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(54) Title: DEVICE TAP DETECTION FOR WIRELESS CONNECTION

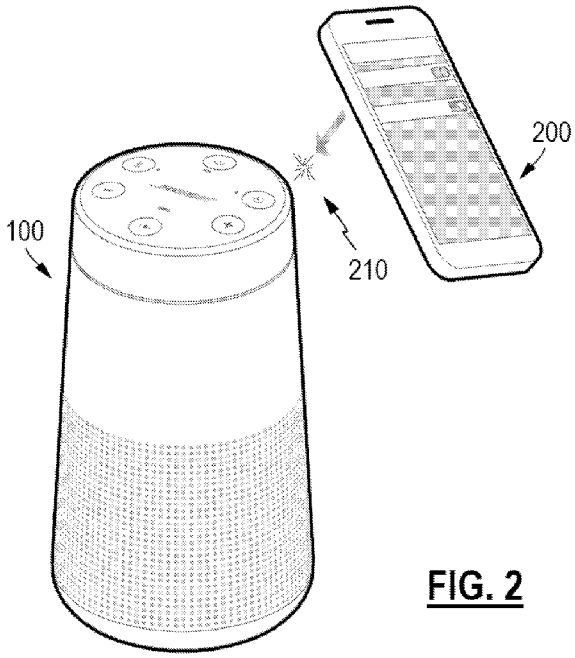

FIG. 2

(57) Abstract: Systems and methods of wirelessly connecting devices that include detecting a physical contact with a peripheral, such as by a double-tap contact with the peripheral, in response to which the peripheral wirelessly connects to a nearby device.

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DEVICE TAP DETECTION FOR WIRELESS CONNECTION

BACKGROUND

Various wireless devices, such as smart phones, tablets, laptops, and the like, include capability to couple with various peripheral wireless devices, such as speakers, headphones, smart light bulbs, etc. In at least one example, an audio speaker may couple to a smart phone or other wireless device to provide an audio output capability. Such an audio speaker may include one or more microphones to enable audio input for various applications, such as speakerphone capability or audio input to a virtual personal assistant, and the like. The audio speaker may typically couple to the smart phone via a wireless connection, such as a Bluetooth connection. Often these devices fail to properly connect, or connect to an unintended device, e.g., such as being configured to connect to the last connected device, or a prioritized ordered list of devices, rather than the nearest device or the user's intended device. There therefore exists a need for improved methods of connecting devices, so that smart devices and their peripherals more easily connect based upon user intention.

SUMMARY

Systems and methods disclosed herein are directed to wireless peripherals and methods that establish wireless connections in response to detecting contact with the peripheral, such as one or more taps (touches) of the peripheral. In some examples a device to which the user wants the peripheral to connect is physically tapped against the peripheral. In certain examples, the peripheral is configured to detect a double-tap and in response thereto the peripheral connects to the closest wireless device. In various examples, the peripheral may detect the one or more taps via a microphone, an accelerometer, a force sensor, or other means.

In some examples the peripheral may detect the closest wireless device by looking for a strong radio signal from the wireless device. The peripheral may monitor for radio signals from a list of wireless devices with which the peripheral has been previously paired and connect to the strongest one. In some examples, the peripheral may select a wireless device with which to connect based upon a received signal strength indicator (RSSI), e.g., upon the expectation that the highest RSSI (or strongest radio signal) is likely to be from the nearest wireless device.

Still other aspects, examples, and advantages of these exemplary aspects and examples are discussed in detail below. Examples disclosed herein may be combined with other examples in any manner consistent with at least one of the principles disclosed herein, and references to "an example," "some examples," "an alternate example," "various examples," "one example" or the like are not necessarily mutually exclusive and are intended to indicate that a particular feature, structure, or characteristic described may be included in at least one example. The appearances of such terms herein are not necessarily all referring to the same example.

BRIEF DESCRIPTION OF THE DRAWINGS

Various aspects of at least one example are discussed below with reference to the accompanying figures, which are not intended to be drawn to scale. The figures are included to provide illustration and a further understanding of the various aspects and examples and are incorporated in and constitute a part of this specification but are not intended as a definition of the limits of the invention(s). In the figures, identical or nearly identical components illustrated in various figures may be represented by a like reference character or numeral. For purposes of clarity, not every component may be labeled in every figure. In the figures:

FIG. 1 is a schematic perspective view of an example device; and

FIG. 2 is a schematic view of an example use of the device of FIG. 1.

DETAILED DESCRIPTION

Aspects of the present disclosure are directed to systems and methods suitable for user interaction with wireless devices to cause the wireless devices to connect (wirelessly couple for communications) in accordance with the user's intent. In various examples, a wireless peripheral detects being tapped (physical contact) and in response thereto attempts to wireless connect with a nearby wireless device. In some instances, the user may double-tap the wireless peripheral with the wireless device to which the user wants the peripheral to connect. In some examples, the wireless peripheral may detect the one or more taps via one or more microphone signals, one or more accelerometer signals, one or more force sensor(s) signals, or any combination of these or other sensor signals.

In various examples, one or more sensor signals (microphone, accelerometer, and/or force) are provided to a processor that is configured to monitor for peaks (such as amplitude)

in the one or more sensor signals, and if the peak exceeds a threshold (such as a sensor signal voltage going above a threshold) the processor may interpret such as a tap, or as an indication of a tap, on the enclosure of the peripheral. In some examples, the processor may be configured to monitor for a second sensor signal peak, above the threshold, within a certain time limit, and may interpret such as a double tap. Any number of additional taps may be detected in a similar manner, e.g., a triple tap or higher. Detecting two or more taps (sensor signal peaks) in a row (within a time limit) may reduce false positives, e.g., if the time limit expires without a second sensor signal peak, then the first sensor signal peak may have simply been incidental, such as the peripheral being bumped by accident. Similarly, a serious of very irregular sensor signal peaks may be indicative of rough handling and not an intentional double tap.

In certain examples, one or more sensor signals (microphone, accelerometer, and/or force) are provided to a neural network process (incorporated with the wireless peripheral) that has been a priori trained to detect microphone signals that indicate a physical tap on the wireless peripheral, such as on the enclosure or housing of the wireless peripheral. According to various examples, in response to detecting the one or more taps, the wireless peripheral may select a wireless device with which to connect based upon a received signal strength indicator (RSSI), such as is described in greater detail in U.S. Patent Application Serial No. 17/314,270, titled PROXIMITY-BASED CONNECTION FOR BLUETOOTH DEVICES and filed on May 7, 2021, the content of which is incorporated herein in its entirety for all purposes.

In various examples, the peripheral device may be an audio device having one or more acoustic transducers for outputting audio (e.g., a loudspeaker). The peripheral may also have one or more acoustic transducers for detecting audio input (e.g., microphone). The peripheral device may have various user interface controls, buttons, sensors, displays, etc., and may have various processors for performing various functions, receiving and processing audio signals and sensor signals, and may include various interfaces, such as for wireless communication (e.g., radio, Wi-Fi, Bluetooth, etc.). Various processors may include (or be coupled with) memory for the storage of data, executable instructions, and the like, and may include or be coupled to power sources (e.g., battery or wired power).

FIG. 1 illustrates an example peripheral device 100 having a loudspeaker output 110, a user control interface 120, and at least one microphone 130. A loudspeaker is included inside the enclosure of the peripheral device 100. One or more processors is also included

inside the enclosure of the peripheral device 100. Various sensors may also be included, such as one or more accelerometers and/or force sensors.

FIG. 2 illustrates an example use scenario of the example peripheral device 100. In the example scenario, a smart phone 200 is quickly brought into contact 210 with the peripheral device 100 and removed, thus defining a "tap" of the smart phone 200 on the peripheral device 100. In various examples, the peripheral device 100 detects the tap. More precisely, a processor within the peripheral device 100 is configured, e.g., by executable instructions, to receive various sensor signals, such as one or more microphone signals, accelerometer signals, and/or force sensor signals, and determine from the signals that a tap has occurred.

In some examples, the processor may be configured with instructions that monitor the one or more sensor signals for a peak that exceeds a threshold and to interpret such as an indication that a tap has or may have occurred. The processor may be configured to monitor for one or more additional sensor signal peaks within a time frame and to interpret such as a series of taps, such as a double tap, triple tap, etc.

In some examples, the processor may be configured with a neural network process that has been a priori trained to distinguish between sensor signals that include a tap and sensor signals that do not include a tap. In certain examples, the processor is configured to detect the tap based upon one or more microphone signals.

In response to the tap, the processor is configured to connect to a "nearby" wireless device, such as the smart phone 200. The processor may be configured to select a wireless device with which to connect based upon a radio signal strength. The processor may be configured to select the wireless device with which to connect from among a list of previously connected or paired devices.

In certain examples, the peripheral device 100 is configured to respond to a double tap, defined by the contact 210 occurring twice in relatively quick succession. In other examples, the peripheral device 100 may be configured to respond to any number of taps, one, two, three, or more.

Examples of the methods and apparatuses discussed herein are not limited in application to the details of construction and the arrangement of components set forth in the above descriptions or illustrated in the accompanying drawings. The methods and apparatuses are capable of implementation in other examples and of being practiced or of being carried out in various ways. Examples of specific implementations are provided herein for illustrative

purposes only and are not intended to be limiting. In particular, functions, components, elements, and features discussed in connection with any one or more examples are not intended to be excluded from a similar role in any other examples.

Also, the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. Any references to examples, components, elements, acts, or functions of the systems and methods herein referred to in the singular may also embrace embodiments including a plurality, and any references in plural to any example, component, element, act, or function herein may also embrace examples including only a singularity. Accordingly, references in the singular or plural form are not intended to limit the presently disclosed systems or methods, their components, acts, or elements. The use herein of "including," "comprising," "having," "containing," "involving," and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. References to "or" may be construed as inclusive so that any terms described using "or" may indicate any of a single, more than one, and all of the described terms. Any references to front and back, left and right, top and bottom, upper and lower, and vertical and horizontal are intended for convenience of description, not to limit the present systems and methods or their components to any one positional or spatial orientation, unless the context reasonably implies otherwise.

Having described above several aspects of at least one example, it is to be appreciated various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this disclosure and are intended to be within the scope of the invention. Accordingly, the foregoing description and drawings are by way of example only, and the scope of the invention should be determined from proper construction of the appended claims, and their equivalents.

What is claimed is:

CLAIMS

1. A peripheral device comprising:

an enclosure;

a sensor coupled to the enclosure; and

a processor coupled to the sensor and configured to detect a physical contact with the enclosure based upon one or more signals from the sensor, and configured to wirelessly connect to a nearby device in response to the detected physical contact.

2. The peripheral device of claim 1 wherein the sensor includes at least one of a microphone, an accelerometer, and a force sensor.

3. The peripheral device of claim 1 wherein the processor is configured to detect the physical contact by monitoring the one or more signals for a peak.

4. The peripheral device of claim 3 wherein the processor is configured to monitor the one or more signals for a peak that exceeds a threshold.

5. The peripheral device of claim 3 wherein the processor is configured to monitor for additional peaks in the one or more signals within a time frame.

6. The peripheral device of claim 1 wherein the processor is configured to detect the physical contact via a neural network.

7. The peripheral device of claim 1 wherein the processor is configured to select the nearby device based upon a radio signal strength.

8. The peripheral device of claim 7 wherein the processor is configured to select the nearby device based upon a received signal strength indicator (RSSI).

9. The peripheral device of claim 1 wherein the physical contact includes a tap, defined as a brief contact with the enclosure by an other object and a subsequent removal of contact with the other object.

10. The peripheral device of claim 9 wherein the physical contact is a number of taps.

11. The peripheral device of claim 10 wherein the physical contact is two taps.

12. A method of wirelessly connecting a peripheral device as performed by the processor of any of claims 1-11.

13. A non-transitory machine-readable storage medium having instructions encoded thereon that, when executed by a processor, cause the processor to perform the method of claim 12.

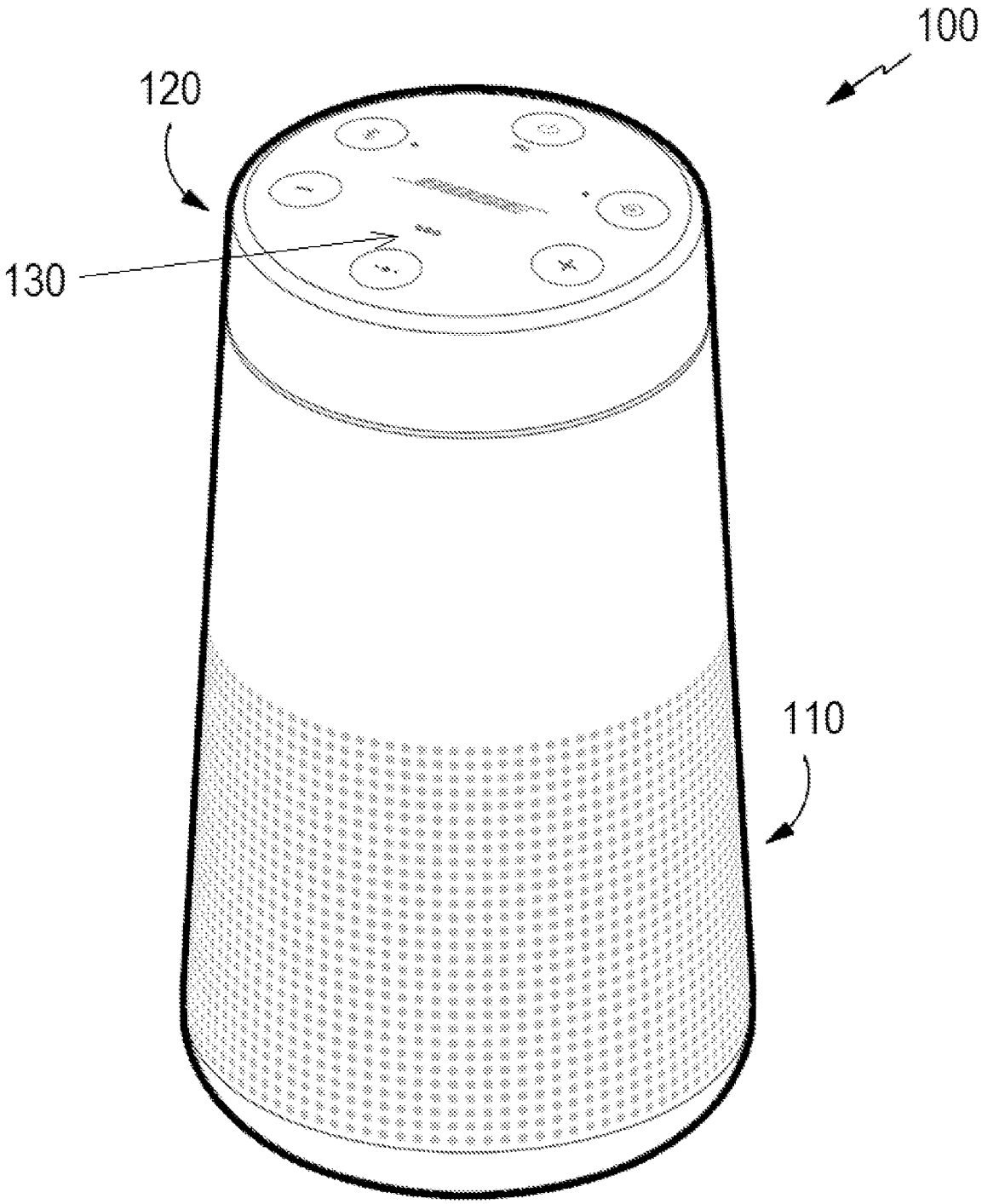

FIG. 1

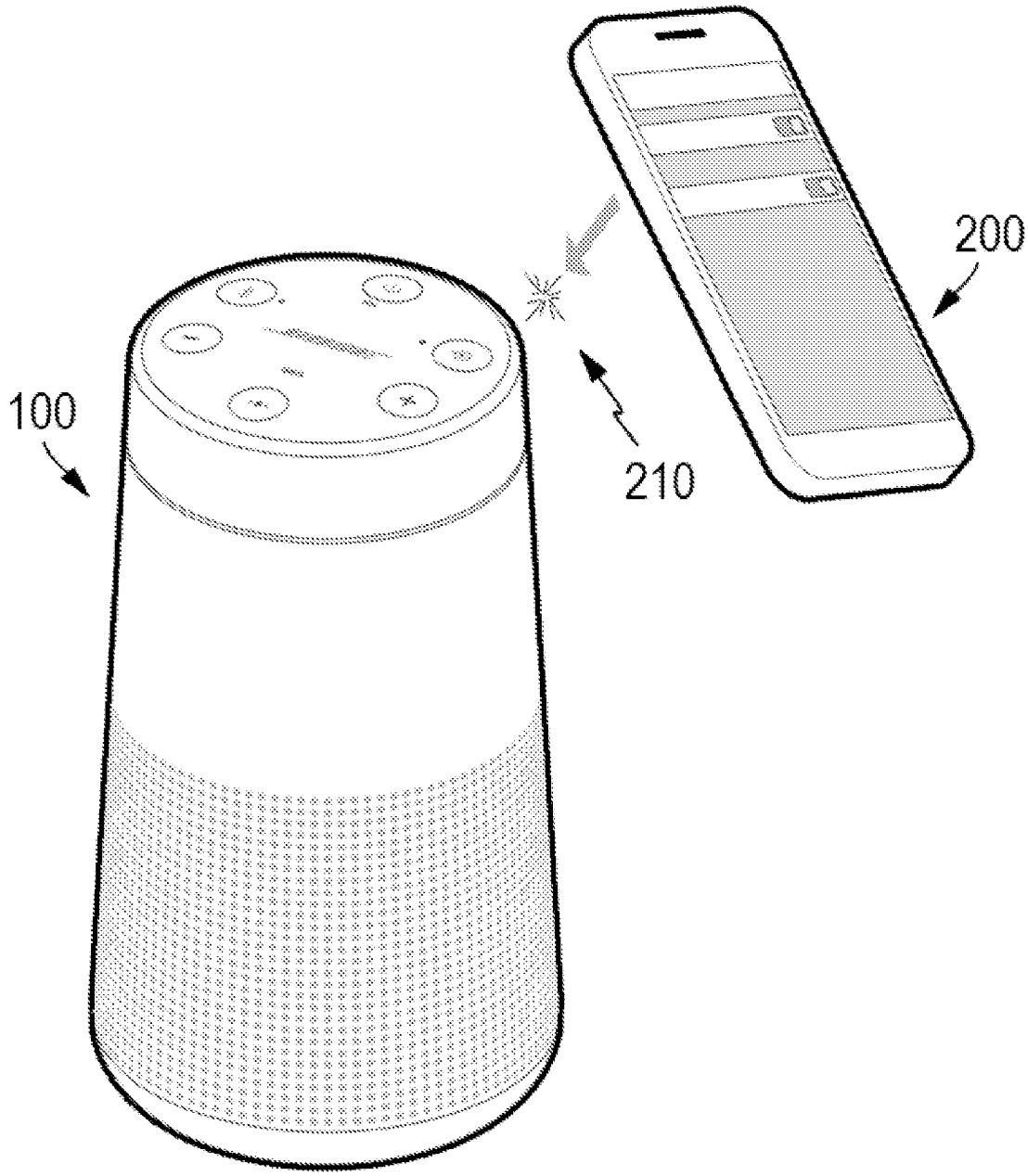

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. H04M1/72412 G06F3/16 H04R1/02 H04W4/80
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)
H04M G06F H04R H04W

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)
EPO-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	WO 2021/008614 A1 (HUAWEI TECH CO LTD [CN]) 21 January 2021 (2021-01-21) paragraph [0009] - paragraph [0027] paragraph [0049] - paragraph [0071] paragraph [0095] - paragraph [0153] figures 1-8	1-13
X	US 2018/356881 A1 (BELVERATO LUIGI [DE]) 13 December 2018 (2018-12-13) paragraph [0026] - paragraph [0045] paragraph [0058] - paragraph [0072] claims 1-8	1-13
X	US 2016/062572 A1 (YANG LAWRENCE Y [US] ET AL) 3 March 2016 (2016-03-03) paragraph [0070] - paragraph [0089] paragraph [0225] - paragraph [0251] figures 9-15	1-13

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[X] Further documents are listed in the continuation of Box C.

[X] 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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"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	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2022/032489

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/106954 A1 (CHATTERJEE MANJIRNATH [US] ET AL) 5 May 2011 (2011-05-05) paragraph [0026] - paragraph [0037] paragraph [0045] - paragraph [0057] paragraph [0102] - paragraph [0106] figures 6-10	1-13

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2022/032489

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