implemented by the toothbrush.

In accordance with an optional feature of the invention, the data communication controller is arranged to receive configuration data from the external communication entity over the short range communication link, and the tooth cleaning device further comprises a configuration controller for configuring the tooth cleaning device in response to the configuration data.

This may provide an improved user experience and may e.g. enable or improve customization of the individual tooth cleaning device to the specific usage. The

approach may allow a more user friendly configuration/customization. In particular, it may allow improved configuration based on usage data as this can be done externally to the tooth cleaning device.

In accordance with an optional feature of the invention, the configuration controller is arranged to configure a software component in response to the configuration data.

This may improve the user experience in many embodiments. The configuration may specifically include an updating of the software component and/or may include a setting of one or more parameters used by the software.

In accordance with an optional feature of the invention, the configuration controller is arranged to configure a user interface function in response to the configuration data.

This may improve the user experience in many embodiments and may in many embodiments allow an improved and more customized user interface. The approach may allow a more user friendly customization, and may in particular allow this to be adapted to the usage data.

In accordance with an optional feature of the invention, the configuration controller is arranged to assign functionality to a user input in response to the configuration data.

This may improve the user experience in many embodiments and may in many embodiments allow an improved and more customized user interface. The approach may allow a more user friendly customization, and may in particular allow this to be adapted to the usage data. The user input may for example be one or more user activated buttons, contacts or switches.

In accordance with an optional feature of the invention, the configuration controller is arranged to configure a user feedback function in response to the configuration data.

This may improve the user experience in many embodiments and may in many embodiments allow an improved and more customized user interface. The approach may allow a more user friendly customization, and may in particular allow this to be adapted to the usage data. The user feedback function may for example include a visual feedback, such as a LED or a display indication, or may e.g. include an audio feedback, such as a warning sound.

In accordance with an optional feature of the invention, the configuration controller is further arranged to configure the tooth cleaning device in response to usage data for the tooth cleaning device.

This may allow improved configuration and customization in many
5 embodiments.

In accordance with an optional feature of the invention, the external communication entity is a portable computational device.

This may provide a particularly advantageous system in many embodiments. In particular, the invention may allow external computational resource and functionality to be
10 used to improve the tooth cleaning experience and performance. This may allow the complexity and thus cost of the tooth cleaning device itself to be reduced. The computational device may for example be a mobile phone (smartphone), a tablet, or a laptop.

In accordance with an optional feature of the invention, the external communication entity is a long range communication device.

This may provide a particularly advantageous system in many embodiments. In particular, the invention may allow external communication resource and functionality to be used to improve the tooth cleaning experience and performance. This may allow the complexity and thus cost of the tooth cleaning device itself to be reduced. Specifically, usage
15 data may be communicated at long distances while only requiring the toothbrush to have sufficient functionality to support short range communication. The long range communication device may for example be a mobile phone (smartphone), a WiFi communication device, a Bluetooth communication device etc. The long range communication device may be a portable communication device.

The long range communication device is arranged to support communication
25 with ranges that exceed that of the short range communication device. Typically, the range will be at least two, five, ten or more times that of the short range communication link. Typically, the range will be at least one, two, five, ten or more meters.

In accordance with an optional feature of the invention, the external communication entity is a charging base for the tooth cleaning device.

This may provide a particularly advantageous system in many embodiments. The charging base may further comprise computational functionality and/or long range
30 communication functionality.

In accordance with an optional feature of the invention, the connection controller is arranged to automatically establish a second short range communication link

with a second communication entity associated with an item, and the data controller is arranged to receive identification data for the item via the second short range communication link.

This may provide an improved user experience in many embodiments. In many scenarios, it may allow an improved analysis of the usage data and/or provide enhanced or more complete usage data. The identification data may be communicated to the external communication entity using the short range communication link also used for usage data.

The approach may for example allow an easy and user friendly detection and monitoring of other items used as part of the tooth brushing experience, such as toothpaste, brush head, mouthwash, floss etc. Thus, a more complete picture of the entire oral hygiene experience may be determined and possibly forwarded to an external device.

In accordance with an optional feature of the invention, the tooth cleaning device is a toothbrush.

In accordance with an optional feature of the invention, the short range communication link forms part of a communication link with a server for receiving usage data from a plurality of tooth cleaning devices, and wherein the usage data is associated with identification of the tooth cleaning device thereby enabling the server to associate the toothbrush usage data with the tooth cleaning device.

This may allow analysis to be performed on a population of tooth cleaning devices, thereby allowing e.g. statistical analysis to be applied to a population of devices; facilitate research into oral hygiene etc. Alternatively or additionally it may allow a centralized authority (such as a health care professional or expert system) to provide specific feedback to the individual user of a toothbrush.

In accordance with an optional feature of the invention, the short range communication link may form part of a communication link to a dental healthcare professional.

This may allow usage data to be monitored by the dental healthcare professional and allow e.g. improved feedback or statistical analysis.

According to an aspect of the invention there is provided tooth cleaning system comprising: a tooth cleaning device; and a charging base for the tooth cleaning device; wherein the tooth cleaning device comprises: a communication element for supporting a bi-directional short range communication, the short range communication having a wireless range of no more than 50 cm; and a communication controller comprising:

a connection controller for automatically establishing a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the communication element, and a data communication controller for communicating data to the external communication entity over the short range communication link, the data including usage data for the tooth cleaning device.

According to an aspect of the invention there is provided a method of operation of a tooth cleaning device, the method comprising: supporting a bi-directional short range communication, the short range communication having a range of no more than 50 cm; automatically establishing a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the wireless communication element; and communicating data to the external communication entity over the short range communication link, the data including usage data for the tooth cleaning device.

These and other aspects, features and advantages of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be described, by way of example only, with reference to the drawings, in which

Fig. 1 illustrates an example of an oral hygiene setup comprising elements of some embodiments of the invention;

Fig. 2 illustrates an example of a tooth cleaning device comprising elements of some embodiments of the invention;

Fig. 3 illustrates an example of a user interface for a tooth cleaning device in accordance with some embodiments of the invention;

Fig. 4 illustrates an example of a tooth cleaning device comprising elements of some embodiments of the invention;

Fig. 5 illustrates an example of a user interface for a tooth cleaning device in accordance with some embodiments of the invention; and

Fig. 6 illustrates a further example of an oral hygiene setup comprising elements of some embodiments of the invention.

DETAILED DESCRIPTION OF SOME EMBODIMENTS OF THE INVENTION

The following description focuses on embodiments of the invention applicable

to a handheld tooth cleaning device and in particular to a toothbrush. However, it will be appreciated that the invention is not limited to this application but may be applied to many other tooth cleaning devices including for example a handheld floss device such as the Philips AirflossTM device.

Fig. 1 illustrates an example of an oral hygiene setup comprising elements of some embodiments of the invention.

The arrangement comprises a toothbrush 101 which has a replaceable brush head 103. The toothbrush 101 is an electrical toothbrush which comprises a motor for imparting movement to the brush head 103 when in use. The toothbrush 101 is arranged to be positioned in a charging base station 105 which can wirelessly transfer power to the toothbrush 101 in order to keep internal batteries of the toothbrush 101 charged.

The toothbrush 101 comprises control circuitry 107 which can control the operation of the toothbrush 101. The toothbrush 101 of the example further comprises a user interface which in the specific example includes a button 109 that can be activated by a user. In addition, the toothbrush 101 may in some embodiments comprise functionality for user feedback such as e.g. a light (e.g. LED), a display or a loudspeaker. The control circuitry 107 may adapt the operation of the toothbrush 101 in response to user activations of the button 109 and may control the user feedback functionality to provide a given user feedback (e.g. a warning light or sound).

In the example of Fig. 1, the toothbrush 101 is furthermore capable of communicating with external communication entities. Accordingly, the toothbrush 101 comprises communication functionality 111 which in the specific examples allows wireless radio based communication via an antenna 113.

In the arrangement of Fig. 1, the toothbrush 101 may accordingly communicate with external functionality and devices. In the example, the toothbrush 101 communicates wirelessly with an external communication entity which in the specific example is (part of) a communication and/or computational device 115. In the specific example, the external device 115 is a smartphone which contains functionality for communicating with the toothbrush 101, with other devices, and for performing computational operations.

In many embodiments, the communication link between the toothbrush 101 and the external device 115 is a bidirectional communication link allowing data to be communicated both to and from the toothbrush 101.

The toothbrush 101 may specifically communicate toothbrush usage data to the external device 115. The external device 115 of Fig. 1 comprises an antenna 117 which is coupled to communication functionality 119 for supporting the communication over the established radio link. The external device 115 further comprises computational functionality 121 for processing the received toothbrush usage data. In the specific example of the external device 115 being a smartphone, the communication functionality 119 may specifically implement a smartphone app that e.g. may present an analysis of the user's tooth brushing behavior based on the toothbrush usage data.

Fig. 2 illustrates elements of the toothbrush 101 in more detail. Fig. 2 illustrates the control circuitry 107 in the form of a toothbrush controller 201, the communication circuitry 111 and the antenna 103.

The communication circuitry 111 comprises a communication controller 203 which is coupled to the toothbrush controller 201 and a communication unit 205 which is coupled to the communication controller 203 and the antenna 103.

The communication unit 205 supports a bi-directional short range communication with an external communication entity which in the example is the external device 115. The communication is a short range communication with a wireless range of no more than 50 cm. Thus, the communication that the communication unit 205 can support has a wireless range of no more than 50 cm. Thus, any air interface communication of the communication link will be restricted to a distance of no more than 50 cm. Such a short range allows the system to exploit and use spatial characteristics to determine the operation of the system, and specifically allows the establishment of connections between devices to be based on spatial characteristics of the devices.

In the following description a short range communication link will be considered to be a communication link for which any wireless/ over the air communication is no more than 50cm. In some embodiments, the communication unit 205 may advantageously support a range of no more than 30 cm, 20 cm, 10 cm, or 5 cm. The lower communication range providing for a more selective spatial characteristic which in turn may benefit particular aspects of the system operation.

In the specific example, the communication unit 205 is specifically arranged to communicate in accordance with the Near Field Communication (NFC) standard. NFC is designed to provide very short range communication between devices. The communication may be a master/slave configuration, or may in many scenarios and embodiments be a peer-to-peer communication. NFC allows a relatively high data rate.

The communication controller 203 comprises a data controller 207 which is arranged to communicate data to the external communication entity of the external device 115 over the short range communication link. The data is provided from the toothbrush controller 201 to the data controller 207 which then proceeds to provide it to the communication unit 205 in the appropriate format. Likewise the data controller 207 may receive data from the communication controller 203 which has been transmitted by the external device 115. This data may be processed (e.g. decoded, deformed, de-encapsulated etc.) before being fed to the toothbrush controller 201.

The data communicated from the toothbrush controller 201 to the external device 115 includes toothbrush usage data. Thus, the data does not (just) include static or permanent data e.g. identifying the toothbrush 101. Rather, the data is indicative of how the toothbrush 101 has been (potentially is being) used. The toothbrush usage data is thus dynamic data that reflects the use of the toothbrush 101, such as for example timing information.

The toothbrush usage data may provide information that does not relate inherently to a property of the toothbrush itself but rather it reflects the user behavior. The toothbrush usage data may accordingly be used to e.g. analyze or evaluate the oral hygiene process of the user.

As an example, the toothbrush usage data may include timing information relating to the times the toothbrush is used. Such timing information may include characteristics of the time intervals the toothbrush is used, such as e.g. a duration for each use, a total duration, the time of each use etc.

As another example, the toothbrush 101 may detect an identity of other items that are used in connection with the toothbrush activity, such as the specific toothpaste, the specific brush head etc., and may communicate such data as part of the toothbrush usage data.

As another example, the toothbrush 101 may monitor and determine the pressure applied to the brush head during brushing, the angle of the toothbrush etc. Data characterizing these characteristics may be included in the toothbrush usage data.

The toothbrush usage data thus contains data that may allow or assist the oral hygiene process of the user being characterized. Indeed, if sufficient data is provided, a relatively accurate picture of the user's oral hygiene routine can be established.

The communication controller 203 further comprises a connection controller 209 which is arranged to automatically establish a short range communication link with an

external communication entity in response to a detection of the external communication entity being within range of the communication element.

In the specific example the connection controller 209 accordingly automatically establishes the communication link with the communication entity of the external device 115 when the toothbrush 101 and the external device 115 are brought sufficiently close to each other.

When the toothbrush 101 does not have any communication link established, the connection controller 209 may continuously monitor for the antenna 103 detecting a signal which is transmitted by another communication entity. The communication supported by the communication unit 205 is a short range (no more than 50cm) communication and the presences of an appropriate signal will occur (only) when the toothbrush 101 and the external device 115 are sufficiently close to each other.

In the example where the communication is based on Near Field Communication (NFC), the connection controller 209 will typically detect the presence of a potential communication target if this is within 10 cm or even less of the toothbrush 101.

If a suitable signal is detected, the toothbrush 101 proceeds to initiate a communication with the corresponding device, i.e. with the external device 115. The toothbrush 101 and the external device 115 then proceed to establish a connection.

It will be appreciated that any process for establishing a communication link which does not require active user interaction may be used. In the specific example, the toothbrush 101 and the external device 115 use NFC communication, and accordingly the detection of a communication and the establishment of a communication link between them is in accordance with the NFC protocols.

The system of Fig. 1 accordingly supports an automatic connection to be established simply by bringing the toothbrush 101 and the external device 115 within range of each other. No other user activity or user input is required, and especially no specific selection or approval of devices is needed to couple the two devices together. Furthermore, no prior initialization or connection configuration is required but rather a fully automatic connection establishment with no user input or activity can be achieved.

Such an approach allows for a very desirable user experience which is particularly suitable for a dental cleaning use scenario. In particular, in contrast to conventional communication techniques, such as Bluetooth or WiFi, where user interaction and active input is required, the system of Fig. 1 allows for the user to simply bring the two devices together. Thus, a much easier operation and a significantly improved user experience

is provided. This is of the utmost importance for tooth cleaning applications, and especially for tooth brushing activities, where any minor inconvenience is likely to dissuade some people from using the functionality.

As an example, the toothbrush 101 may monitor, record and store data of when the toothbrush is used. At some stage, the user may want to evaluate this. He may then simply “scan” the toothbrush 101 to his smartphone (e.g. simply bring the devices together such that their antennas are brought to within 10cm). The usage data can then be downloaded to the smartphone which can proceed to run an app e.g. providing a visual representation of the data. For example, the smartphone may provide a graphic representation of the duration of the tooth brushing activities such as e.g. illustrated in Fig. 3. The user can then evaluate the tooth brushing performance, or e.g. a parent can evaluate the tooth brushing performance of a child.

Such an approach may not only improve the user experience but may also assist in improving the oral hygiene. Indeed, the toothbrush is at the heart of the oral cleaning program that people use to maintain good oral health. Most people brush their teeth twice a day, although for not as long as they should. As part of the process, they may also use other cleaning products to maintain good oral hygiene, like inter-dental cleaners, mouth rinses and products for maintaining gum health. As such the toothbrush is stationed in the bathroom permanently and is available as an ideal hub to collect and store data to monitor the whole oral cleaning cycle.

In the system of Fig. 1, the toothbrush is equipped with NFC communication functionality so that the toothbrush can communicate with other NFC devices that are brought into close contact with the toothbrush.

NFC is unlike other wireless connectivity standards in that it is only able to transfer data when within a very close proximity (typically less than 10cm) of another NFC device. The data may be exchanged at a data rate of up to 424kbits/s. This provides a number of distinct advantages over conventional data communication approaches, including:

- Intuitive connections to other devices as the act of bring devices together not only enables the connection but also makes it clear which two devices are connected, which is highly desirable for oral hygiene applications
- Increased security and privacy as the other connected device must be in close proximity
- Enables active NFC devices to communicate with each other

- Enables an active NFC device to communicate with multiple passive RFID tags at the same time
- Enables an active NFC device to communicate with NFC devices that are not powered but which emulate an RFID tag when in a passive state

5 Transferring data to an external computational device which may e.g. have suitable means for providing a user interface (especially a large display) may result in improved user interaction. It also enables a record of brushing activity to be kept externally, and provides the opportunity for analysis and motivation to improve brushing.

Also, smartphones are becoming increasingly ubiquitous and benefits from
10 familiar user interfaces and excellent connectivity to the outside world. Increasingly, these devices are becoming a part of users' daily routine and people increasingly keep them close to hand at all times, thus making them available in the bathroom as well.

Enabling smartphones and toothbrushes with a short range communication functionality, such as NFC, enables them to communicate with each other when brought in
15 close contact. This enables the phone to act as a computing resource controlled by an application that can monitor brushing performance, set targets and provide coaching to the user. This would typically be enabled by bringing the phone and toothbrush together, resulting in the tooth brushing application automatically being initialized and thus appear as an application on the phone that the user can run. The application can then analyze and
20 display results (e.g. as in Fig. 3).

The system may provide an easy to use user interaction and feedback while keeping cost low as the user's own smartphone can be used. The approach may improve the user's tooth brushing routine with feedback on performance becoming a significant part of the daily/weekly routine to improve brushing adherence (and improve oral health).

25 Furthermore, this is achieved with little inconvenience to the user. Indeed, merely scanning the toothbrush to the smartphone allows the brushing time history information to be transferred for analysis and display on the smartphone.

In the example, the usage data comprises timing data for the use of the toothbrush. This data can include the brushing history to enable the tracking of brushing
30 cycle lengths and incidents. However, it will be appreciated that the usage data may alternatively or additionally comprise other data relating to the use of the toothbrush. In some embodiments, the usage data may further include use context data. For example, as described in more detail later, the toothbrush 101 may detect the identity of other items used in

connection with the tooth brushing (such as toothpaste) and may include such information in the usage data.

In some embodiments, other parameters reflecting characteristics of the toothbrush 101 when in use may additionally or alternatively be transmitted. For example, characteristics of the handling of the toothbrush may be included such as the pressure applied to the brush head, or the angle of the toothbrush. As another example, movement data for the toothbrush when in use may be included. Such movement data may be detected from one or more accelerators mounted in the toothbrush and/or the brush head. The movement data may provide an accurate indication of the specific technique used by the user, such as whether the user spends a long time on each tooth, moves quickly, keeps the brush still for each tooth or uses a back and forth or rotational movement to the brush etc. Such data can then be analyzed in detail by the external device and e.g. be compared to previous or desired data.

Such brushing information may provide assistance for e.g. a decision on whether to change the brush setting to harder, softer, longer shorter, slower, faster etc. It can also aid the user in adapting/reducing the pressure he/she applies on the toothbrush to avoid damaging the gums (by visualization over time).

The communication link to the external device 115 is in the system of Fig. 1 a bidirectional communication link. The external device 115 may accordingly transmit data back to the toothbrush 101 which the toothbrush 101 may use to adapt its operation.

As an example, the external device 115 may transmit data indicative of the result of the analysis performed by the external device 115. For example, the external device 115 may perform an analysis and as a result determine a preferred parameter. Specifically, based on the result, it may determine a desired duration for the brushing of each section of teeth. The external device 115 may then communicate the suggested usage data (in the specific example the suggested duration) back to the toothbrush 101. The toothbrush 101 may then provide a user feedback based on a comparison of the actual usage and the desired usage as indicated by the external device 115. The user feedback may for example be in the form of a visual indication (e.g. a LED lighting up) or an audio signal which is provided when the toothbrush 101 has been used for the desired duration (e.g. for each teeth segment).

As a specific example, based on the received usage data, the external device 115 may evaluate that for the specific brush head, toothpaste and pressure applied by a user, the brushing of each section should preferably be performed for a given duration. The external device 115 may then send this data to the toothbrush 101. The toothbrush may then monitor usage and provide an indication (e.g. warning signal) after this duration has expired

thereby informing the user that he should move on to the next section (the user may e.g. press a button when moving on to the next section thereby initializing the timer for the following section).

It will be appreciated that the toothbrush 101 may also communicate other forms of data, such as toothbrush operational data. For example, data such as charge level, brush head age and operation modes etc. may be communicated. In some embodiments, other parameters from internal sensors or timers can also be uploaded to the external device 115.

In some embodiments, the external device 115 may transmit configuration data to the toothbrush 101 over the short range communication link and the toothbrush 101 may use this to configure an element of the toothbrush 101 in accordance with the configuration data.

Fig. 4 illustrates an example of a toothbrush 101 in accordance with such embodiments. The example corresponds to the example of Fig. 2 with the addition of a configuration controller 401 which is arranged to configure the toothbrush 101 in response to the configuration data.

For example, the configuration controller 401 may be arranged to configure a software component in response to the configuration data. The software (including firmware) of the toothbrush controller 201 may be configured in response to configuration data that is received from the external device 115. The configuration may for example be by setting various parameters used in the process, e.g. for setting a preferred brush pressure.

In many embodiments, the configuration controller 401 may update some or all of the software based on the received configuration data. Indeed, in some embodiments the configuration data may include a new software package that may update the currently used software.

The short range link and the external device 115 may accordingly be used as a tool for configuring the toothbrush 101. This may provide a practical and easy way of adapting and customizing the toothbrush 101. In particular, it may allow a software upgrade to be downloaded using the smartphones enhanced communication capabilities (e.g. over the Internet) and provided to the toothbrush 101 via the short range communication link.

Furthermore, the update can be controlled using the improved user interface of the smartphone.

In some embodiments, the configuration data may include user interface configuration data and the configuration controller 401 may be arranged to configure a user interface of the toothbrush in response to the configuration data. The configuration data may

relate to the user interface for providing feedback to a user and/or to the user interface for receiving user inputs.

Thus, in some embodiments, the configuration controller 401 may configure a user interface function in response to the configuration data.

5 For example, many advanced electrical toothbrushes may include buttons that allow the user to provide a user input by depressing the button. However, in order to allow simple and easy operation (and keep cost down), the number of such buttons is typically kept to a very low number, and most commonly to only one button.

10 In accordance with some embodiments, the function of this (or these) button(s) may be configurable from the external device 115. Thus, the external device 115 may be used to reconfigure the button. The configuration data received from the external device 115 may be used to assign a function to a specific user input, such as a specific user activatable button or switch. The data may specifically define a function to be assigned to the button, or in other
15 embodiments more complex data may be provided such as data defining which function is assigned in various situations. For example, the configuration data may prescribe one function when the toothbrush 101 is not used, another when it is in use but no pressure is applied, or a third function when pressure is applied.

20 As another example, a sequence of functions may be assigned. This may e.g. provide a program where each press of the button advances the toothbrush to the next operation. This may e.g. allow a tooth brushing activity to be defined where the user is requested to proceed through a sequence of steps. For example, first the user is requested to brush the upper rear left side teeth. The toothbrush 101 may be configured to provide an audio tone when this has been done for sufficiently long. The user is then expected to move
25 on to brushing the front teeth. When he does so, he presses the button, and this initiates the timer for the next interval and sets the parameters for the next interval. Thus, each press of the button results in a reconfiguration of the function of the toothbrush 101.

30 The configuration data may in some embodiments allow the user feedback to be changed. For example, in the previous example, the warning sound may be changed for each interval thereby providing an indication of where in the program the toothbrush 101 is. In some embodiments, the configuration data may simply allow the user to customize the toothbrush to his personal preferences, such as a preferred audio sound or visual indication (e.g. flashing or constant light of a warning light).

Such approaches may allow for a user friendly and practical customization and configuration of toothbrush devices. Indeed, conventional electric toothbrushes have very

simple user interfaces, although they are becoming increasingly complex devices with feedback mechanisms, different operating modes, warnings, and new features like plaque and calculus detection etc. It can be highly desirable to reprogram the default operation of a core button on the device to simplify operation for the user. Instead of overloading a single button with multiple functions to change modes, the button can in the example be reprogrammed by the external device 115, and in the specific example by a smartphone. This enables the smartphone to select which modes are relevant for the user. In particular, the user may himself customize the toothbrush 101 using the large touchscreen user interface of the smartphone. This process can take the user through the process in a clear step by step process and even show a simulation of the toothbrush operation. When the user is happy he can scan the smartphone to the toothbrush and reprogram the buttons to set a customized behavior to suit the user. Options to resort to factory settings would typically also be made available.

Such an approach could e.g. include enabling the button to set a combination of:

- Brush frequency
- Brushing length
- Brushing timing intervals (e.g. extend from 30seconds to 45 seconds per mouth quadrant)
- Number of brushing intervals (e.g. if additional brushing is required for problem areas)
- Arrange settings for specific person that shares the toothbrush
- Arrange setting for a specific purpose (e.g. gum massage)
- Ability to switch modes off and on like plaque and calculus detection

As examples of user feedback features that may be configurable by the configuration data, this could e.g. be used to:

- Arrange setting of effects (e.g. emissive colors)
- Set parameters for user interface LEDs, that indicate power level, brushing speed or intensity
- Set warning sounds, alarms, volume levels

As yet another example, children's toothbrushes can include a sound transducer which allows it to play content, and in particular tunes, to entertain children while they brush. The smartphone can be used to select different tunes, or upload tunes over the network, or unlocked as a reward for good brushing by the coaching application. The content can be managed by the smartphone application and uploaded via NFC to the toothbrush. The

smartphone may allow a very simple user interface, such as the one illustrated in Fig. 5, to be used to configure the toothbrush 101.

In some embodiments, the toothbrush 101 may be configured in response to the configuration data and toothbrush usage data. The configuration data may specifically
5 specify different configurations for different usage scenarios. For example, the button may be configured to have one function when the toothbrush 101 has been used less than a given time interval, and a different function when it has been used for more than the given time interval. The configuration may for example specify that the button is first used to start the toothbrush 101, after which it should have no function until after a desired brushing time
10 interval has expired, and then it should allow the toothbrush 101 to be switched off. The configuration controller 401 may then configure the button dynamically dependent on the usage. It will be appreciated that more complex dependencies may typically be employed.

In the previous examples, the short range communication is established using peer-to-peer communication. However, in some embodiments, the short range
15 communication may support master/slave communication in which one of the communication entities is the controlling entity, whereas the other one merely reacts to the other entity.

For example, for NFC, communication may be established as peer-to-peer communication or may be established with one device being the dominant active master
20 device and the other being the passive slave device. Such communication is in particular used for RFID tags where an NFC communication device may establish contact and receive data transmitted from the tag in response to the signal from the NFC communication device.

Thus, in some embodiments, the communication may be performed by one communication entity initiating and controlling the data transfer. In such embodiments, the
25 communication unit 205 may be arranged such that the communication unit 205 can be used as a master communication unit or as a slave communication unit, or indeed as a peer-to-peer communication. This may allow improved interoperability and may especially allow the communication unit 205 to be used with a range of different devices.

In particular, it may allow that the toothbrush 101 can be used with a range of
30 devices or communication items and indeed may be used with different communication entities simply by a reconfiguration of the communication unit 205.

Indeed, it may allow the communication unit 205 to be used both for NFC peer-to-peer communications and for RFID communications. For example, the toothbrush 101 may establish an NFC connection with the external device 115 using a peer-to-peer

communication, and also read RFID tags by initiating the communication as a master communication unit.

In e.g. such embodiments, the toothbrush 101 may also establish communication with a communication entity that is not part of the external device 115. This second communication may specifically be an RFID connection where the communication unit 205 acts as a master communication unit that reads data from the tag. The toothbrush 101 may use this approach to acquire identification data for items that are used in connection with the toothbrush 101 and tooth brushing activity. This information may then be forwarded to the external device 115 over the communication link with the external device 115. This may provide additional information that allows an even more exhaustive, elaborate and accurate analysis to be performed.

Such an example is illustrated in Fig. 6 where the toothbrush 101 of Fig. 1 may further read ID tags of items such as dental floss 601, mouthwash 603, and toothpaste 605.

The toothbrush 101 may for example use such an approach to detect the specific brush head 103 that is used. For example, the replaceable brush head 103 may have an RFID tag attached to it. The user may then scan the toothbrush against the brush head 103 thereby allowing the communication unit 205 to read the tag. Alternatively, the positioning of the RFID tag and the brush head 103 may be such that the RFID tag will automatically be sufficiently close to allow it to be read automatically when the brush head 103 is placed on the toothbrush 101. The details of the brush head 103 can then be transmitted to the external device 115 thereby allowing the analysis to take this information into account. For example, the analysis may reflect whether the brush head 103 corresponds to a hard brush or a soft brush. Alternatively or additionally, the information may allow the cleaning program of the toothbrush 101 to be automatically adjusted based on the specific brush head used. In some embodiments, such an adjustment may be provided via the configuration data provided from the external device 115.

In some embodiments the approach may e.g. be used to determine when it is time to change the brush head in order to keep toothbrush working efficiently. The tag may then be used to record the moment the brush head was changed. Also, the level of brush head wear can be calculated more accurately from the data extracted from the toothbrush that include measured parameters: e.g. age, total brushing time, brushing intensity, brushing frequency and brush pressure. A replacement head could be ordered directly using the smartphone.

As another example, the brush head tag may allow identification of the individual user in scenarios where a plurality of users use the same toothbrush but with different brush heads. In such examples, each user may have an RFID tag that they attach to their own brush head.

5 As another example, the item detected and read by the toothbrush 101 may be the toothpaste used by the user. Toothbrushes are increasingly complex as they enable different modes of operation. However, the user doesn't want or feel the need to set a brushing mode when switching to different toothpaste. Instead, this can in the example be enabled by using the NFC communication functionality, for example by detecting the RFID
10 tag embedded in the toothpaste tube 605 as the toothpaste is applied to the toothbrush. This may allow the toothbrush 101 to be optimized for the specific toothpaste, for instance by switching to a tooth whitening mode when a specific brand of whitening toothpaste is detected or when a specific whitening toothpaste brush head is detected.

Other examples of items that may be scanned to provide a more complete
15 picture of the oral cleaning process includes other oral products such as tooth floss or mouthwash. The user may scan such products against the toothbrush to provide the information to the toothbrush 101.

Accordingly, in the system of Fig. 1, the toothbrush 101 is equipped with NFC communication functionality that allows it to communicate with RFID tags and other NFC
20 devices that are brought into close contact, such as e.g. dental floss, mouthwash, the brush head, the charging base, smartphones etc. As such the toothbrush is an ideal place to capture details of the oral cleaning behavior of the user, identifying not only which elements are used during a given routine as they are scanned against the toothbrush, but also to derive the intervals between each to indicate what time each cleaning method was applied.

25 In some embodiments, the external device 115 may comprise a long range communication device. A long range communication will have a range that significantly exceeds that of the short range communication link. Indeed, it will typically be at least twice as long and often more than five or ten times as long. Typically the range of the long range communication link is at least 1, 2 or 5 meters.

30 For example, in the specific example of Fig. 1 the external device 115 is a smartphone that can support long range communications such as cellular communications or WiFi. In some embodiments, the external device 115 may be a communication hub that does not include any computational functionality for processing the usage data but which is capable of transmitting the data on to a remote entity.

The approach may allow the toothbrush to be used with a remote computational entity. Thus, the short range communication link can be part of a longer communication link to a remote entity. For example, the system may connect to a home network thereby allowing the analysis and user presentation to be performed e.g. on a computer in a different room.

In some embodiments, the short range communication link forms part of a communication link with a (typically) remote server. The server may be a common server that receives toothbrush usage data from a plurality of toothbrushes. In such embodiments, the data may include identification data which allows the usage data to be identified to belong to the toothbrush 101. This may allow an analysis and specifically statistical analysis to be performed on data from a population of toothbrushes.

As a specific example, the system of Fig. 1 may allow an easy connection of the toothbrush 101 to the Internet via the external device 115 thereby allowing upload or download of data. Specifically, it allows brushing data to be transferred to external networks for analysis, automatic gathering of statistics for studies, providing dental cleaning data to dental professionals and education establishments etc.

Specifically, a smartphone can also use its wide area connectivity to enable the application to use external networks in order to share data derived from the oral cleaning thereby enabling e.g. archiving of data and further analysis. The data can be used to provide sharing of data on social networks or databases to promote competition between individuals to encourage better oral health. Such brushing data can also be shared with a dentist thereby providing the dentist with evidence to use in forming advice to the patient.

Data gathered by the toothbrush relating to brushing time, brushing pressure, and any other sensor data gathered (e.g. plaque/calculus levels) and use of other cleaning products, e.g. tooth floss, mouthwash etc. can be relayed to and analyzed by remote expert systems or dental professionals. In return, specific recommendations for a specific user can be sent back to the smartphone, perhaps recommending a specific toothbrush product, or brush head, or operation mode to aid the customer or that toothbrush timings should be changed to meet the individual's needs.

The approach may also be used to provide research data and the information will be valuable to a wide range of oral health organizations, companies, dentists, hygienists and dental education professionals. E.g. Government organizations (e.g. Adult Dental Health Survey, UK) and independent companies (e.g. AFG Research, USA) spend a lot of time and effort compiling studies to assess oral health of their clients in a geographical region. If data

relating to oral healthcare regimes is available directly from devices out in the field, key aspects of such studies can be conducted automatically with real user data, rather than that obtained from a questionnaire or interview.

Once the oral healthcare data is gathered onto a smartphone it can easily (and
5 anonymously) be shared across internet based computers. This enables such computers to conduct real-time dental studies. Types of data that may be transmitted include:

- Data that is directly associated with a specific user. This can e.g. be used by dental professionals to treat a client and make targeted recommendations for improvement
- Data of an anonymous user, but which does contain specific data relating to a
10 product and software releases. This can e.g. be gathered as statistics to evaluate products, demographic areas for studies and make operational decisions.

In the examples above, the external device 115 was specifically a
smarthphone. However, in some embodiments the external device 115 may be the charging base
105 for the toothbrush. This may in particular be advantageous for embodiments wherein the
15 external device 115 is used to provide a connection to a long range communication system.

For example the toothbrush charging base 105 can be enabled with NFC
communication functionality allowing it to communicate with the toothbrush each time this is
returned to the base. The charging base 105 can be enabled with other communication means
(for example WiFi, power line communication, telephone communication) that connects it
20 e.g. to a home network or the Internet. The charging base 105 may thus function as a
communication hub providing an interface to other communication systems that may forward
the data to a remote server.

In the previous description, the short range communication link has been an
NFC wireless link. However, in some embodiments the communication link from the
25 toothbrush 101 to the external device 115 may include sections that are not wireless. These
may further have a range that exceeds 50 cm. Thus, the wireless range of the communication
from the toothbrush 101 to the external device 115 is no more than 50 cm. However, the
devices may possibly be further apart as the communication path may in some embodiments
include wired sections.

30 In particular, in some embodiments, the communication link includes or
consists in a Body Coupled Communications (BCC) link such as the Philips Active Digital
Aura (ADA) link which enables users to interact with Smart Objects simply by touch. In
contrast with RFID/NFC solutions, there is no need for users to explicitly 'swipe' a card over
a reader in order to interact with a Smart Object. Instead, the user is required to carry a BCC

‘dongle’ which enables a communication link to be formed between the user and smart objects. In the BCC technology, the human body serves as a communication channel. The basic principle of BCC is that a small electric field is induced onto the human body in order to propagate a signal between devices that are in the proximity of, or in direct contact with, the human body. As such this technology can be used to transfer data to and from a toothbrush seamlessly when it is picked up by a user. BCC may specifically replace NFC as the communication link to the toothbrush, enabling a wide range of additional features as described above. A separate link to external networks can be provided by the external device 115.

The previous description has focused on examples of a toothbrush. However, it will be appreciated that the principles and described examples may as appropriate be applied to other tooth cleaning devices. In particular, the description may as appropriate be equally applicable to e.g. a handheld floss device, such as the Philips AirflossTM device. Such a device uses a high pressure air stream with micro-droplets of water to clean between teeth. Such a device is used in a very similar way to a toothbrush 101 and the use scenario as well as the user experience and behavior is very similar. Applying the described techniques to such a device may accordingly provide similar advantages of an improved user experience, improved analysis and improved oral care.

It will be appreciated that the above description for clarity has described embodiments of the invention with reference to different functional circuits, units and processors. However, it will be apparent that any suitable distribution of functionality between different functional circuits, units or processors may be used without detracting from the invention. For example, functionality illustrated to be performed by separate processors or controllers may be performed by the same processor or controllers. Hence, references to specific functional units or circuits are only to be seen as references to suitable means for providing the described functionality rather than indicative of a strict logical or physical structure or organization.

The invention can be implemented in any suitable form including hardware, software, firmware or any combination of these. The invention may optionally be implemented at least partly as computer software running on one or more data processors and/or digital signal processors. The elements and components of an embodiment of the invention may be physically, functionally and logically implemented in any suitable way. Indeed the functionality may be implemented in a single unit, in a plurality of units or as part

of other functional units. As such, the invention may be implemented in a single unit or may be physically and functionally distributed between different units, circuits and processors.

Although the present invention has been described in connection with some embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. Additionally, although a feature may appear to be described in connection with particular embodiments, one skilled in the art would recognize that various features of the described embodiments may be combined in accordance with the invention. In the claims, the term comprising does not exclude the presence of other elements or steps.

Furthermore, although individually listed, a plurality of means, elements, circuits or method steps may be implemented by e.g. a single circuit, unit or processor. Additionally, although individual features may be included in different claims, these may possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. Also the inclusion of a feature in one category of claims does not imply a limitation to this category but rather indicates that the feature is equally applicable to other claim categories as appropriate. Furthermore, the order of features in the claims do not imply any specific order in which the features must be worked and in particular the order of individual steps in a method claim does not imply that the steps must be performed in this order. Rather, the steps may be performed in any suitable order. In addition, singular references do not exclude a plurality. Thus references to "a", "an", "first", "second" etc. do not preclude a plurality. Reference signs in the claims are provided merely as a clarifying example shall not be construed as limiting the scope of the claims in any way.

CLAIMS:

1. A tooth cleaning device comprising:

a communication element (205) for supporting a bi-directional short range communication, the short range communication having a wireless range of no more than 50 cm; and

5 a communication controller (203) comprising:

a connection controller (209) for automatically establishing a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the communication element (205), and

10 a data communication controller (207) for communicating data to the external communication entity over the short range communication link, the data including usage data for the tooth cleaning device.

2. The tooth cleaning device of claim 1 wherein the connection controller
15 establishes the short range communication link without user interaction or user input.

3. The tooth cleaning device of claims 1 or 2, wherein the data communication controller (207) is arranged to receive suggested usage data from the external communication entity over the short range communication link, and the tooth cleaning device further
20 comprises a user feedback controller (201) for generating a user feedback in response to an evaluation of usage of the tooth cleaning device relative to the suggested usage data.

4. The tooth cleaning device of claims 1 or 2, wherein

the communication element (205) is arranged to support the bi-directional
25 short range communication as a peer-to-peer communication unit, a slave communication unit or as a master communication unit; and

the connection controller (209) is arranged to configure the wireless communication element as a peer-to-peer communication unit, a master communication unit or a slave communication unit for the short range communication link.

5. The tooth cleaning device of claims 1 or 2, wherein the short range communication link is:

- a Near Field Communication link, or
- 5 - a Body Coupled Communications link.

6. The tooth cleaning device of claims 1 or 2, wherein the data communication controller (207) is arranged to receive configuration data from the external communication entity over the short range communication link, and the tooth cleaning device further
10 comprises a configuration controller (401) for configuring the tooth cleaning device in response to the configuration data.

7. The tooth cleaning device of claim 6, wherein the configuration controller (401) is arranged to configure a software component in response to the configuration data.

8. The tooth cleaning device of claim 6, wherein the configuration controller (401) is arranged to configure a user interface function in response to the configuration data.

9. The tooth cleaning device of claim 8, wherein the configuration controller is
20 arranged to assign functionality to a user input in response to the configuration data.

10. The tooth cleaning device of claim 8, wherein the configuration controller (401) is arranged to configure a user feedback function in response to the configuration data.

11. The tooth cleaning device of claim 6, wherein the configuration controller (401) is further arranged to configure the tooth cleaning device in response to usage data for the tooth cleaning device.

12. The tooth cleaning device of claims 1 or 2, wherein the external
30 communication entity is a portable computational device.

13. The tooth cleaning device of claims 1 or 2, wherein the external communication entity is a long range communication device.

14. The tooth cleaning device of claims 1 or 2, wherein the external communication entity is a charging base for the tooth cleaning device.

15. The tooth cleaning device of claims 1 or 2, wherein the connection controller (209) is arranged to automatically establish a second short range communication link with a second communication entity associated with an item, and the data controller (207) is arranged to receive identification data for the item via the second short range communication link.

16. The tooth cleaning device of claims 1 or 2, wherein the tooth cleaning device is a toothbrush.

17. The tooth cleaning device of claims 1 or 2, wherein the short range communication link forms part of a communication link with a server for receiving usage data from a plurality of tooth cleaning devices, and wherein the usage data is associated with identification of the tooth cleaning device thereby enabling the server to associate the toothbrush usage data with the tooth cleaning device.

18. A tooth cleaning system comprising:
a tooth cleaning device (101); and
a charging base (105) for the tooth cleaning device; wherein the tooth cleaning device comprises:

a communication element (205) for supporting a bi-directional short range communication, the short range communication having a wireless range of no more than 50 cm; and

a communication controller (203) comprising:

a connection controller (209) for automatically establishing a short range communication link with an external communication entity in response to a detection of the external communication entity being within range of the communication element (205), and

a data communication controller (207) for communicating data to the external communication entity over the short range communication link, the data including usage data for the tooth cleaning device.

19. A method of operation of a tooth cleaning device, the method comprising:
supporting a bi-directional short range communication, the short range
communication having a range of no more than 50 cm;

5 automatically establishing a short range communication link with an external
communication entity in response to a detection of the external communication entity being
within range of the wireless communication element; and

communicating data to the external communication entity over the short range
communication link, the data including usage data for the tooth cleaning device.

10 20. A computer program product comprising computer program code means
adapted to perform all the steps of claim 19 when said program is run on a computer.

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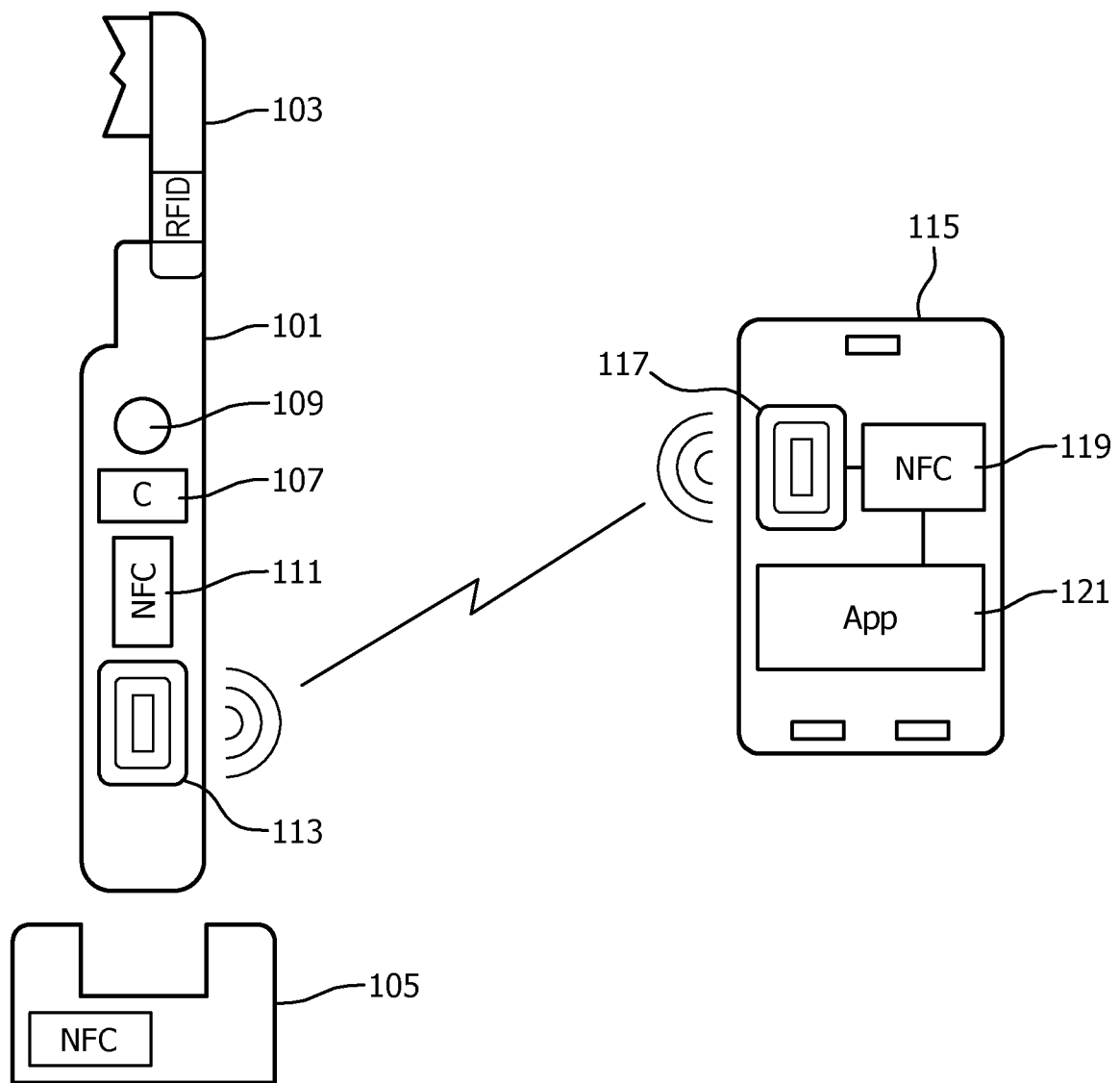


FIG. 1

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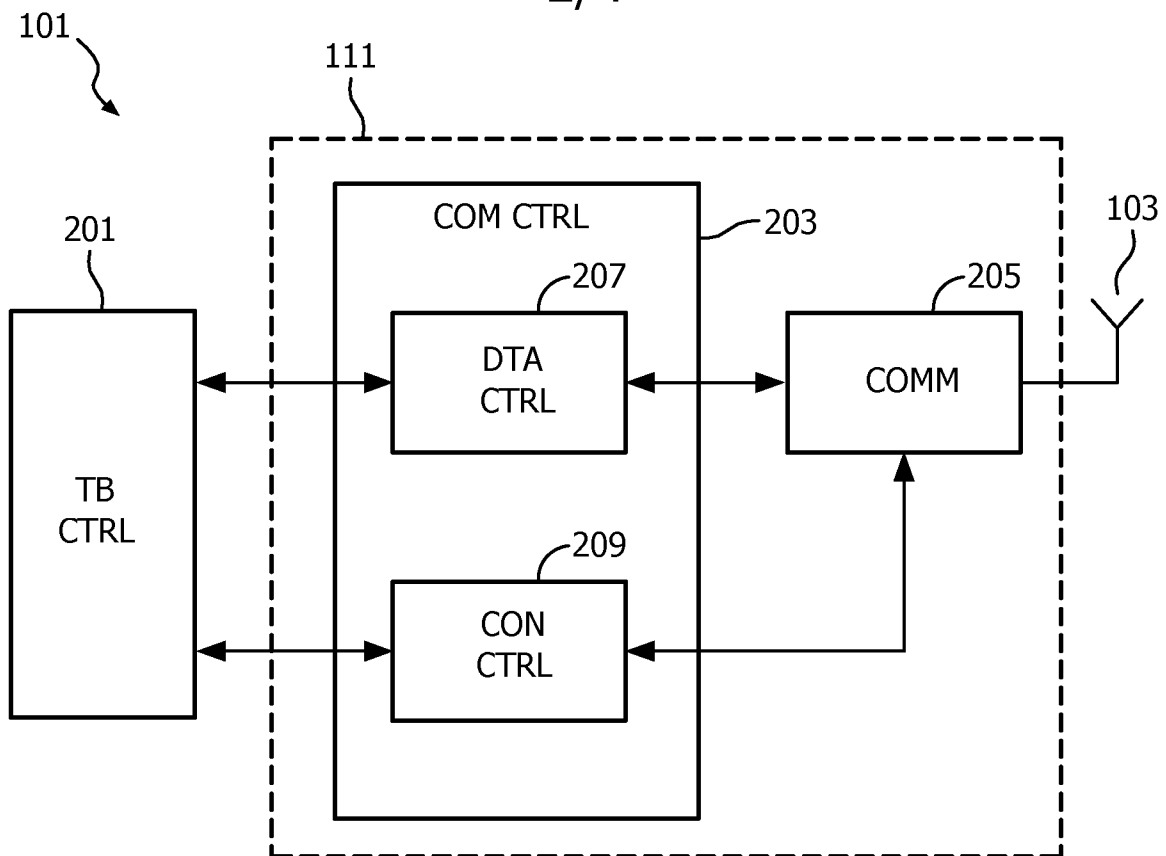


FIG. 2

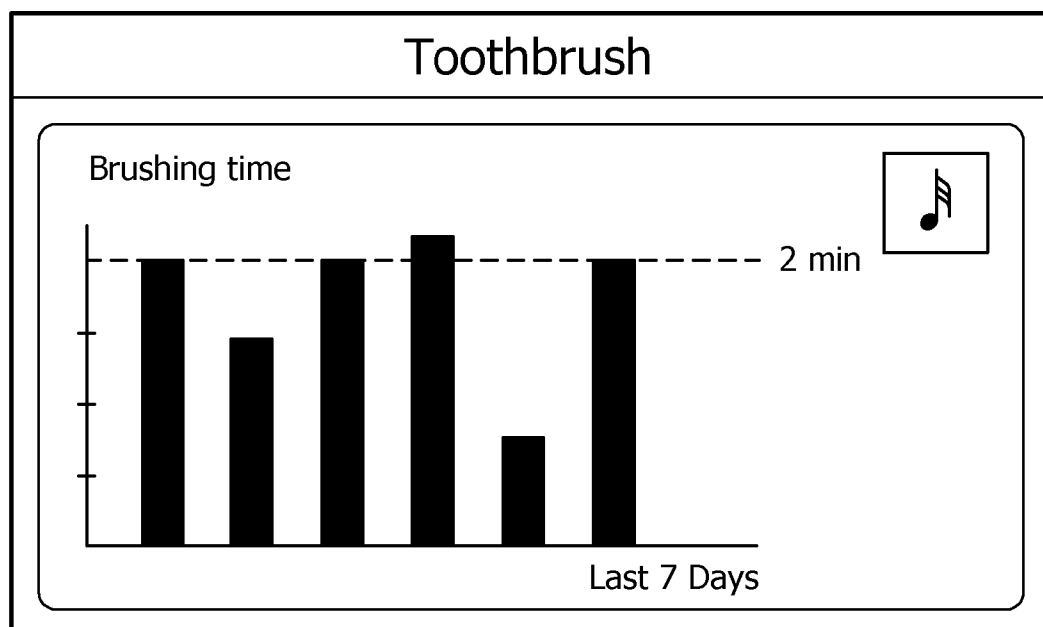


FIG. 3

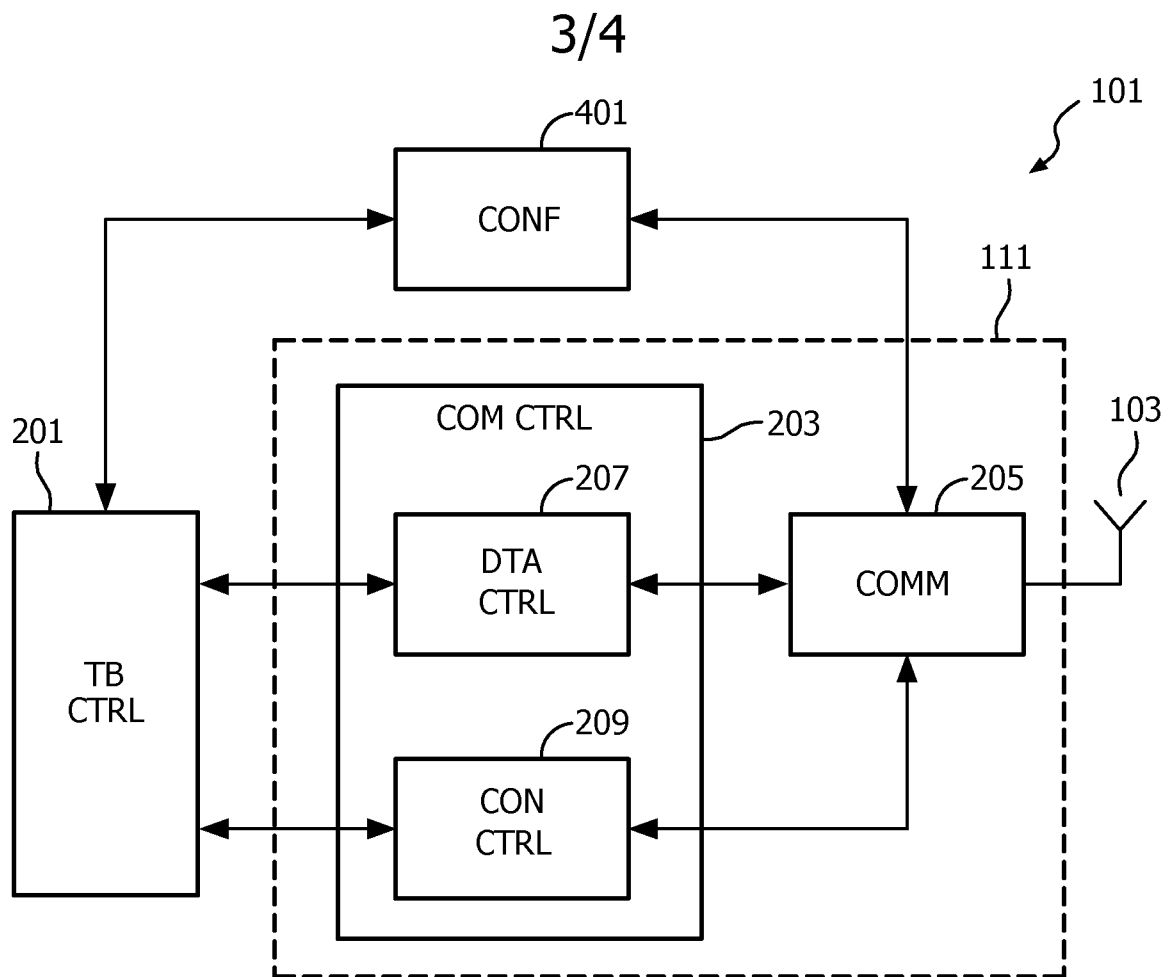


FIG. 4

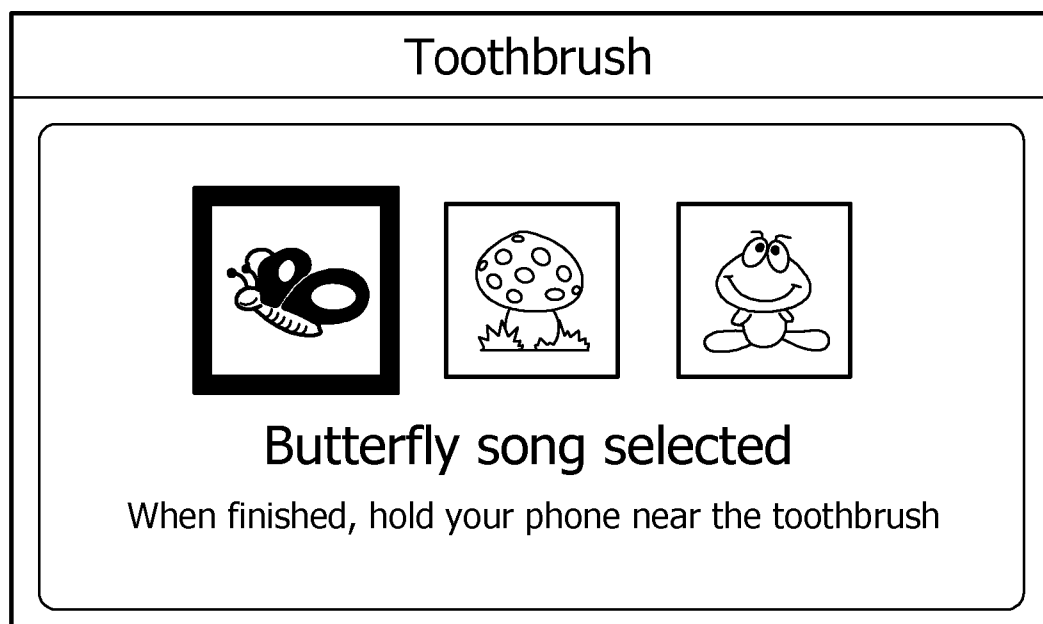


FIG. 5

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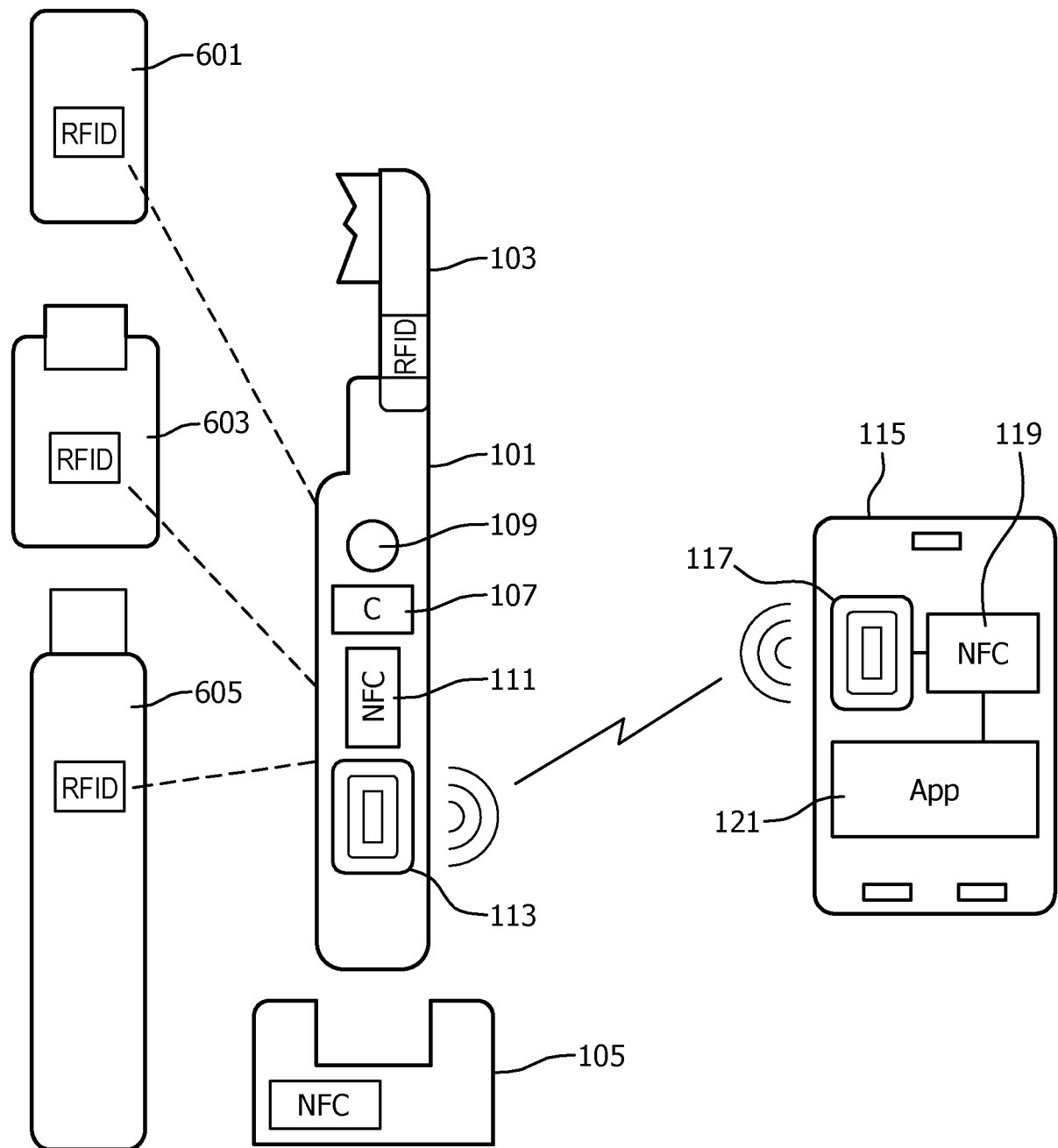


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2013/055574

A. CLASSIFICATION OF SUBJECT MATTER

INV. A46B15/00 A61C17/22
ADD.

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)

A46B A61C

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 practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/171657 A1 (ORTINS MARC PHILIP [US] ET AL) 5 July 2012 (2012-07-05) paragraphs [0050], [0055], [0058], [0061], [0063], [0088], [0093], [0094], [0099], [0109], [0128] - [0135] paragraphs [0139], [0160], [0161] figures 2A, 2B, 12 -----	1-20
X	US 2009/291422 A1 (PUURUNEN JUHA-PEKKA [FI] ET AL) 26 November 2009 (2009-11-26) paragraphs [0045], [0047] - [0051] figure 10 ----- -/--	1-20



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

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"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

28 November 2013

Date of mailing of the international search report

05/12/2013

Name and mailing address of the ISA/

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

Authorized officer

Chabus, Hervé

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/055574

C(Continuation). 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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