Wireless Finger Micro-Gestures Device

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ABSTRACT

A system may include wireless electronic devices equipped with sensors such as an accelerometer and gyroscope. The devices may be located on the outer side of fingers, capture finger motion, preprocess motion on the devices, transmit information between the devices, classify motion (gesture), and transmit any final or intermediate result to other electronic devices using a wireless connection (e.g. Bluetooth or Wi-Fi). The devices may form a locally distributed storage, communication, and computational network with each other and other electronic devices such as mobile phones, electronic glasses, and virtual reality headsets. The devices may be located on other body parts than fingers. The devices may be placed on finger segments, using glue, double-sided tape, a suction cup, single-sided tape, finger clothes, a device for mounting on a fingernail, and other mounting devices.

BACKGROUND

Humans may perform finger micro-gestures, a large variety of tiny gestures that may be executed with high-frequency if needed.

Wearable devices such as gloves and rings are used as gestural input devices for mixed and virtual reality applications and computer-generated imaginary applications. Wearable devices such as these may provide insufficient functionality or may not be safe and comfortable for a user.

Gloves cover a significant part of the user's hand palm, which may increase discomfort caused by hand sweating and reduce the quality of the tactile experience. Reduced tactile experience, gloves weight, and gloves resistance to finger motion may reduce the user's ability to execute a variety of micro-gestures at a high-frequency rate.

Rings placement on adjacent fingers may cause an uncomfortable user experience, e.g., rings may bump against each other when a user wears the devices on the index and middle fingers and performs micro-gestures that require these fingers to touch each other. Rings may be easily lost when used on a tip finger segment. The location of the ring device on the middle and base segments instead of the tip segments of the user's fingers reduces the variability of recognizable micro-gestures. The use of multiple rings may increase the probability of catching on objects in the user's environment. Such catching on objects in the user's environment may cause injuries of the user or may destroy the ring itself.

SUMMARY

A wireless finger micro-gestures device is an electronic device that may be used to gather input from a user to control electronic equipment. The device may consist of gestural devices and master devices. The gestural device includes sensors and may be located on the outer side of a user's fingers, hands, and other body parts. The master device may contain sensors and be a gestural device charging case. The master device may use a wireless connection, USB cable, or other connection types for communication with other electronic devices. The gestural device may connect to the master device and other electronic devices using a wireless connection.

The wireless finger micro-gestures device may provide high-resolution and high-frequency micro-gesture motion capture and control command recognition. The device and micro-gestures may be used to maximize the quality, diversity, and frequency of user-produced control commands. The device may be used with virtual reality and mixed reality technologies. Its portable nature, small size, and safe placement may allow safe and comfortable indoor and outdoor usage.

The device placement reduces the amount of covered skin and preserves a user's tactile experience. The placement, wireless connection circuit, and small device size preserve the

simplicity and comfortability of the gesture execution. Positioning at the tip finger segment may increase sensitivity compared to the base and middle segments of the finger. There may be different gestural device placement methods optimized for different use cases. Optionally, the gestural devices may be used on the user's legs and other body parts.

BRIEF DESCRIPTIONS OF THE DRAWINGS

FIG.**1** is a schematic diagram of an illustrative system of a wireless finger micro-gestures device with gestural devices, master devices, and electronic devices in accordance with an embodiment.

FIG.**2**. is a general illustrative principle of gestural device placement in accordance with an embodiment.

FIG.**3** shows the basic locations of the gestural devices on the hand in accordance with an embodiment.

FIG.**4** is the top view of one of the possible placement options of gestural devices on fingers and hands in accordance with an embodiment.

FIG.**5** is the side view of one of the possible placement options of gestural devices in accordance with an embodiment.

FIG.**6A-6F** is a side view of gestural devices attached to the tip finger segment using glue, double-sided tape, suction cup, single-sided tape, finger clothes, and device for mounting on fingernail in accordance with an embodiment.

FIG.**7A-7F** is an exploded side view of gestural devices attached to the tip finger segment, using glue, double-sided tape, suction cup, single-sided tape, finger clothes, and device for mounting on fingernail in accordance with an embodiment.

FIG.**8A** is an exploded perspective view of gestural devices attached to the tip finger segment with finger clothes in accordance with an embodiment.

FIG.**8B** is a side view of gestural devices attached to the tip finger segment with finger clothes to a finger in a bent position in accordance with an embodiment.

FIG**.9A-9D** is a side view of gestural devices attached to the middle finger segment using glue, double-sided tape, single-sided tape, and finger clothes in accordance with an embodiment.

FIG.**10A-10D** is an exploded side view of gestural devices attached to the middle finger segment using glue, double-sided tape, single-sided tape, and finger clothes in accordance with an embodiment.

FIG.**11A-11D** is a side view of gestural devices attached to the base finger segment (glue, double-sided tape, single-sided tape, finger clothes) in accordance with an embodiment.

FIG.**12A-12D** is an exploded side view of gestural devices attached to the base finger segment (glue, double-sided tape, single-sided tape, finger clothes) in accordance with an embodiment.

FIG**.13** is a top view of the possible placement options of gestural devices on the feet in accordance with an embodiment.

FIG.**14** is a side view of the possible placement options of gestural devices on the feet in accordance with an embodiment.

FIG.**15A is** an illustrative diagram of a neutral finger position with gestural devices in accordance with an embodiment.

FIG.**15B**-FIG.**15C** are illustrative diagrams of two different micro-gestures of the thumb and the index fingers in accordance with an embodiment.

FIG.**15D**-FIG.**15E** are illustrative diagrams of two different micro-gestures of the thumb and the middle fingers in accordance with an embodiment.

DETAILED DESCRIPTION

A wireless finger micro-gestures device may consist of at least one gestural device and, optionally, a master device. Gestural devices and master devices are electronic devices with control circuitry and communication circuitry. The devices may gather the user's input and supply output.

Gestural devices may gather information on the user's micro-gestures, gestures, and interactions with the user's surroundings. Gestural devices may be placed on a hand, on the outer side of each finger, on the tip, middle, and base finger segments. In addition, a user may place gestural devices and master devices on feets and other body parts, clothes, video cameras, light sources, game balls, game rockets, baseball-bats, various sports equipment, drones, vehicles, ships, boats, electronic devices, work tools, and surrounding objects. Depending on the user's needs, the gestural devices may be attached to the placement position by glue, double-sided tape, a suction cup, single-sided tape, finger and other clothes, a device for mounting on a fingernail, and other mounting devices. These attachment methods may minimize the hand’s skin coverage by the devices and retain the user’s tactile experience. The gestural device may transmit information received from the user to the master device(s) or directly to the electronic device(s), using a wireless connection (e.g., Bluetooth, Wi-Fi) by an antenna. The gestural device may have a wireless connection. The gestural device's battery may be recharged when placed in a master device. The master device may serve as a case and a charger for gestural devices.

Master devices may be used as a connection proxy for gestural devices and electronic devices. For transmission, the master device may use a wireless connection (e.g. Bluetooth, Wi-Fi), USB cable, or other types of connection. Gestural devices and master devices may use a public or proprietary wireless connection protocol to communicate with each other.

Master devices may have a greater possibility of power consumption and data transfer than the gestural device. The master device may receive and transmit information on position changes and motion of gestural devices and transmit information of the changes of its position and motion. The master device may be attached to a user or electronic devices, such as cameras. Such an approach may allow to synchronize observer (e.g., a camera) and observed object (e.g., a user) in a unified system. Such a system may be useful for computer-generated imaginary applications, game development, broadcast of sports games, and medical and scientific applications. Unified software and hardware solutions for wearable and nonwearable devices may simplify work with the system and reduce the time required for the system configuration and testing as well. The master device may mark the initial position of the gestural devices and transmit corresponding data to the user's other electronic device, such as a virtual reality headset, laptop, smartwatch, or other devices.

Gestural devices and master devices may form a wireless computational network and wireless locally distributed database. Such a network and database may help to distribute and balance power consumption and data space and reduce communication and computational latency.

The gestural device and the master device may use IMU (Inertial measurement unit) for positioning in space. The IMU may be represented as a combination of sensors such as accelerometers and gyroscopes.

The gestural device and master device may provide haptic output to the user by the haptic output devices. For example, the haptic output device may vibrate to notify a user about some events provided by the software, e.g. about interaction with objects in the user’s environment and virtual and mixed reality. The gestural device and master device may have a display. Displays may show information about the software configuration and other information that may be useful for a user. The display may serve as a dynamic coloration for aesthetic purposes.

At least one gestural device and, optionally, a master device may constitute a wireless finger micro-gestures device that may connect with other electronic devices. The wireless finger micro-gestures device may connect with such electronic devices as personal computers, phones, tablets, and electronic styluses, wearable electronic devices such as smartwatches and glasses, mixed and virtual reality glasses and headsets, and other devices. Electronic devices may consist of control circuitry, communications circuitry, and other devices. The control circuitry may be used to connect devices in the system and to control communication circuitry. The communications circuitry may be used to support connection and communication between electronic devices, gestural devices, and master devices. The wireless finger micro-gestures device may be used for text input through micro-gestures. All surfaces of the fingers and hands (e.g., fingertips and finger pads) may be involved in micro-gestures commands. The thumb may play one of the major roles due to its mobility and well-developed muscles. For example, the device may recognize a thumb touching a specific area

of the other finger or palm as a particular letter and use such gestures as an analog of a keyboard.

The diagram in FIG**. 1** schematically shows system **33** of the wireless finger micro-gestures device with gestural device(s) **10**, master device(s) **11**, and electronic device(s) **12**.

Gestural device **10** and master devices **11** may consist of sensors, a haptic output device, a display, a battery, an antenna, and other devices. Device **10** may include a sensor **19**, haptic output device **20**, battery **21**, antenna **22**, display **23**, and other devices **38** (e.g. storage system, processing system, control circuit, communication circuit). Device **11** may include a sensor **24**, haptic output device **25**, battery **26**, antenna **27**, display **28**, and other devices **29** (e.g. storage system, processing system, control circuit, communication circuit).

Electronic devices **12** may be devices such as the wireless finger micro-gestures devices, other gestural devices, personal computers, laptops, mobile phones, tablets, electronic stylus, smartwatches, electronics glasses, other wearable electronic devices, mixed and virtual reality glasses, virtual reality headsets, and other devices. Electronic devices **12** may contain control circuitry **13**, communications circuitry **14**, and other devices **15** (e.g. memory storage). Communication circuitry **14** may be used to support a connection in system **33**. Control circuitry **13** may include storage, processing, and high-level communication layer systems. The communications circuitry **14** may include different types of receiving and transmitting devices, e.g., antennas.

Haptic output devices **20** and **25** may generate vibrations or other notable types of motions. Devices **20** and **25** may include any motors, actuators, repulsive devices, and vibrators.

Displays **23** and **28** may show information about c software configuration (e.g. size, shape, transparency of the selected brush, brush color, current layer, etc.), and other information that may be useful for a user. Displays **23** and **28** may serve as screen wallpaper for aesthetic purposes. A battery **21** may recharge during storage in the master device 11.

Sensors **19** and **24** may be suitable for positioning. Sensors **19** and **24** may gather input from the user, such as information about the user's interactions with the environment. Sensors **19** and **24** may include a three-axis accelerometer, three-axis gyroscope, temperature sensors, three-axis magnetometer, touch and proximity sensors, force sensors, optical sensors, muscle activity sensors, and other sensors.

Devices **10**, **11**, and **12** may use antennas to transmit information to each other through a wireless connection (e.g., Bluetooth, Wi-Fi). Antennas **22** and **27** may be used for wireless connection (e.g. Bluetooth, Wi-Fi) between the devices. Device(s) **10** may connect to one or many device(s) **11** by wireless connection **16**, e.g., Bluetooth, and Wi-Fi. Devices **10** may connect directly to devices **12** by wireless connection **18** (e.g. Bluetooth, Wi-Fi). Device **11** may connect to device **12** with a wireless or wired connection **17**, by Bluetooth, Wi-Fi, USB, and other connection types.

Device **11** or **12** may be used to recharge the battery **21** of device **10**. Device **12** may be used to recharge the battery **26** of device **11**. Battery **26** may be used for charging battery **21**.

FIG.**2** illustrates the placement of device **10** to the different positions on user's body **30`**, shown FIG.**3** to FIG **5**, FIG.**13**, and FIG.**14.** Positions **30`** include positions from **30A** to **30P** from FIG.**3** to FIG **5**, FIG.**13**, and FIG.**14**.

FIG.**3** shows some basic placements of the devices **10** on the hand. Each device **10** may be attached to different segments of a finger **31**. A tip finger segment **31A** corresponds to the distal phalanx, a middle finger segment **31B** corresponds to the middle phalanx, and a base finger segment **31 C** corresponds to the proximal phalanx. Device **10** can be placed on any finger segment. A user may place devices **10** on a tip segment **31A** of a finger at positions 3**0A**, **30D**, **30G**, **30J**, and **30M**; on a middle segment **31B** of a finger at positions **30B**, **30E**, **30H**, **30K**, and **30N**; on base segment **31C** of a finger at positions **30C**, **30F**, **30I**, **30L**, and **30O**. Device **10** may be attached in the middle of the wrist **30** in position **30 P**.

FIG.**4** and FIG.**5** show one of the possible placement set of devices **10** on the hand, a top view, and a side view. One device on each tip finger segment **31A** e.g., position 3**0A** for the little finger, **30D** for the ring finger, **30G** for the middle finger, **30J** for the index finger, and **30M** for the thumb. Device **10** may be placed in position **30P** on a base segment **31 C** for the middle finger. Placement on tip finger segments **31A** may increase the quality of micro-gestures recognition by the finger micro-gestures device. In addition, the devices **10** placed on middle finger segments **31B** and base finger segments **31C**, e.g., **30I,** may improve general finger gesture recognition.

FIG**.6A** shows a side view of the device **10** attachment method based on glue **32A** to finger segment **31A.**

FIG**.6B** shows a side view of the device **10** attachment method based on single-sided tape **32B** to finger segment **31A.**

FIG**.6C** shows a side view of the device **10** attachment method based on double-sided tape **32C** to finger segment **31A.**

FIG**.6D** shows a side view of the device **10** attachment method based on finger clothes **32D** to finger segment **31A.** The attachment method **32D** may consist of a natural and artificial fabric, synthetics, silicone, genuine or faux leather, and other natural and artificial materials. The attachment method **32D** may be created from stretch material or easy-to-break material, which may help users' fingers to safely escape from the attachment method **32D** when the attachment method **32D** or device **10** catches an object in the user's environment. The attachment method **32D** may be created from stretch material, which may reduce the risk of losing the device **10**. The attachment method **32D** may include a hollow for device **10** into which device **10** can be inserted.

FIG**.6E** shows a side view of the device **10** attachment method based on suction cup **32E** to finger segment **31A.**

FIG**.6F** shows a side view of the device **10** attachment method based on device mounting on fingernail **32F** to finger segment **31A.** The mounting **32F** may be made of metal, plastic or other material and may be attached only to the nail of tip finger segment **31A.** Device **10** may be inserted into(onto) **32F**.

FIG**.7A** shows an exploded side view of the device **10** attachment method based on glue **32A** to finger segment **31A.**

FIG**.7B** shows an exploded side view of the device **10** attachment method based on single-sided tape **32B** to finger segment **31A.**

FIG**.7C** shows an exploded side view of the device **10** attachment method based on double-sided tape **32C** to finger segment **31A.**

FIG**.7D** shows an exploded side view of the device **10** attachment method based on finger clothes **32D** to finger segment **31A.**

FIG**.7E** shows an exploded side view of the device **10** attachment method based on suction cup **32E** to finger segment **31A.**

FIG**.7F** shows an exploded side view of the device **10** attachment method based on device mounting on fingernail **32F** to finger segment **31A.**

FIG.**8A** shows an exploded perspective view of the attachment method **32D** to segment **31A**. As shown, the attachment method **32D** may consist of a finger cloth. A user's finger **31** may be inserted into attachment method **32D**. The attachment method **32D** wraps around the user's finger. The attachment method **32D** may have a cutout **39**. The cutout **39** may be empty or may be covered with a perforated fabric or a fabric made of a thinner material.

FIG.**8B** shows a side view of the attachment method **32D** on the tip finger segment **31A**. The attachment method **32D** may have a cutout **39** to reduce the amount of covered skin and retain the user's tactile experience. FIG.**8B** shows finger **31** in a bent position. As shown, attachment method **32D** may not affect the movement of the user's finger (e.g., attachment method **32D** may not affect the user's ability to bend the finger).

FIG.**9A** shows a side view of the device **10** attachment method based on glue **32A** to finger segment **31B**.

FIG.**9B** shows a side view of the device **10** attachment method based on single-sided tape **32B** to finger segment **31B**.

FIG.**9C** shows a side view of the device **10** attachment method based on double-sided tape **32C** to finger segment **31B**.

FIG.**9D** shows a side view of the device **10** attachment method based on finger clothes **32D** to finger segment **31B**.

FIG**.10A** shows an exploded side view of the device **10** attachment method based on glue **32A** to finger segment **31B.**

FIG**.10B** shows an exploded side view of the device **10** attachment method based on single-sided tape **32B** to finger segment **31B.**

FIG**.10C** shows an exploded side view of the device **10** attachment method based on double-sided tape **32C** to finger segment **31B.**

FIG**.10D** shows an exploded side view of the device **10** attachment method based on finger clothes **32D** to finger segment **31B.**

FIG.**11A** shows a side view of the device **10** attachment method based on glue **32A** to finger segment **31C**.

FIG.**11B** shows a side view of the device **10** attachment method based on single-sided tape **32B** to finger segment **31C**.

FIG.**11C** shows a side view of the device **10** attachment method based on double-sided tape **32C** to finger segment **31C**.

FIG.**11D** shows a side view of the device **10** attachment method based on finger clothes **32D** to finger segment **31C**.

FIG.**12A** shows an exploded side view of the device **10** attachment method based on glue **32A** to finger segment **31C**.

FIG.**12B** shows an exploded side view of the device **10** attachment method based on single-sided tape **32B** to finger segment **31C**.

FIG.**12C** shows an exploded side view of the device **10** attachment method based on double-sided tape **32C** to finger segment **31C**.

FIG.**12D** shows an exploded side view of the device **10** attachment method based on finger clothes **32D** to finger segment **31C**.

FIG.**13** shows a side view of one of the possible locations **30'** for device **10** on foot **40**. One device on each tip finger segment **31A** e.g., position **30M** for the big toe, **30J** for the index toe, and an additional position **30P** on the footbridge.

FIG.**14** shows a top view of one of the possible locations **30'** for device **10** on foot **40**. One device on each tip finger segment **31A** e.g., position **30M** for the big toe, **30J** for the index toe, **30A** for the little toe, and additional position **30P** on the footbridge.

FIG.**15A** illustrates a neutral micro-gesture position with three devices **10** located on segments **31A**. The thumb **31-1** does not touch the index finger **31-2** and the middle fingers **31-3**.

FIG.**15B** shows a micro-gesture. The thumb **31-1** touches the index finger **31-2** and does not touch the middle finger **31-3**. Thumb **31-1** moves into position **31-1B**. To perform such a gesture, the user needs to move segment **31A** of the thumb **31-1** slightly. The lower amplitude of movements contributes to a higher frequency of gesture execution.

FIG.**15C** shows a micro-gesture. The thumb **31-1** touches the index finger **31-2** and does not touch the middle finger **31-3**. Thumb **31-1** moves into position **31-1C**. To perform such a gesture, the user needs to move segment **31A** of the thumb **31-1** slightly.

FIG.**15D** shows a micro-gesture. The thumb **31-1** touches the index finger **31-2** and does not touch the middle finger **31-3**. Thumb **31-1** moves into position **31-1D**. To perform such a gesture, the user needs to move segment **31A** of the thumb **31-1** slightly.

FIG.**15E** shows a micro-gesture. The thumb **31-1** touches the index finger **31-2** and does not touch the middle finger **31-3**. Thumb **31-1** moves into position **31-1E**. To perform such a gesture, the user needs to move segment **31A** of the thumb **31-1** slightly.

Sheet 1 of Drawings

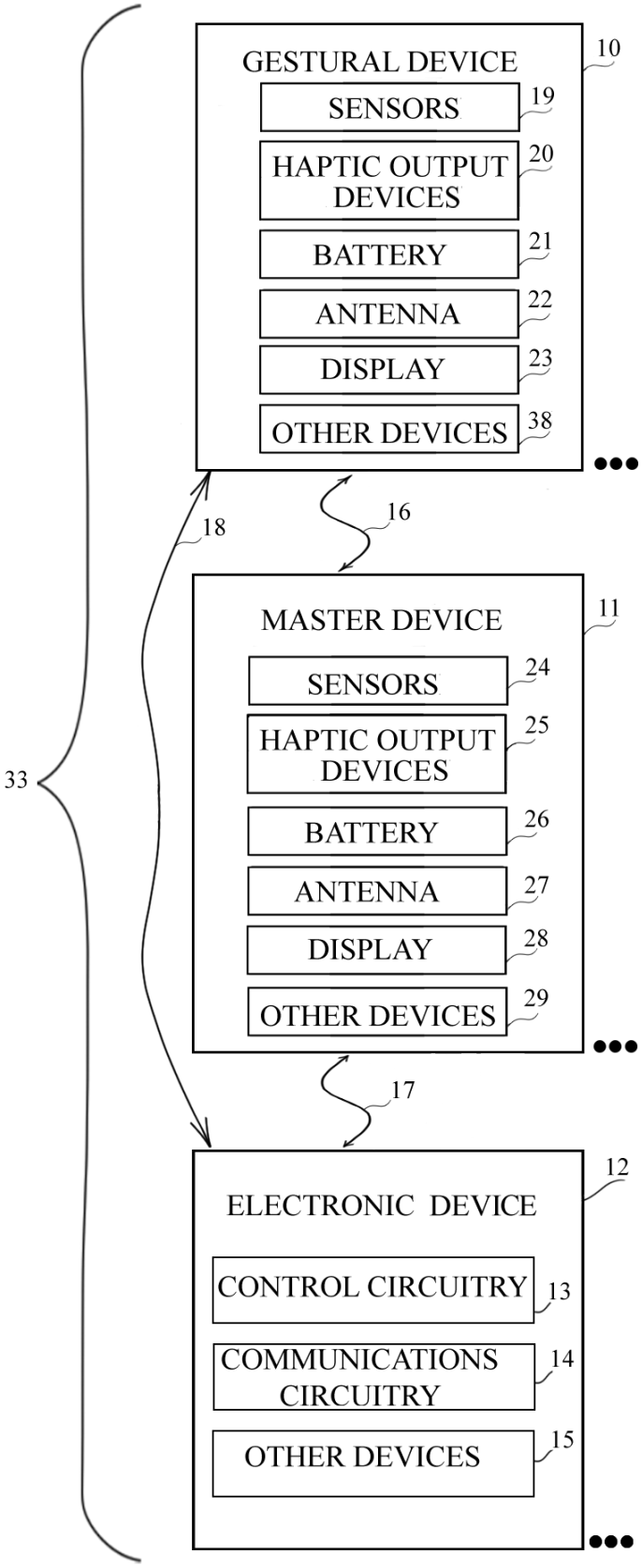

FIG.1

Sheet 2 of Drawings

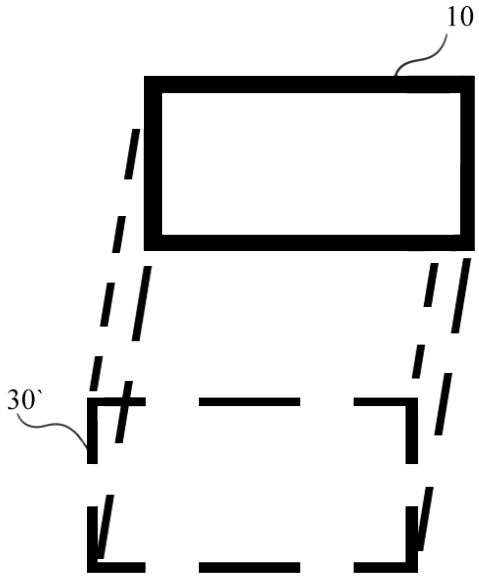

FIG.2

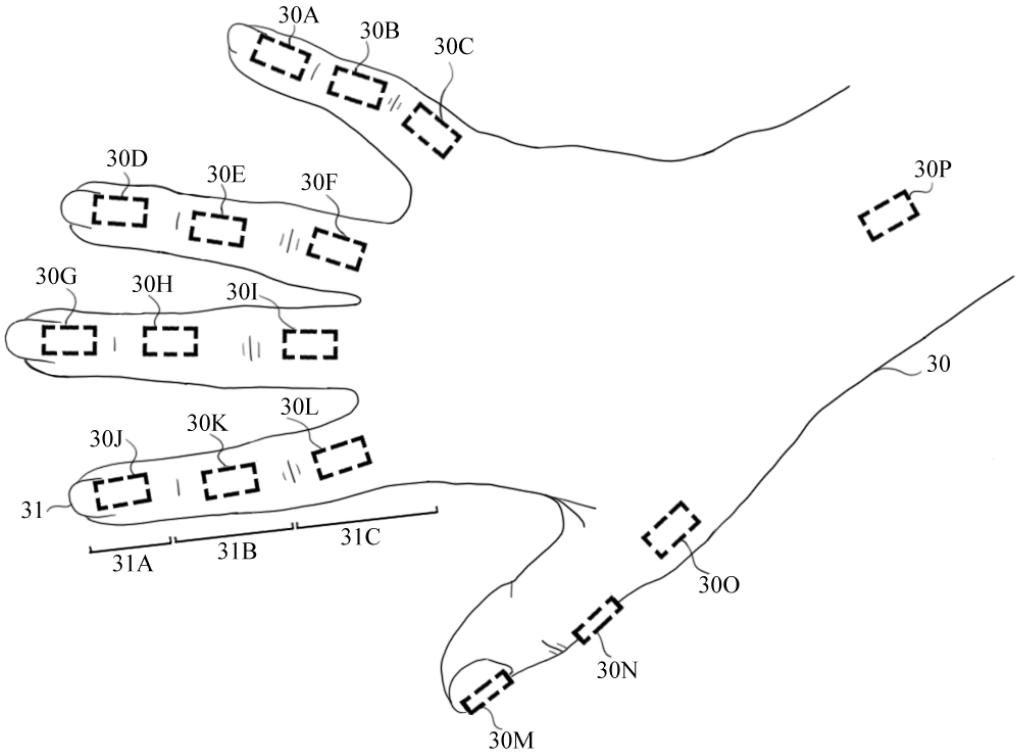

FIG.3

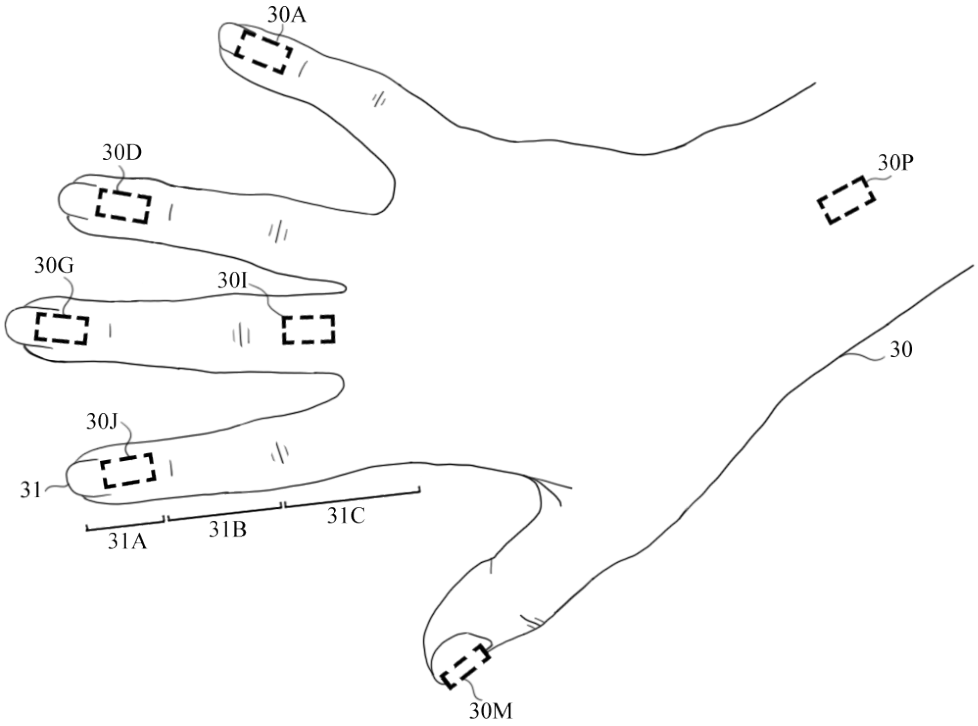
30A
30D
30P
30G
30I
30
30J
31
31A
31B
31C
30M

FIG.4

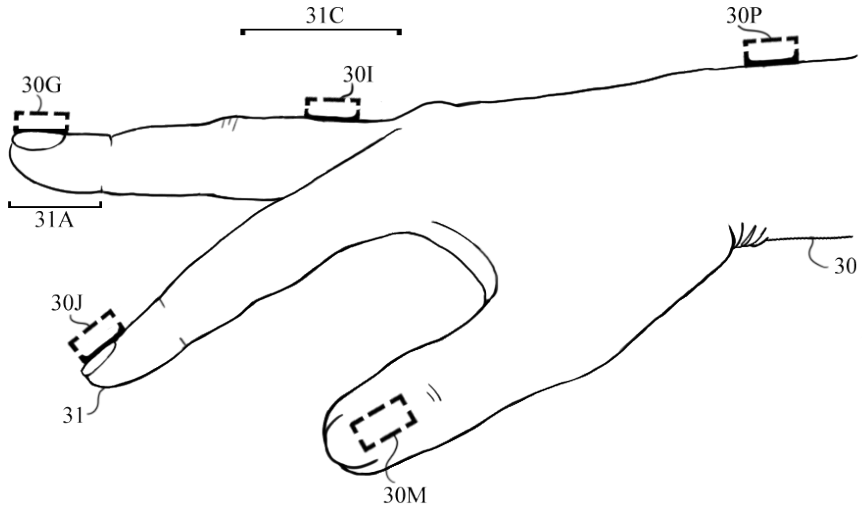
31C
30P
30G
30I
31A
30
30J
31
30M

FIG.5

Sheet 4 of Drawings

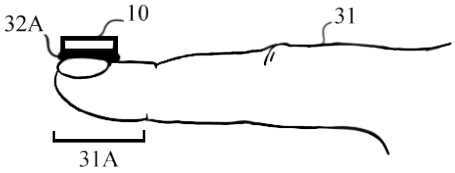

FIG.6A

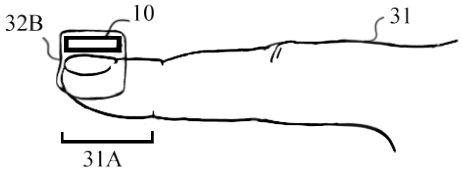

FIG.6B

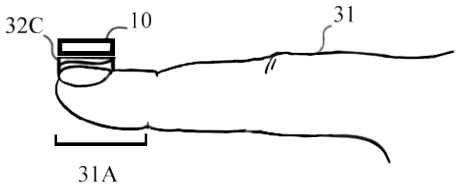

FIG.6C

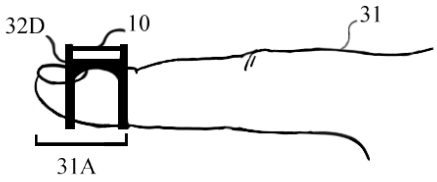

FIG.6D

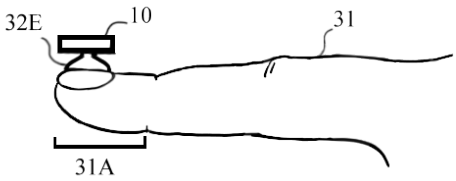

FIG.6E

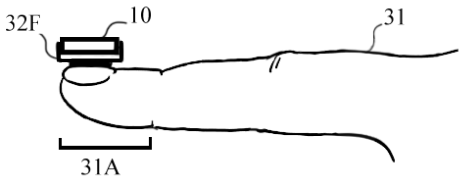

FIG.6F

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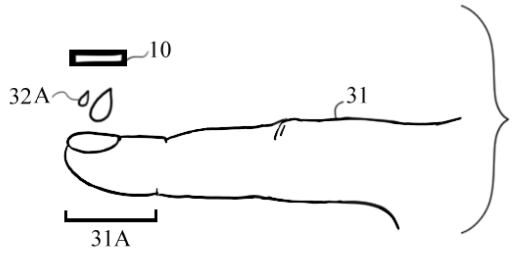

FIG.7A

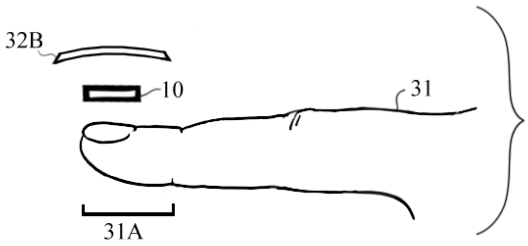

FIG.7B

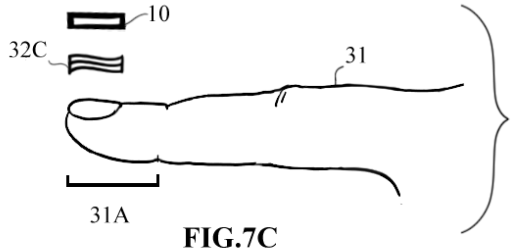

FIG.7C

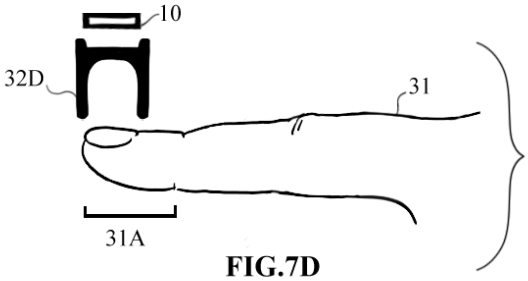

FIG.7D

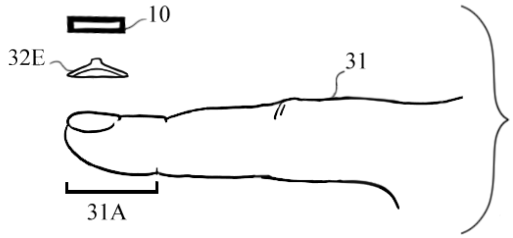

FIG.7E

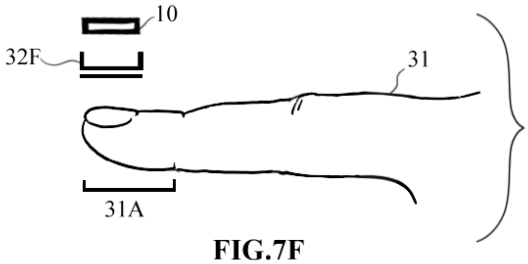

FIG.7F

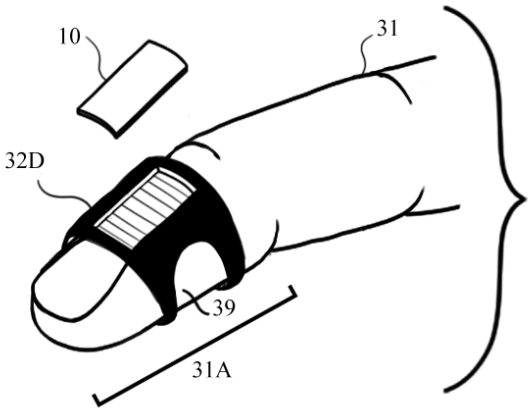

FIG.8A

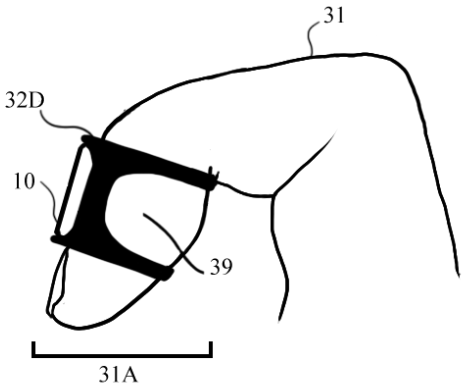

FIG.8B

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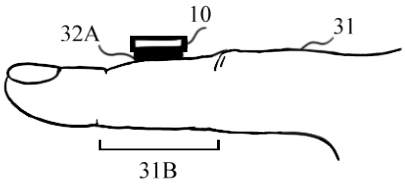

FIG.9A

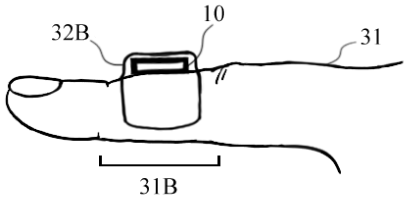

FIG.9B

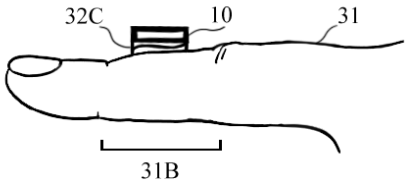

FIG.9C

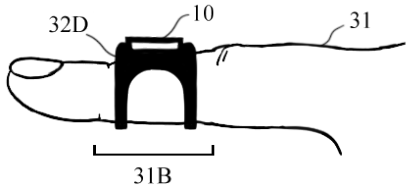

FIG.9D

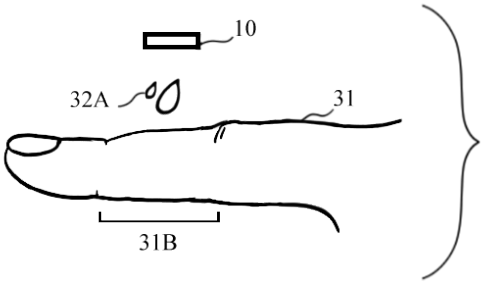

FIG.10A

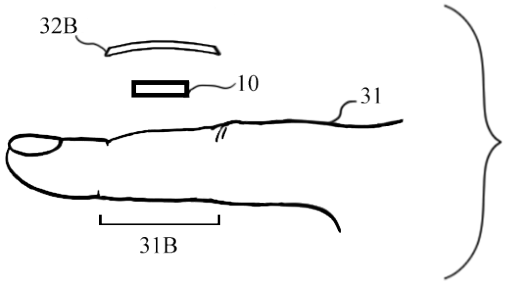

FIG.10B

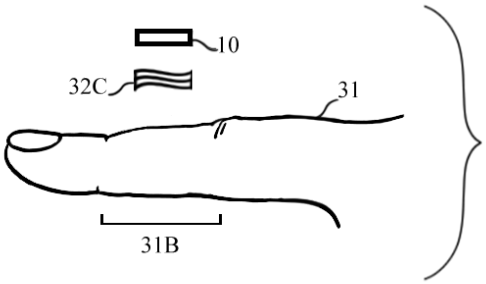

FIG.10C

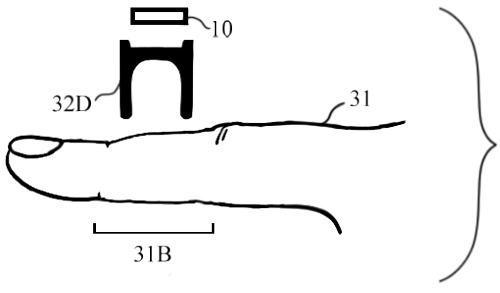

FIG.10D

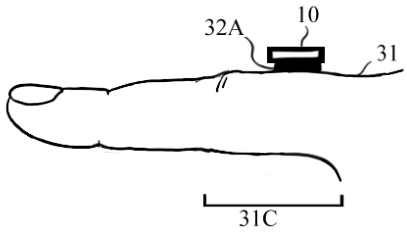

FIG.11A

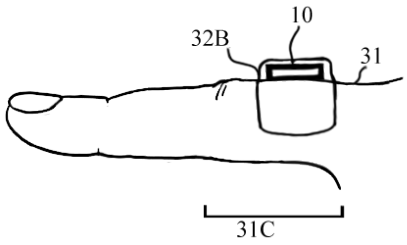

FIG.11B

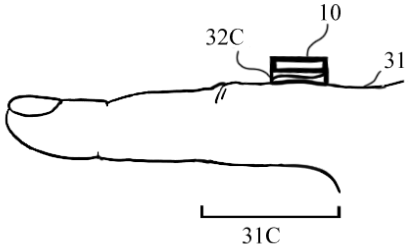

FIG.11C

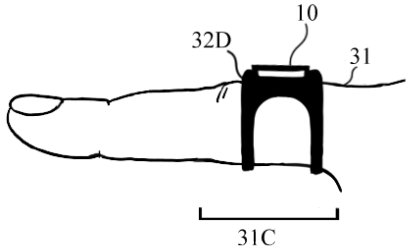

FIG.11D

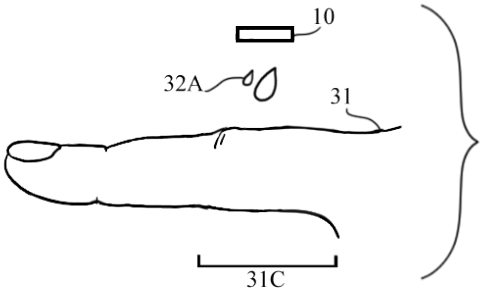

FIG.12A

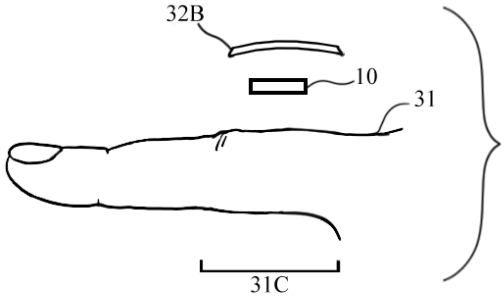

FIG.12B

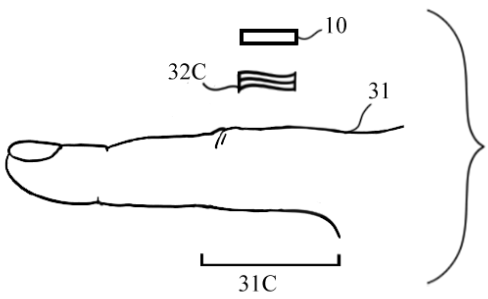

FIG.12C

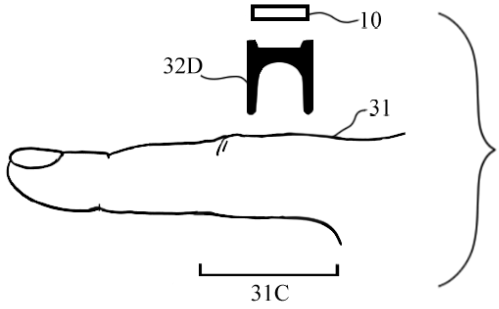

FIG.12D

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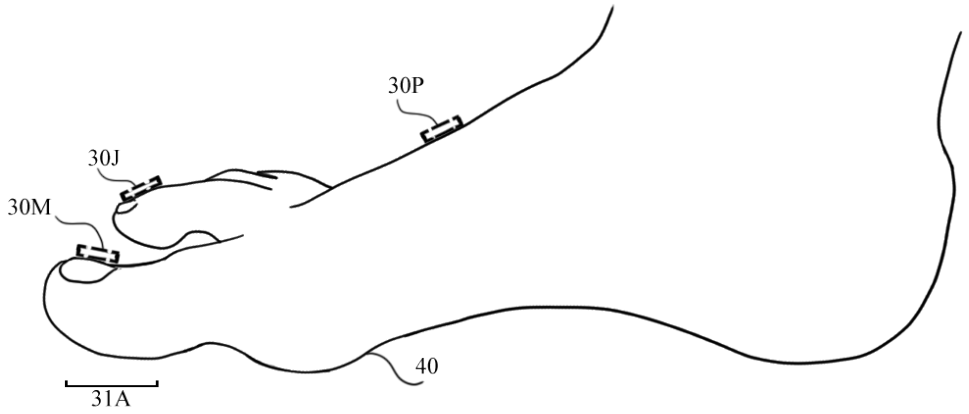

FIG.13

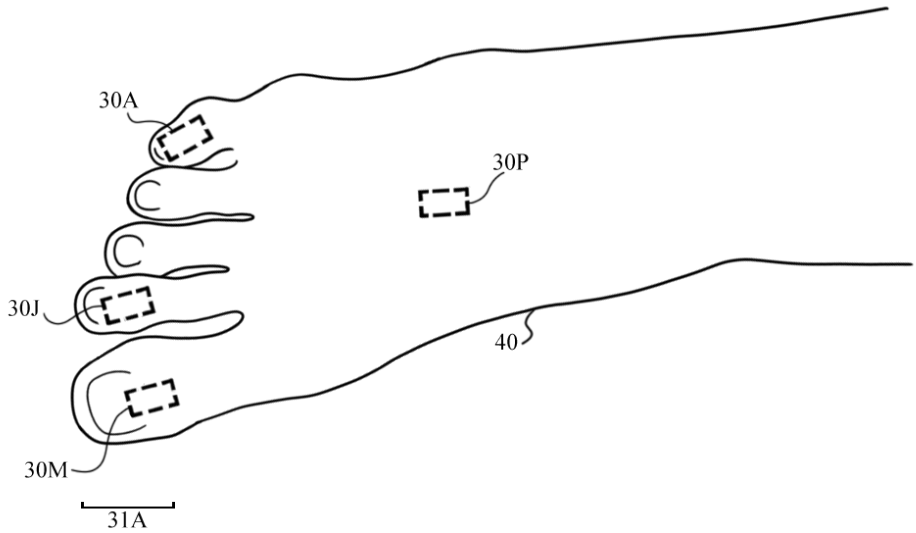

FIG.14

FIG.15A

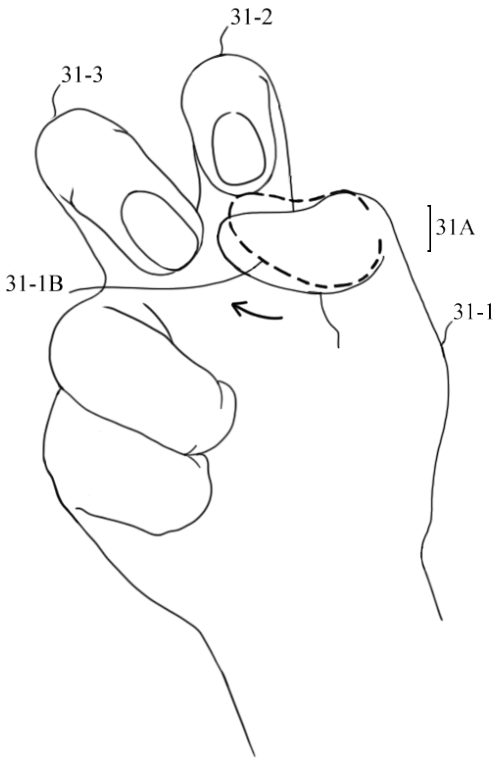

FIG.15B

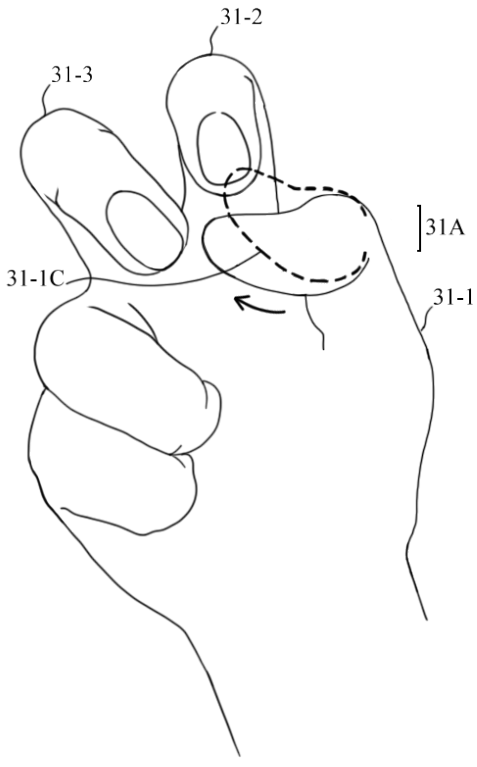

FIG.15C

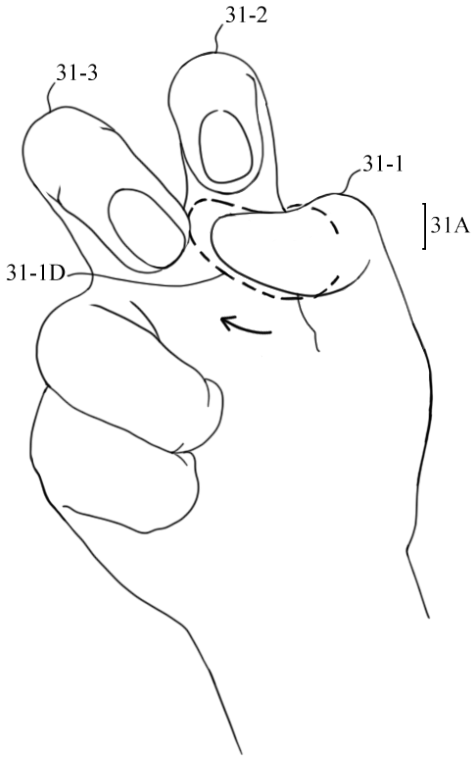

FIG.15D

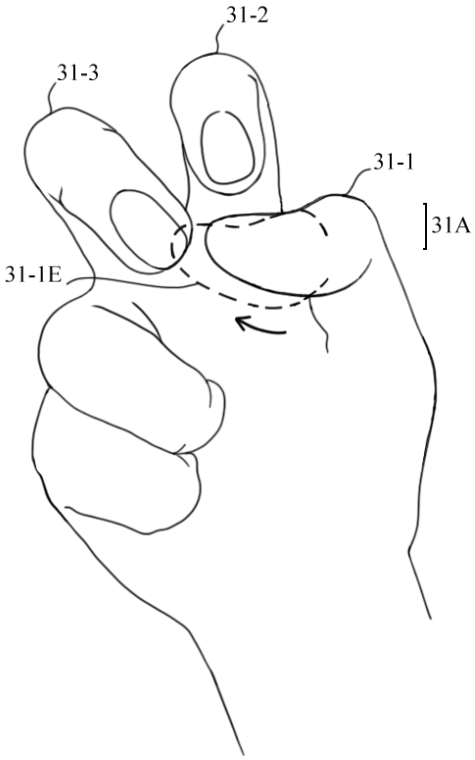

FIG.15E