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Kim et al.

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(54) **BRAILLE LEARNING APPARATUS AND BRAILLE LEARNING METHOD USING THE SAME**

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H04M 1/02 (2006.01)
H04M 1/725 (2006.01)

(52) **U.S. Cl.**
CPC ***G09B 21/004*** (2013.01); ***G09B 21/006*** (2013.01); ***H04M 1/0202*** (2013.01); *H04M 1/72594* (2013.01)

(58) **Field of Classification Search**
CPC G09B 21/004
USPC 434/113
See application file for complete search history.

Primary Examiner — Kesha Frisby

(57) **ABSTRACT**

A braille learning apparatus includes a plurality of slave blocks for receiving braille from a learner, and a master station configured to: receive braille learning information from an external braille learning information terminal, when slave blocks corresponding to a specific braille inputted by the learner are mounted, determine whether the specific braille inputted to the slave blocks match a learning word, and transmit a determination result to the external braille learning information terminal.

10 Claims, 14 Drawing Sheets

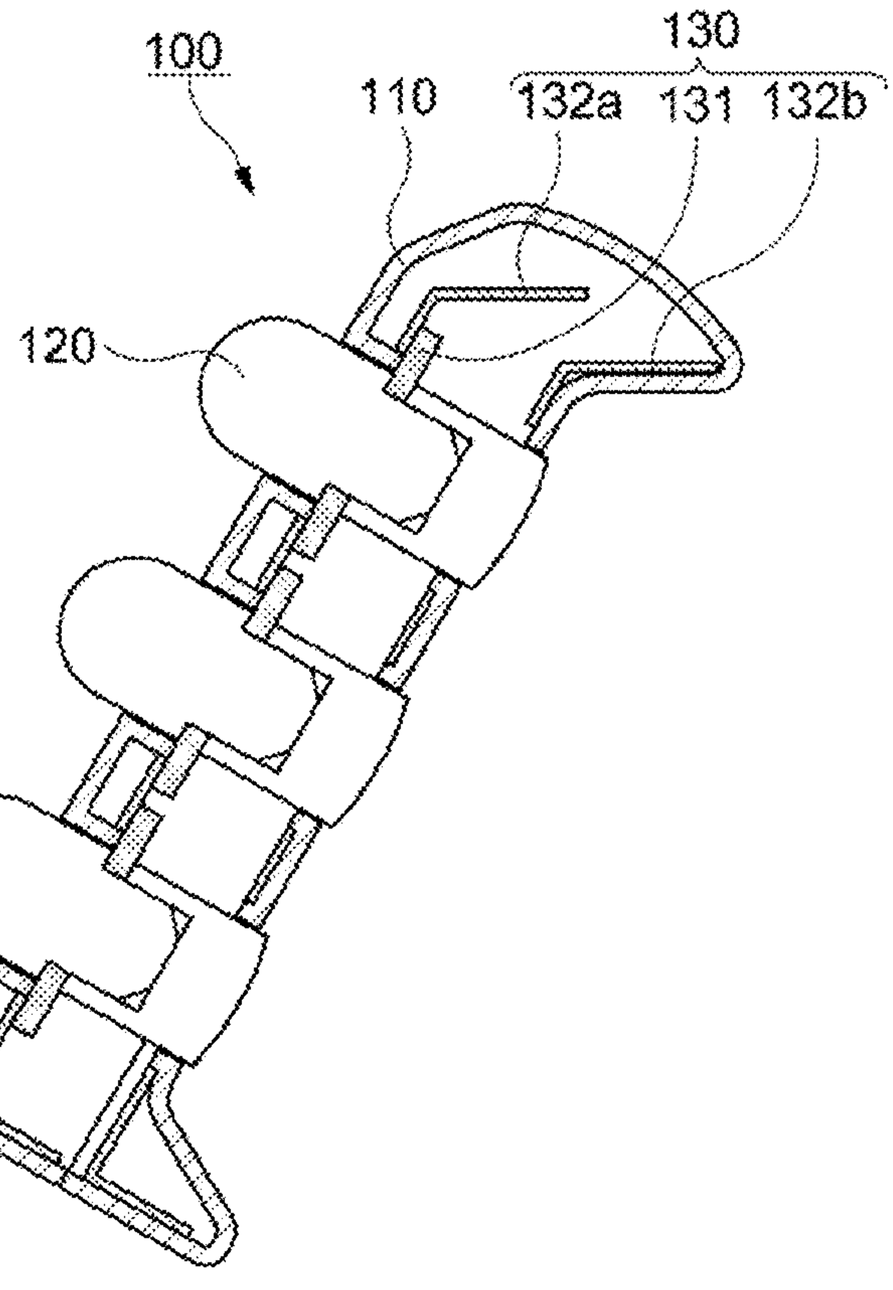


FIG. 1

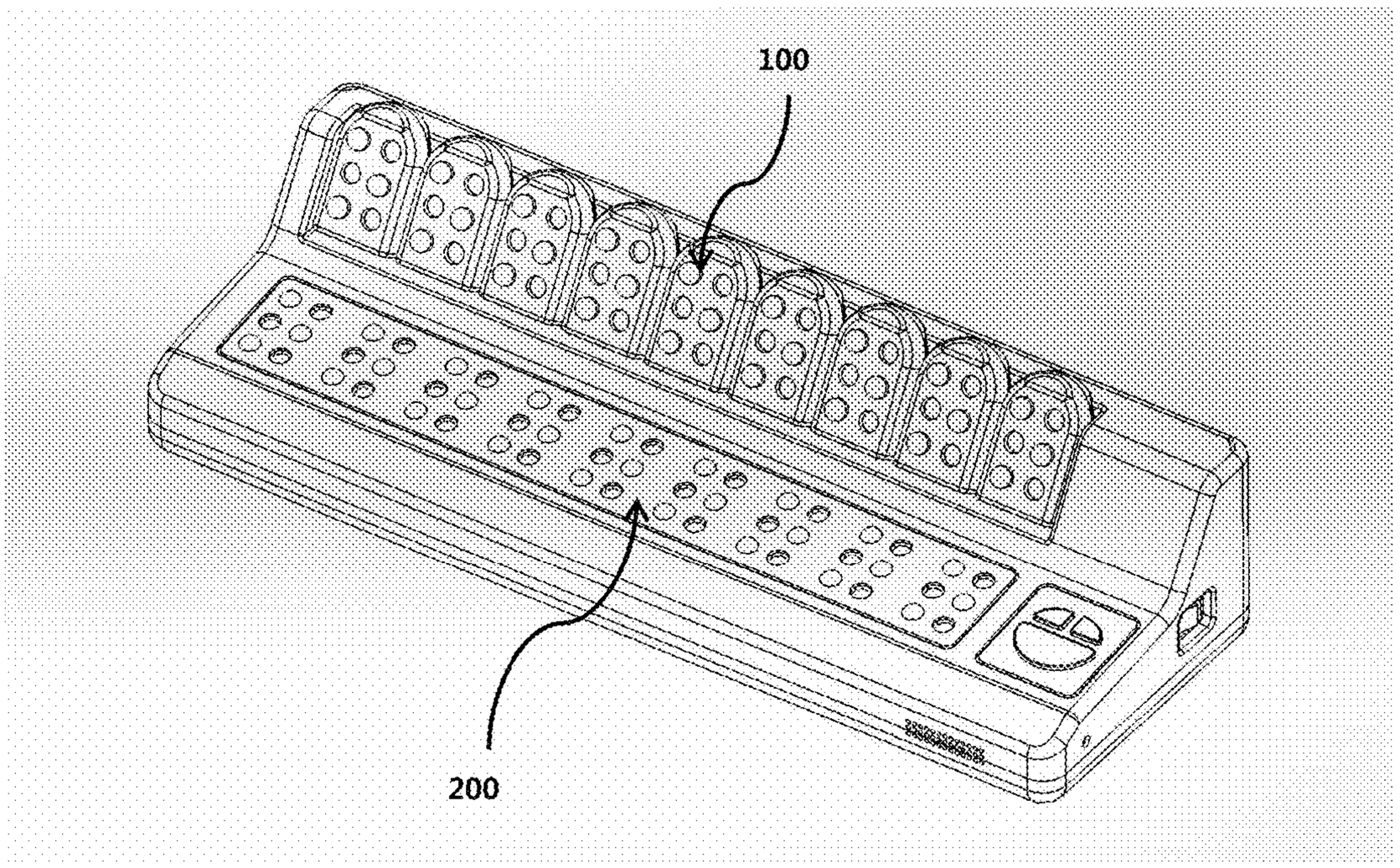


FIG. 2

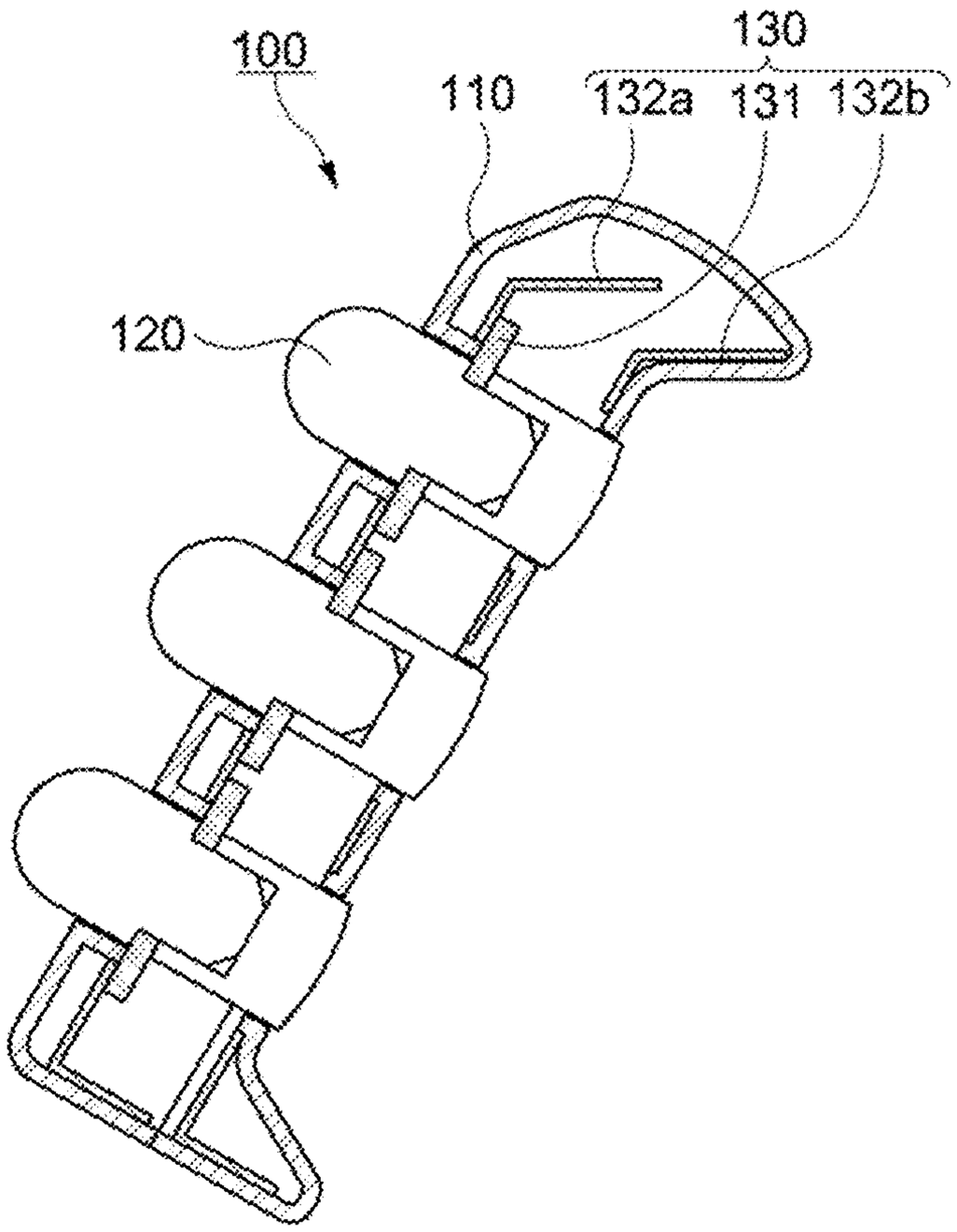


FIG. 3

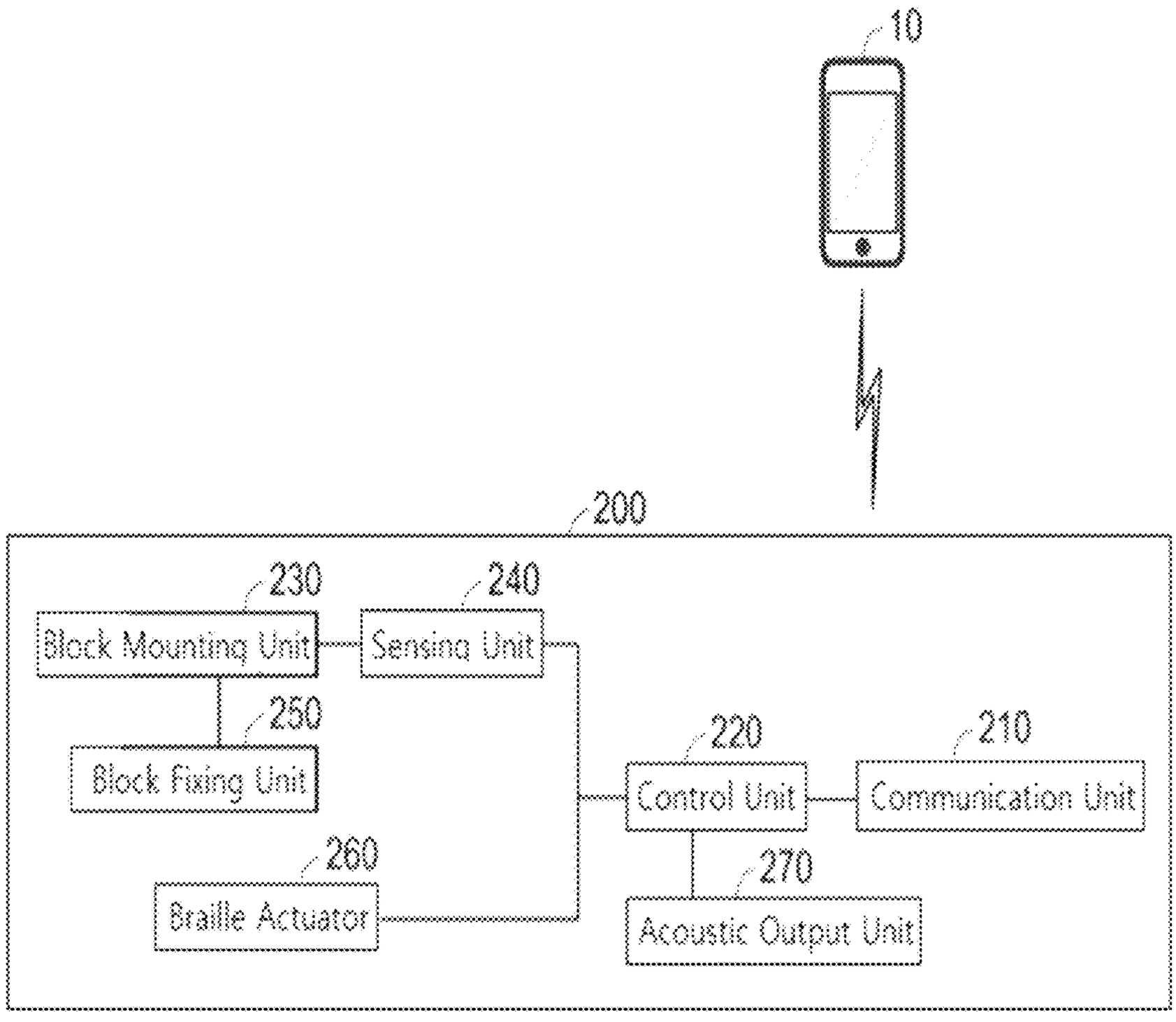

10
200
230
Block Mounting Unit
240
Sensing Unit
250
Block Fixing Unit
260
Braille Actuator
220
Control Unit
210
Communication Unit
270
Acoustic Output Unit

FIG. 4

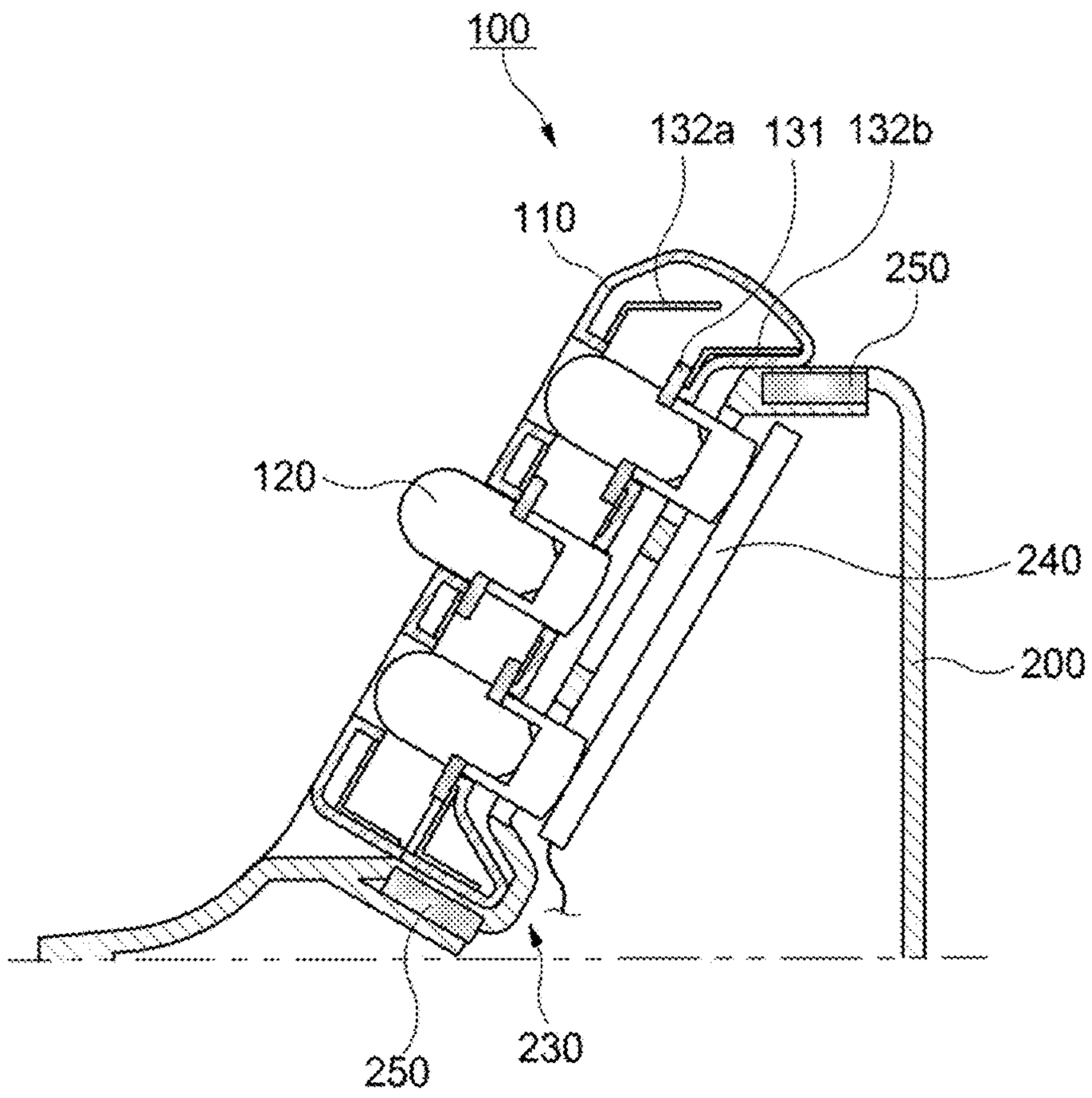


FIG. 5A

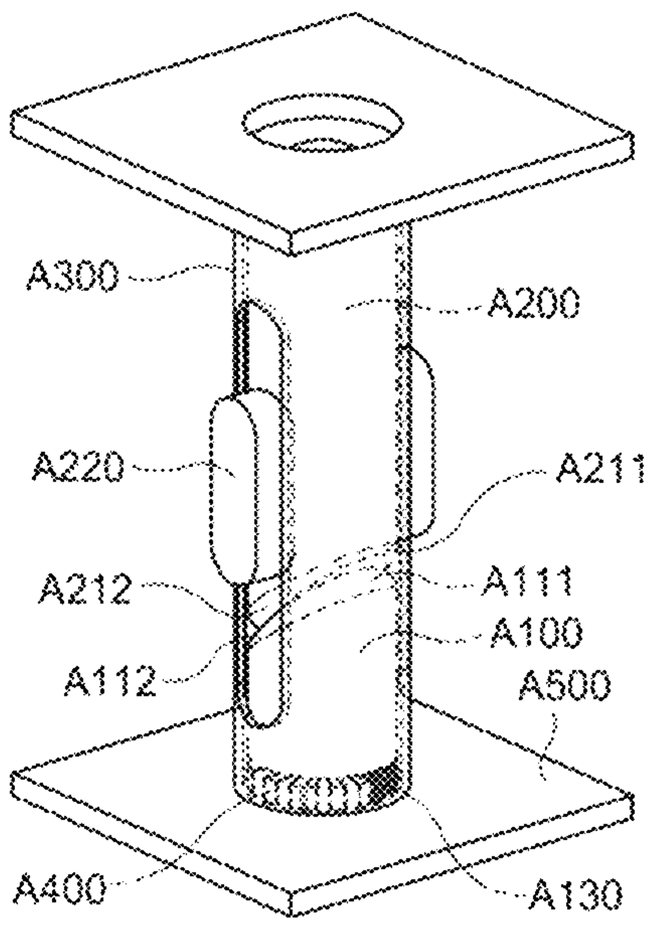

A300
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A212
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FIG. 5B

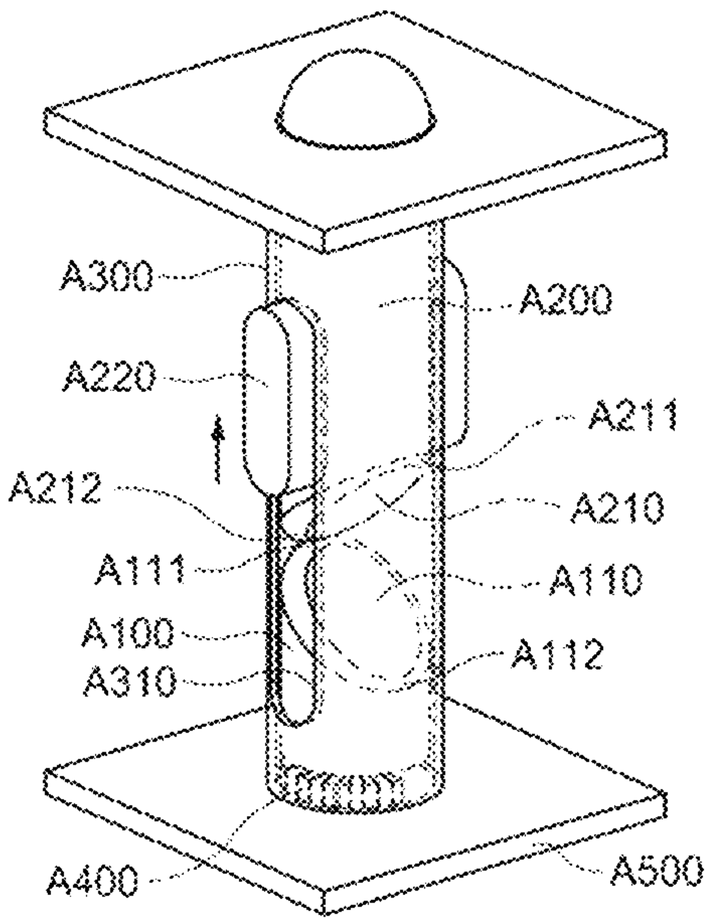

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FIG. 6AA

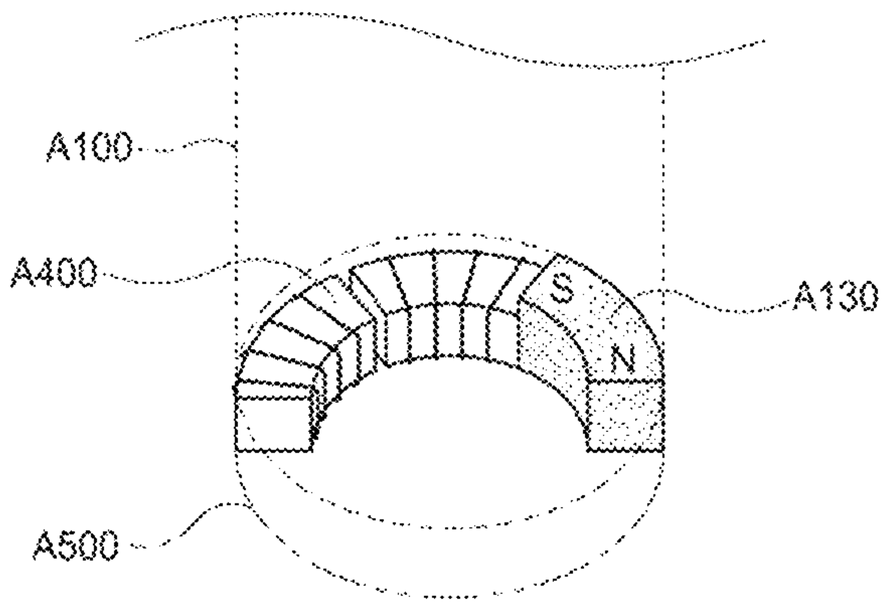


FIG. 6AB

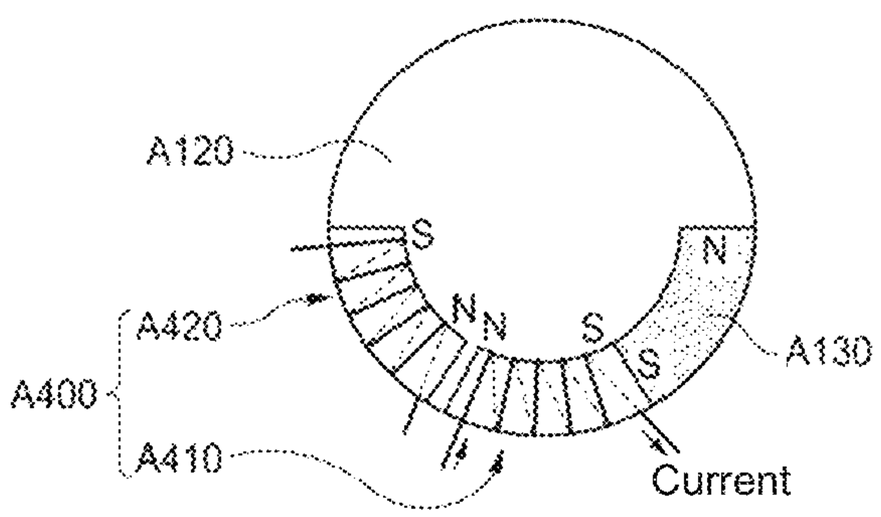


FIG. 6AC

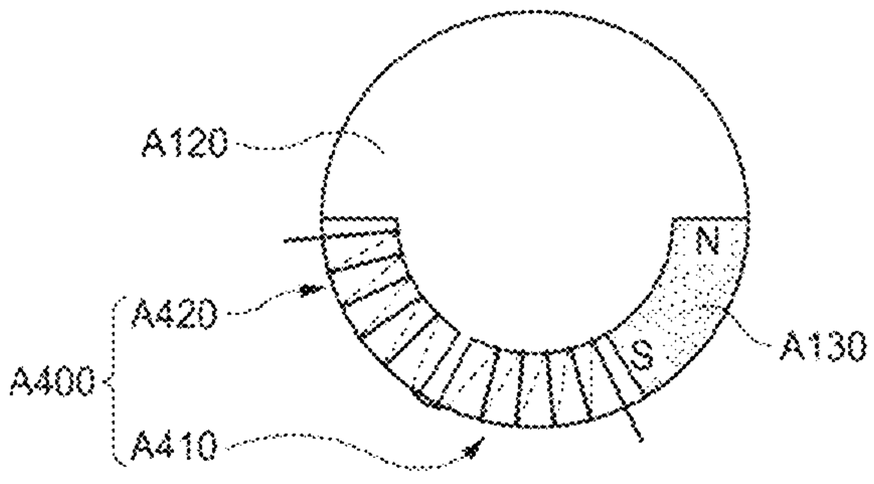


FIG. 6BA

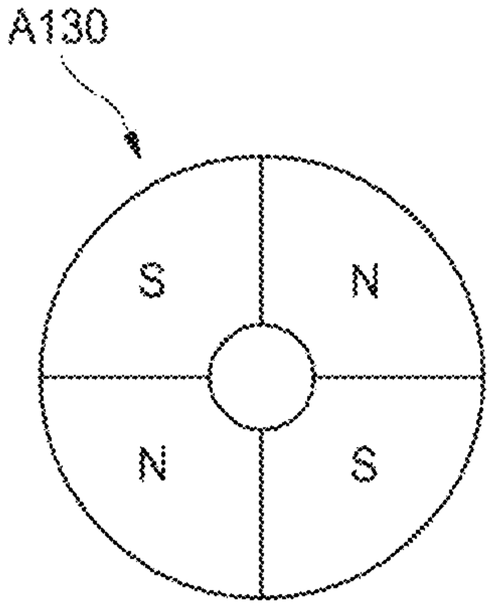


FIG. 6BB

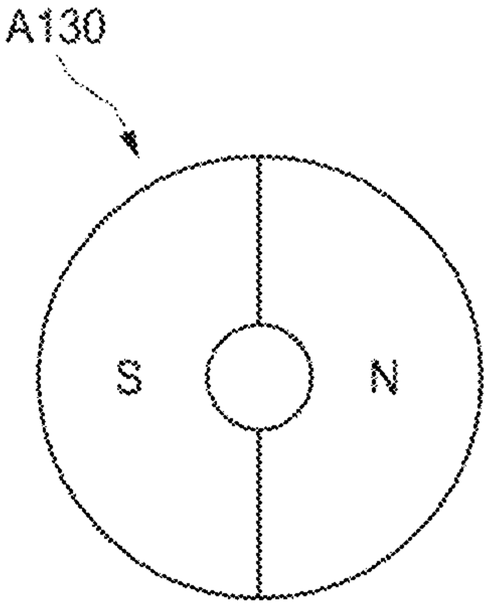


FIG. 7A

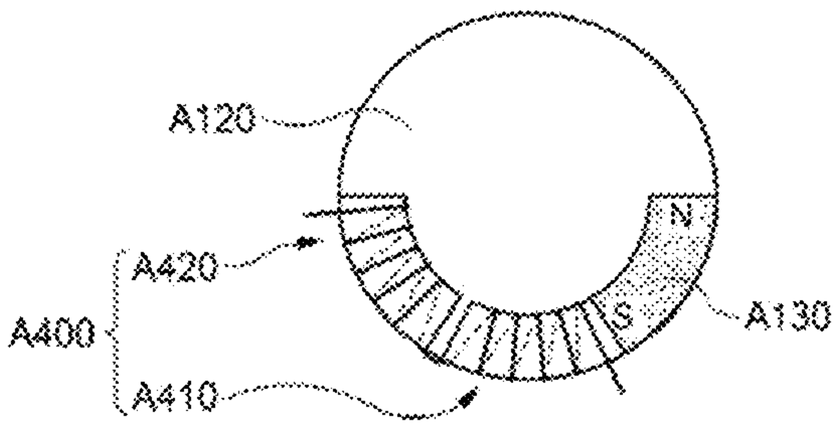


FIG. 7B

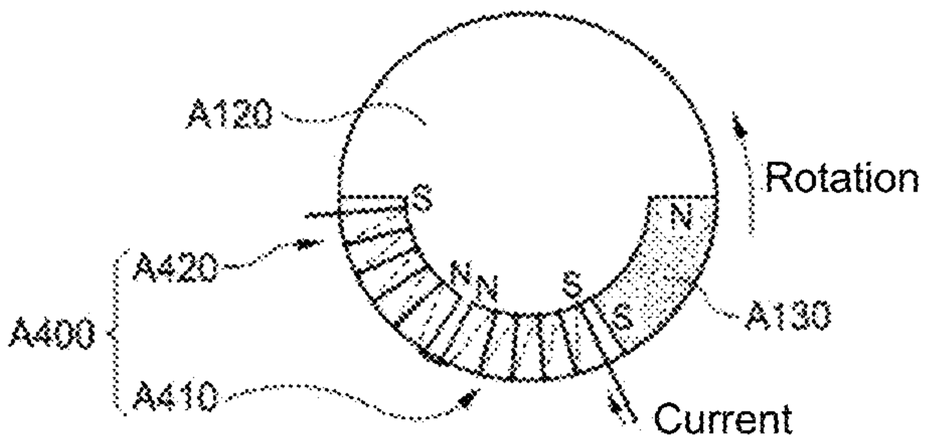


FIG. 7C

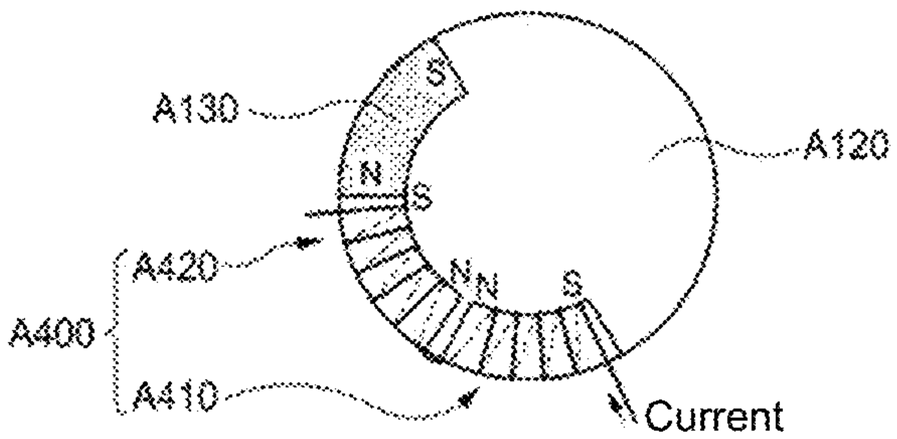


FIG. 7D

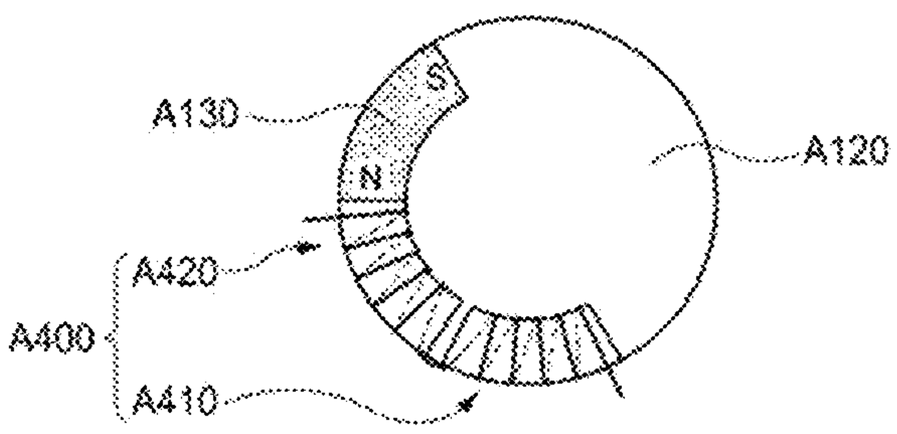


FIG. 8

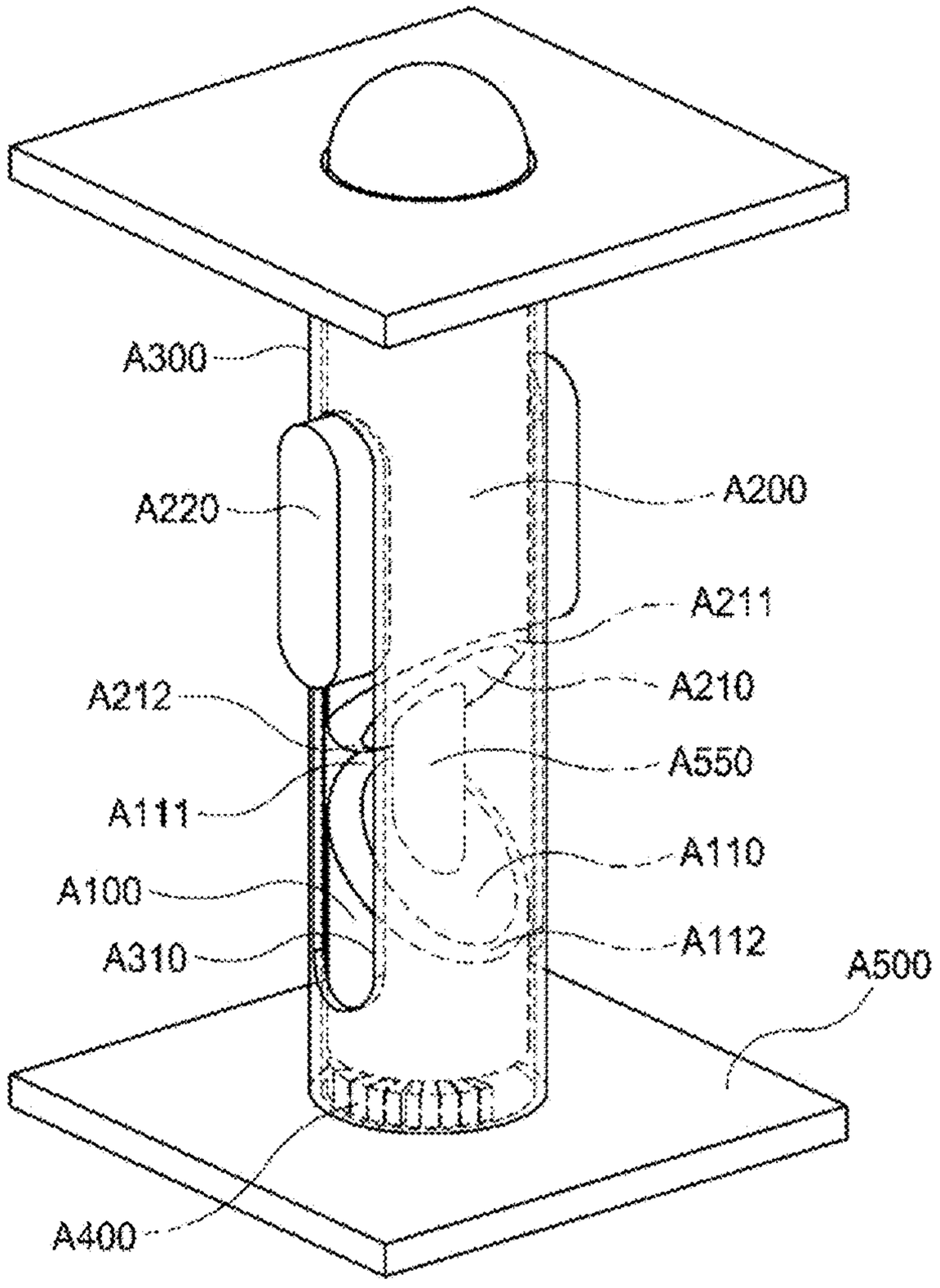

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FIG. 9

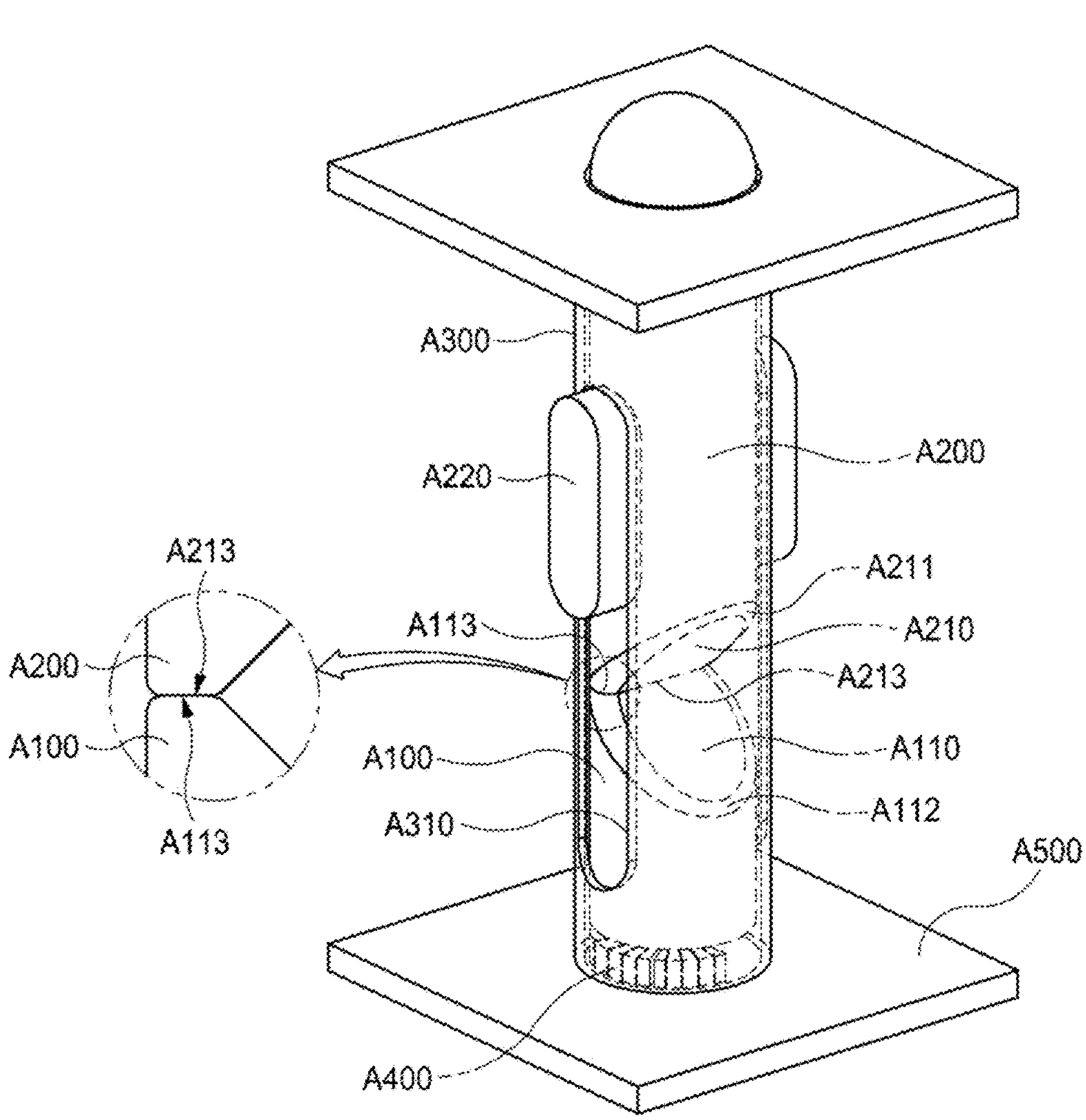

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FIG. 10

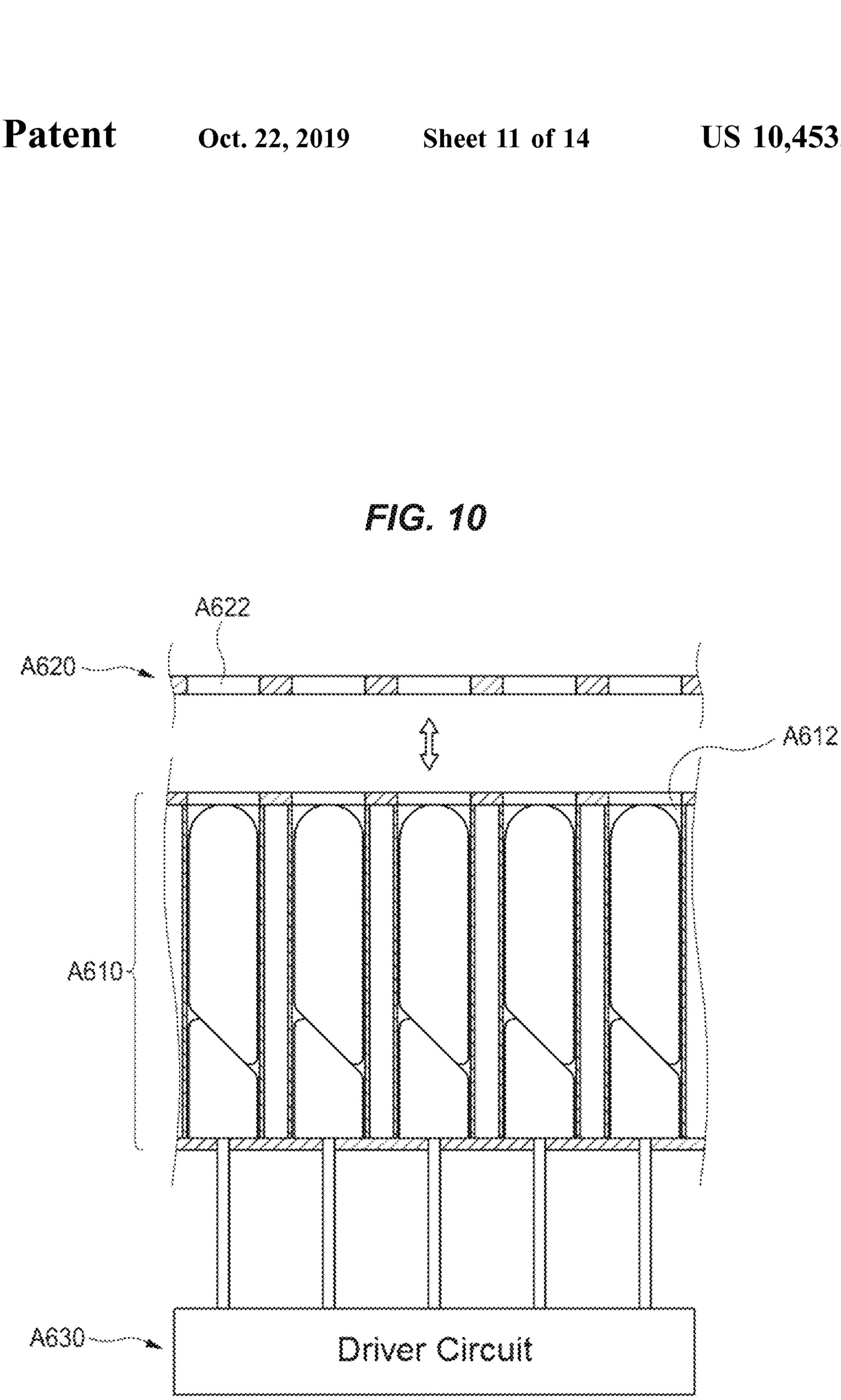


FIG. 11

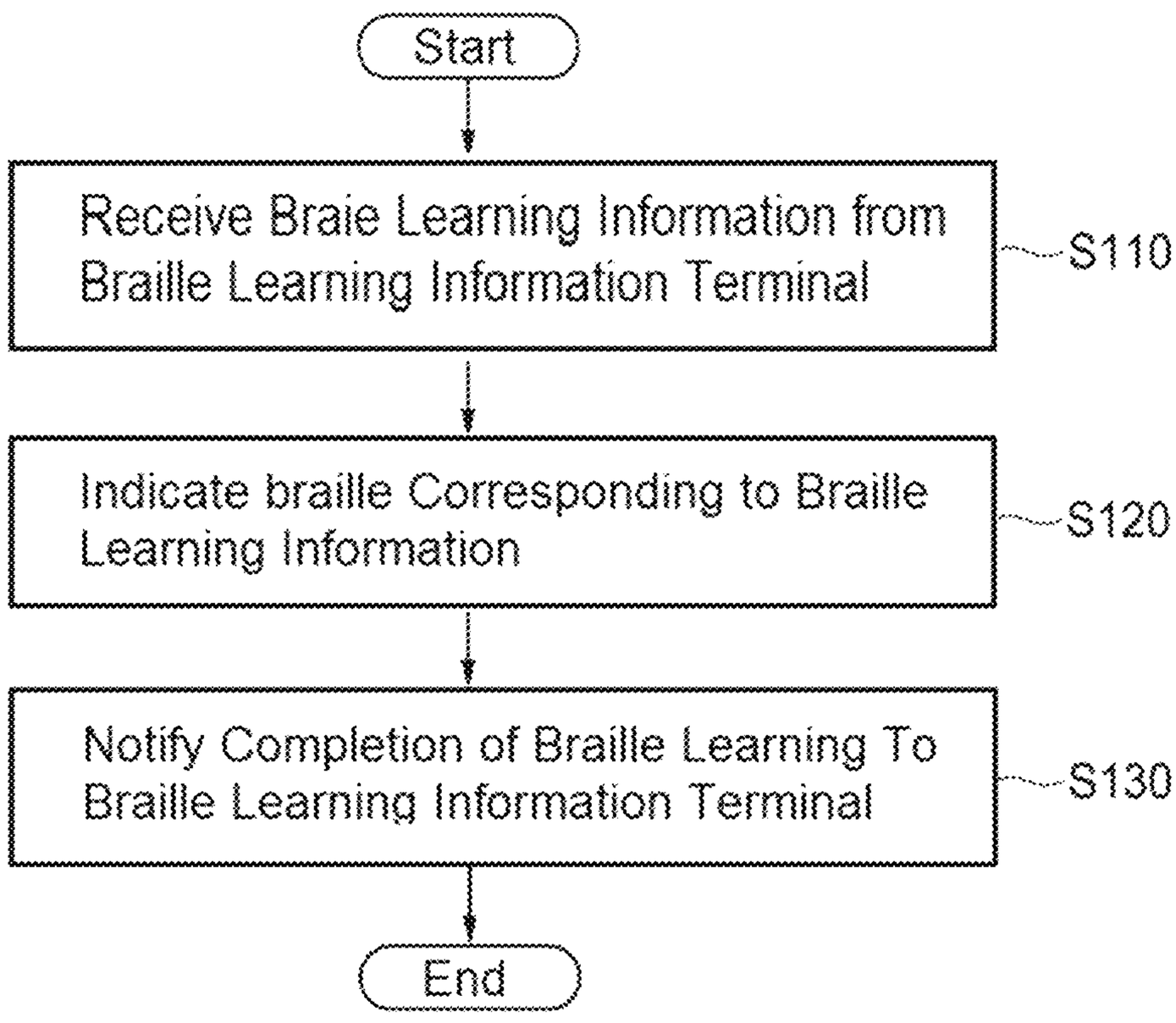

Start
Receive Braie Learning Information from Braille Learning Information Terminal
S110
Indicate braille Corresponding to Braille Learning Information
S120
Notify Completion of Braille Learning To Braille Learning Information Terminal
S130
End

FIG. 12

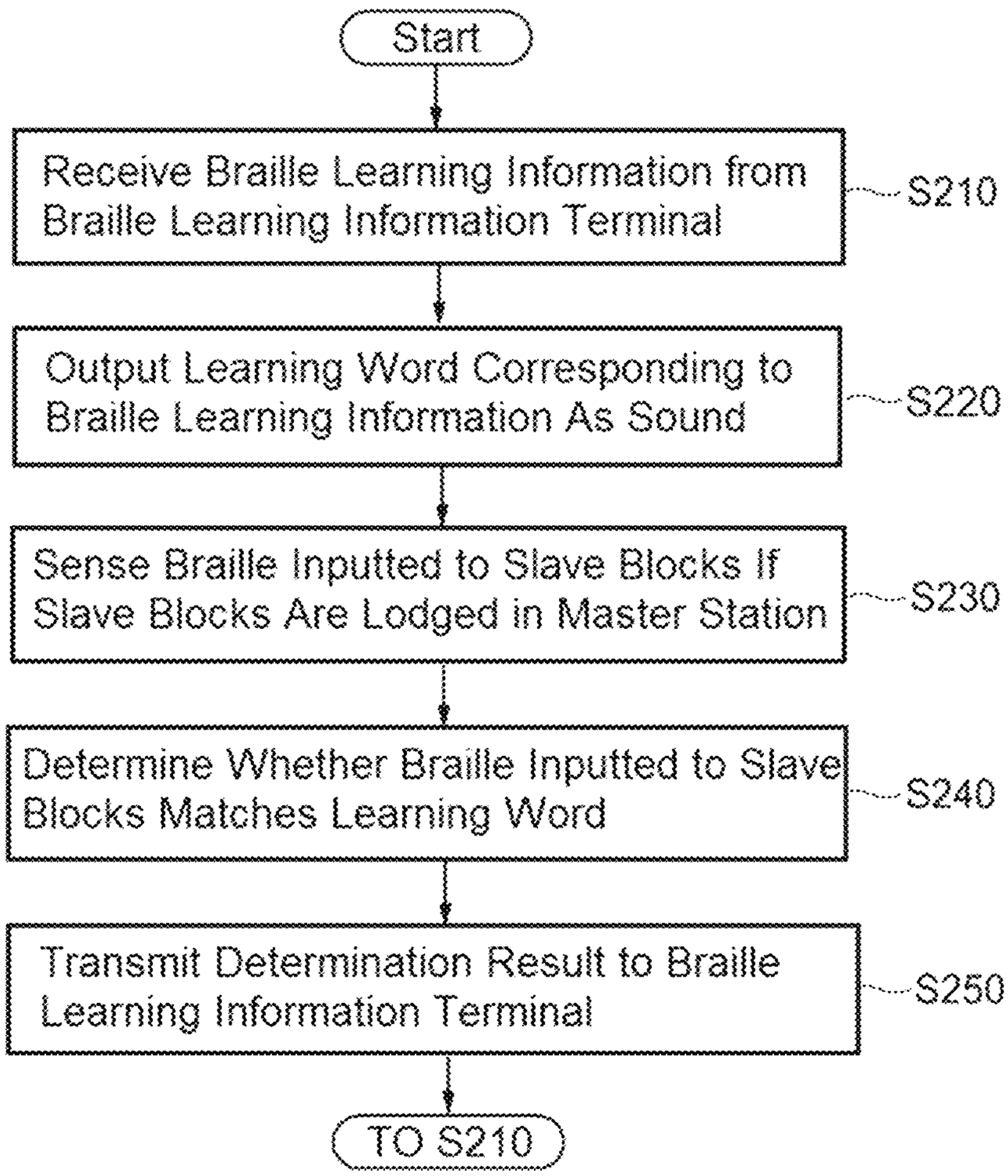
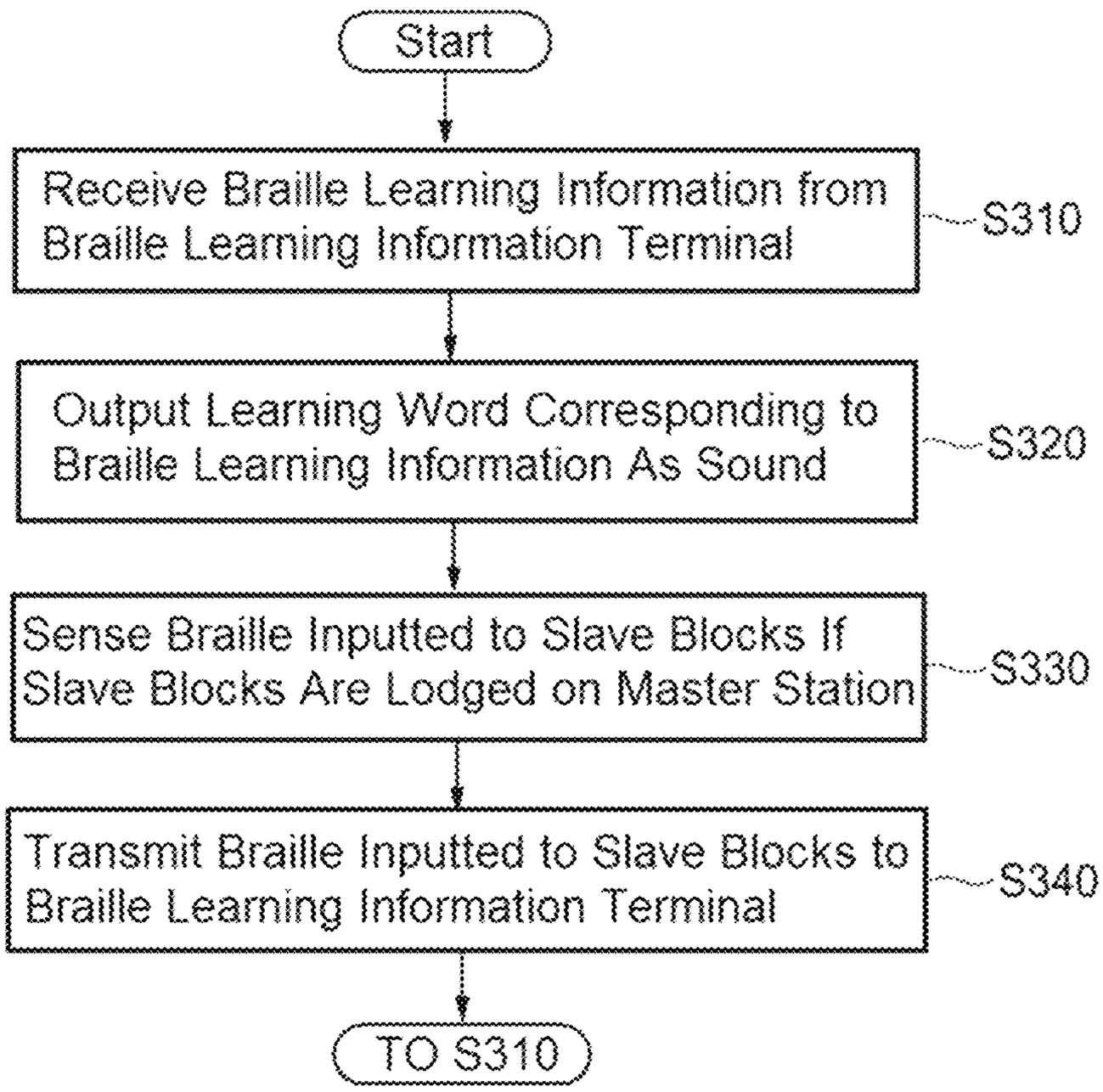

Start
Receive Braille Learning Information from Braille Learning Information Terminal
S210
Output Learning Word Corresponding to Braille Learning Information As Sound
S220
Sense Braille Inputted to Slave Blocks If Slave Blocks Are Lodged in Master Station
S230
Determine Whether Braille Inputted to Slave Blocks Matches Learning Word
S240
Transmit Determination Result to Braille Learning Information Terminal
S250
TO S210

FIG. 13


Start
Receive Braille Learning Information from Braille Learning Information Terminal
S310
Output Learning Word Corresponding to Braille Learning Information As Sound
S320
Sense Braille Inputted to Slave Blocks If Slave Blocks Are Lodged on Master Station
S330
Transmit Braille Inputted to Slave Blocks to Braille Learning Information Terminal
S340
TO S310

BRAILLE LEARNING APPARATUS AND BRAILLE LEARNING METHOD USING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority of Korean Patent Application No. 10-2016-0048267, filed on Apr. 20, 2016, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present disclosure generally relates to a braille learning apparatus and a braille learning method using thereof. More specifically, the present disclosure relates to a braille learning apparatus capable of enabling a learner wishing to learn braille to actively learn to read and write braille characters, and a braille learning method using the same.

TECHNICAL BACKGROUND OF THE INVENTION

Generally, braille for the visually impaired can express the initials, the vowels, the consonants, the predefined abbreviations and numbers using six braille dots. Thus, braille is an important means of acquiring information for a visually impaired person. It is the only letters that a visually impaired person can read and write on his/her own, and enables knowledge education of the visually impaired. Therefore, braille is called "Hun-Maeng-Jeong-Eum" (meaning letters for visually impaired in Korean) as compared to "Hum-Min-Jeong-Eum" (meaning letters in Korean). Meanwhile, while braille books and braille publications for the visually impaired are provided to increase the convenience of the visually impaired in places such as the library dedicated to the visually impaired, braille books and braille publications for the visually impaired are remarkably few in number because of the extra expense and effort in the production process, unlike regular books. In particular, since there are not enough braille textbooks for braille education compared to the number of visually impaired people, a considerable number of visually impaired people can not receive braille education.

In addition, conventional braille books and publications are limited only to the use of the tactile indication by the visually impaired persons, and because the visually impaired person must use tools such as a stapler and a pencil for writing braille, there were many difficulties for the visually impaired to learn braille characters through writing braille characters by themselves.

DISCLOSURE OF THE INVENTION

The invention has been made in view of the above problems, and it is an object of the present invention to provide a braille learning apparatus and a braille learning method using the braille learning apparatus.

Further, the purpose of the present invention is to provide a braille learning device and a braille learning method, with which, when an educator who instructs braille learning inputs a learning word using a braille learning information terminal, the learner can read or write the corresponding braille by himself.

The objects of the present invention are not limited to the above-mentioned objects, and other objects not mentioned can be clearly understood by those skilled in the art from the following description.

Means for Solving the Problems

According to one aspect, there is provided a braille learning apparatus which includes: a plurality of slave blocks for receiving braille from a learner; and a master station configured to: receive braille learning information from an external braille learning information terminal, when slave blocks corresponding to a specific braille inputted by the learner are mounted, determine whether the specific braille inputted to the slave blocks match a learning word, and transmit a determination result to the external braille learning information terminal.

According to another aspect, there is provided a braille learning apparatus, which includes: a plurality of slave blocks for receiving braille from a learner; and a master station configured to: receive braille learning information from an external braille learning information terminal, and when slave blocks corresponding to a specific braille inputted by the learner are mounted, transmit information on the specific braille to the external braille learning information terminal.

In a preferred embodiment, each of the plurality of slave blocks includes: a block body having a plurality of through holes provided on a front surface and a rear surface thereof, which are opposite each other; and a plurality of braille input pins accommodated in the block body, each of the plurality of braille input pins being configured to be pressed through an external force of the learner, wherein one end of each of the plurality of braille pins protrudes via a through hole at the front surface of the block body when the braille is not inputted, and another end of each of the plurality of braille pins protrudes via a through hole at the rear surface of the block body when the braille is inputted.

In a preferred embodiment, each of the plurality of slave blocks further includes: a braille input pin fixing member for fixing the braille input state or an uninput state so as not to change until the external force of the learner is applied to each of the braille input pins.

In a preferred embodiment, the braille input pin fixing member includes: a permanent magnet fixedly coupled to a predetermined position of the braille input pin; and a pair of magnetic bodies spaced apart from each other by a predetermined distance so that the permanent magnet can move inside the block body.

In a preferred embodiment, the master station includes: a block mount unit for providing a predetermined space in which the slave blocks are mounted; and a sensing unit which is turned on by pressing a braille input pin protruding from a rear surface of each of the slave blocks when the slave blocks are mounted on the block mounting unit.

In a preferred embodiment, the master station further includes a block fixing unit for applying a predetermined attractive force when the slave blocks are mounted in the block mounting unit to firmly fix the slave blocks.

In a preferred embodiment, the master station further includes: a communication unit for communicating with the braille learning information terminal and receiving the braille learning information; and a controller for checking the braille inputted to the slave blocks based on whether the sensing unit is turned on and controlling the driving of the master station.

In a preferred embodiment, the communication unit transmits the braille inputted to the slave blocks to the braille learning information terminal under the control of the control unit, or compares the braille inputted to the slave blocks with the learning word corresponding to the braille learning information by the control unit, and transmits a determination result based on the comparison to the braille learning information terminal.

In a preferred embodiment, the master station further includes an acoustic output unit for outputting a learning word corresponding to the braille learning information to a sound.

In a preferred embodiment, the master station further comprises a braille actuator for indicating the learning word corresponding to the braille learning information in braille.

In a preferred embodiment, the braille actuator includes: an electromagnet provided on a lower surface and whose polarity changes according to a current flow; a rotary member having an inclied upper surface, a permanent magnet provided on a lower surface thereof, and rotated by an attractive force or a repulsive force acting on the electromagnet; and a braille protrusion formed as an inclined surface such that the bottom surface thereof contacts the inclined surface of the rotary member, and is raised or lowered along the inclined surface of the rotary member when the rotary member is rotated.

According to another aspect, there is provided a braille learning method performed by a braille learning apparatus, including: (1) receiving, by the master station, braille learning information from an external braille learning information terminal; (2) converting, by the master station, the learning word corresponding to the braille learning information into braille and indicates the braille; and (3) transmitting, by the master station, a signal informing completion of learning to the braille learning information terminal after receiving from the learner whether or not the completion of the learning of the indicated braille has been completed.

According to another aspect, there is provided a braille learning method performed by a braille learning apparatus, including: (1) dislodging, by a master station, a plurality of slave blocks and receiving braille learning information from an external braille learning information terminal; (2) outputting, by the master station, a learning word corresponding to the braille learning information by sound; (3) when the braille is inputted to the slave blocks by the learner and the slave blocks are mounted to the master station, sensing the braille inputted to the slave blocks by the master station; (4) determining, by the master station, whether or not the braille inputted to the slave blocks matches the learning word; and (5) transmitting, by the master station, a determination result to the braille learning information terminal

According to another aspect, there is provided a braille learning method performed by a braille learning apparatus, including: (1) dislodging, by a master station, a plurality of slave blocks and receiving braille learning information from an external braille learning information terminal; (2) outputting, by the master station, a learning word corresponding to the braille learning information by sound; (3) when the braille is inputted to the slave blocks by the learner and the slave blocks are mounted to the master station, sensing the braille inputted to the slave blocks by the master station; and (4) transmitting, by the master station, the braille inputted to the slave blocks to the braille learning information terminal

Advantageous Effect

According to the above-mentioned problem solving means, according to the present disclosure, there is provided which includes: a plurality of slave blocks for receiving braille from a learner; and a master station configured to: receive braille learning information from an external braille learning information terminal, when slave blocks corresponding to a specific braille inputted by the learner are mounted, determine whether the specific braille inputted to the slave blocks match a learning word, and transmit a determination result to the external braille learning information terminal. Accordingly, when the educator who instructs the braille learning inputs the learning word using the braille learning information terminal, the learner can directly write the corresponding braille so that the learning efficiency of the braille can be improved.

Further, the present aspects of the invention can indicate the learning words of the braille learning information received from the braille learning information terminal in braille, so that the learner can directly read various words and sentences without having additional braille books and teaching materials Thereby, the learning efficiency of the braille can be further improved.

The present disclosure also relates to an electromagnet which is installed on the lower surface and whose polarity changes according to the current flow, a rotary member which is formed with an inclined surface on its upper surface and a permanent magnet on its lower surface, And a braille protrusion which is formed as an inclined surface such that its lower surface is in contact with the inclined surface of the rotary member and which is raised or lowered along the inclined surface of the rotary member when the rotary member is rotated, Even when the upper surface of the rotating rotary member rotates the rotary member by the permanent magnet and the repulsive force or attraction and the upper surface of the rotating rotary member lifts the lower surface of the braille projection to output the braille and then stops the current supply to the electromagnet, it is possible to maintain the output state and thus to reduce the power consumed by the braille output remarkably.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram for explaining a braille learning apparatus according to an embodiment of the present invention;

FIG. **2** is a view for explaining an internal structure of a slave block;

FIG. **3** is a view for explaining a master station;

FIG. **4** is a view for explaining a block mounting unit, a sensing unit, and a block fixing unit of the master station;

FIGS. **5**A and **5**B are diagrams showing an overall configuration of a braille actuator;

FIGS. **6**AA to **6**AC are views showing a structure of an electromagnet fixed on a lower surface and a permanent magnet installed on a rotary member according to a first preferred embodiment of the present invention;

FIGS. **6**BA and **6**BB are views showing a structure of an electromagnet fixed on a floor surface and a permanent magnet installed on a rotary member according to a second preferred embodiment of the present invention;

FIGS. **7**A to **7**D are diagrams illustrating a manner in which the rotary member of the present invention rotates according to a preferred embodiment of the present invention;

FIG. **8** is a view showing the structure of a braille actuator according to another embodiment of the present invention;

FIG. **9** is a view showing a structure of a braille actuator according to another embodiment of the present invention;

FIG. **10** is a view for explaining an installation environment of the braille actuator;

FIG. **11** is a diagram for explaining a braille learning method according to an embodiment of the present invention;

FIG. **12** is a diagram for explaining a braille learning method according to another embodiment of the present invention; and

FIG. **13** is a diagram for explaining a braille learning method according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Although specific details of the present invention are set forth in the following description to provide a more thorough understanding of the present invention, it will be obvious to those of ordinary skill in the art that the present invention may be practiced without these specific details.

Hereinafter, preferred embodiments according to the present invention will be described in detail with reference to FIGS. **1** to **13**, and a description will be given largely based on the parts necessary for understanding the operation and operation according to the present invention.

FIG. **1** is a diagram for explaining a braille learning apparatus according to an embodiment of the present invention.

Referring to FIG. **1**, the braille learning apparatus according to an embodiment of the present invention includes a plurality of slave blocks **100** and a master station **200**.

The plurality of slave blocks **100** allow a learner, such as a visually impaired person, to manually input braille characters such as initials, vowels, consonants, predefined abbreviations and numbers.

Also, since multiple slave blocks **100** are provided, the learner can input braille characters into the plurality of slave blocks **100** to complete various words and sentences.

The master station **200** confirms the braille inputted to the slave blocks **100** from the learner and transmits the information to the braille learning information terminal of the educator who guides the braille learning.

For example, The master station **200** receives the braille learning information from the braille learning information terminal of the educator and recognizes the braille characters inputted to the slave blocks **100** when the slave blocks **100** to which the specific braille characters are inputted have been mounted by the learner to determine whether or not the braille characters match the learning word based on the braille learning information. In addition, the master station **200** transmits the determination result to the braille learning information terminal or transmits the braille inputted to the slave blocks **100** to the braille learning information terminal.

Further, the master station **200** may receive the braille learning information from the braille learning information terminal of the educator who guides braille learning, and indicate the corresponding braille at a predetermined positions so that the learner can read the braille learning information.

Meanwhile, the above-mentioned braille learning information terminal refers to a device that communicates with the master station to transmit braille learning information and performs a function of receiving information such as a determination result from the master station. For example, the braille learning information terminal may be implemented as a braille information instrument capable of inputting by way of a braille keyboard and braille output based on an interface for a visually impaired person or may be implemented as a smart terminal such as a smart phone on which an application program with the aforementioned functionalities is installed and implemented.

Therefore, the braille learning apparatus according to an embodiment of the present invention can be utilized for the purpose of braille education, allowing a learner to directly use various braille characters using the slave blocks **100**. The learning efficiency of the braille can be improved compared to the conventional braille text material by allowing the station **200** to read the braille or to check whether the braille inputted to the slave blocks **100** are correct or not.

Hereinafter, the slave blocks **100** and the master station **200** according to an embodiment of the present invention will be described in more detail.

FIG. **2** is a diagram for explaining an internal structure of a slave block.

Referring to FIG. **2**, a slave block **100** according to an embodiment of the present invention includes a block body **110**, a braille input pin **120**, and a braille input pin fixing member **130**.

The block body **110** forms a predetermined outer appearance, and a plurality of braille input pins **120** and a braille input pin fixing member **130** are accommodated in the block body **110**.

A plurality of through holes opposing each other are formed on the front surface and the rear surface of the block body **110**. Each braille input pin **120** protrudes through the through hole to allow the learner to apply an external force. In the embodiment, the braille input pins **120** are provided in six, and two braille input pins **120** are arranged in the horizontal direction and three braille input pins **120** are arranged in the vertical direction.

Furthermore, one end of the braille input pin **120** protrudes into the through hole on the front surface of the block body **110** when the braille is not inputted. Also, when the braille is inputted, the other end of the braille input pin **120** protrudes into the through hole on the rear surface of the block body **110**.

That is, when a learner applies an external force to a specific braille input pin **120** from the front of the block body **110** to input braille, the braille input pin **120** moves by the external force to protrude into the rear surface of the block body **110**. On the contrary, at the time of initializing the braille inputted to the slave block **100**, an external force is applied to the braille input pins **120** protruding from the rear surface of the block body **110** so that all the braille input pins **120** may protrude from the front surface of the block body **110**.

Also, the braille input pins **120** are fixedly supported by the braille input pin fixing member **130**. For example, the braille input pin fixing member **130** can fix the braille input state or the braille non-input state until an external input of the learner is applied to each braille input pin **120**.

To achieve this, the braille input pin fixing member **130** may include a permanent magnet **131** fixedly coupled to a predetermined position of the braille input pin **120** and a pair of magnetic bodies **132***a* and **132***b* spaced apart from each other with the permanent magnet **131** disposed therebetween. Preferably, each of the magnetic bodies **132***a* and **132***b* may be formed of a metal such as iron.

Also, the magnetic bodies **132***a* and **132***b* can have a configuration such that the magnetic bodies **132***a* and **132***b* are respectively disposed on the inner front surface and the inner rear surface of the block body **110** and the permanent magnet **131** can move only between the magnetic bodies **132***a* and **132***b*.

Also, when an external force is applied to the braille input pin **120** from the front surface of the block body **110** to move the braille input pin **120** to the rear surface of the block body **110**, the permanent magnet **131** fixedly coupled to the block body **110** and the magnetic body **132***b* disposed on the rear surface of the block body **110** are brought into contact with each other by attraction.

In contrast, when an external force is applied to the braille input pin **120** from the rear surface of the block body **110**, the respective braille input pin **120** moves to the front surface of the block body **110**, and the magnetic body **132***a* disposed on the front surface of the block body **110** are brought into contact with the permanent magnet **131** by attraction.

That is, the braille input pin **120** can be fixed by the attractive force between the permanent magnet **131** and one of the magnetic bodies **132***a* and **132***b*.

Also, by forming bent portions bent at predetermined positions of the magnetic bodies **132***a* and **132***b* toward the rear surface of the block body **110**, the attraction force of the block fixing unit **250** of the master station **200**, which will be described later, may work more effectively. In addition, if the slave block **100** is provided with a recess on the rear surface thereof, the slave block **100** can be mounted more easily when the slave block **100** is mounted on the block mounting unit **230**.

FIG. **3** is a view for explaining a master station, and FIG. **4** is a view for explaining a block mounting unit, a sensing unit, and a block fixing unit of the master station.

Referring to FIGS. **3** and **4**, a master station **200** according to an embodiment of the present invention basically includes a communication unit **210**, a control unit **220**, a block mounting unit **230**, a sensing unit **240**, the block fixing unit **250**, and a braille actuator **260**, and may further include an acoustic output unit **270**.

Here, the acoustic output unit **270** may output audio or sound under the control of the control unit **220**. The acoustic output unit **270** may be implemented as various types of speakers which convert an electric signal into a sound wave and output it.

The communication unit **210** is for communicating with the external braille learning information terminal **10**. The communication unit **210** receives the braille learning information from the braille learning information terminal **10** and, under the control of the control unit **220** (to be described later), transmits various information related to the braille inputted to the slave blocks **100** to the braille learning information terminal **10**.

In addition, the communication unit **210** may include various communication modules capable of transmitting and receiving predetermined information to and from the braille learning information terminal **10**, and may be a W-Fi module or a Bluetooth module.

The control unit **220** controls the overall operation of the master station **200**. In particular, the control unit **220** controls the braille actuator (to be described later) according to the learning information received by the communication unit **210** to output braille, output a sound through the acoustic output unit **270**, or check the braille inputted from the learner to the slave blocks **100**.

For example, when the communication unit **210** receives the braille learning information transmitted by the educator using the braille learning information terminal **10**, the control unit **220** can control the acoustic output unit **270** to output the learning word corresponding to the braille learning information as a sound through the acoustic output unit **270**, implemented by a speaker.

Also, the control unit **220** performs a function of checking the braille inputted to the slave blocks **100** according to whether the sensing unit **240** is turned on or not. The control unit **220** may also compare the braille inputted to the slave blocks **100** and the learning word according to the braille learning information to decide whether they match each other.

At this time, the determination result of the control unit **220** is transmitted to the braille learning information terminal **10** through the communication unit **210**. Meanwhile, the control unit **220** may transmit the braille information itself inputted to the slave blocks **100** to the braille learning information terminal **10** through the communication unit **210**.

In addition, the control unit **220** may control the braille actuator **260** (to be described later) to indicate braille corresponding to the braille learning information.

The block mounting unit **230** is provided at a predetermined position on the master station **200** to provide a predetermined space on which the slave blocks **100** are mounted. In addition, the learner may listen to the learning word, input braille to the slave blocks **100**, and then mount the slave blocks **100** on the block mounting unit **230**.

Meanwhile, the block mounting unit **230** may have a structure corresponding to the shape of the rear surface of the slave block **100**. The block mounting unit **230** may be provided with the through holes into which the braille input pins **120** protruding from the rear surface of the slave blocks **100** are inserted.

The sensing unit **240** senses the braille inputted to each slave block **100**. The sensing unit **240** may be disposed inside the block mounting unit **230**. The sensing unit **240** may be implemented by a plurality of switches each being pressed to be turned on by the braille input pin **120** protruding toward the rear surface of the slave block **100**.

Preferrably, the sensing unit **240** may be a membrane switch, and may be electrically connected to the controller **220** through a connector or the like.

Accordingly, when the learner listens to the learning word and inputs the braille to the slave blocks **100** and then places the braille on the block mounting unit **230**, only the switches pressed by the braille input pins **120** of the block **100** are turned on among the plurality of switches constituting the sensing unit **240**. The control unit **220** may identify the positions where the turn-on signals are generated in the sensing unit **240** and recognizes the braille.

The block fixing unit **250** fixes the slave blocks **100** by applying a predetermined attractive force when the slave blocks **100** are mounted on the block mounting unit **230**. The block fixing unit **250** may be implemented by a magnet disposed at a predetermined position of the block mounting unit **230**.

Therefore, the slave block **100** may be in contact with and fixed to the block fixing unit **250** by the attractive force between the magnetic bodies **132***a* and **132***b* provided inside the slave block **100** and the block fixing unit **250**.

The braille actuator **260** is provided inside the master station **200** and operates under the control of the control unit **220** to indicate braille so as to indicate a braille word corresponding to the braille learning information by externally projecting the protrusions to indicate braille so that the learner can read the braille corresponding to the braille learning information.

The braille actuator **260** may be implemented by various types of actuators capable of projecting protrusions for indicating braille using a mechanical driving force or a magnetic force.

For example, the braille actuator **260** may be implemented as a solenoid-type actuator which includes a permanent magnet at a predetermined position of the protrusion, or may include a permanent magnet as the protrusion itself, and an electromagnet may be installed on the upper surface or the lower surface of the braille actuator **260** so as to raise the protrusion by attraction or repulsion between the electromagnet with the current being supplied thereto and the permanent magnet. On the other hand, permanent magnets may be provided on the upper surface or the lower surface of the braille actuator **260**, and electromagnets may be provided at predetermined positions of the protrusions.

As another example, the braille actuator **260** may be implemented as a piezoelectric-type actuator which is equipped with a projection for indicating braille as a piezoelectric body, the length of which changes according to the voltage applied to the piezoelectric body so as to allow recognition of braille by the changed length of the piezoelectric body.

As another example, the braille actuator **260** may be implemented as a polymer dielectric type actuator which compresses the polymer dielectric layer in the thickness direction by an attractive force generated by applying electrodes to both surfaces of a polymer material having a high dielectric constant such as silicon or urethane and applying a voltage thereto so as to project the protrusion outside to indicate the braille.

However, since the actuators of the above-described type must continuously be supplied with current or voltage to maintain the projecting state of the protrusions for indicating braille, power consumption may be excessively caused.

Therefore, the braille actuator **260** according to the embodiment of the present invention is implemented to be easily applicable to various portable electronic devices operating with limited battery power by minimizing power consumption.

Hereinafter, the braille actuator **260** according to an embodiment of the present invention will be described in more detail.

FIGS. **5**A and **5**B are diagrams showing an overall configuration of a braille actuator according to an embodiment of the invention.

Referring to FIGS. **5**A and **5**B, the braille actuator **260** of the present invention operates under the control of the controller **220** to indicate a braille word corresponding to the braille learning information. The braille actuator **260** may basically include electromagnets A**400**, a rotary member A**100**, and a braille projection A**200**. The braille actuator **260** may further include a housing A**300**.

First, the electromagnets A**400** are fixedly installed on the floor A**500** of the braille actuator, and the polarity thereof is changed in accordance with the direction of the incoming current. The electromagnets A**400** may be realized by typical electromagnets A**400** having a magnetic core such as an iron core around which a coil is wound.

The rotary member A**100** may be formed such that the upper surface A**110** thereof is formed as an inclined surface and a permanent magnet A**130** is provided on the lower surface A**120** so that an attractive or dispulsive force to the permanent magnet A**130** installed on the lower surface is exerted to rotate the permanent magnet A**130** clockwise or counterclockwise, thereby raising or lowering the braille projection A**200**. The configuration of the rotary member A**100** will be described in more detail with reference to FIG. **6**AA to FIG. **6**BB.

The braille projection A**200** is formed to have an inclined surface so that the lower surface A**210** is in contact with the inclined surface of the rotary member A**100**. When the rotary member A**100** rotates, the braille projection A**200** rises or falls along the inclined surface of the rotary member A**100**. The inclination angle formed by the inclined surface of the braille projection A**200** is formed to be equal to the inclination angle formed by the inclined surface of the rotary member A**100** so that the inclined surface of the rotary member A**100** is in surface contact with the inclined surface of the braille projection A**200**. However, it is not necessary that the both inclined surfaces are completely in close contact with each other.

The side surface of the braille projection A**200** is provided with a guide A**220** for preventing the braille projection A**200** from rotating together with the rotary member A**100** while allowing the braille projection A**200** to perform only up and down movement, respectively.

The braille actuator of the present invention may further include a housing A**300** for accommodating the braille projection A**200** and the rotary member A**100** therein. As shown in FIG. **5**B, a guide groove A**310** to which the guide A**220** is coupled is formed in the longitudinal direction at a position corresponding to the guide A**220** formed on the side surface of the braille projection A**200**.

Referring to FIGS. **5**A and **5**B, the operation of the braille actuator of the present invention will be described. First, in a state in which the braille is not projected (see FIG. **5**A), the inclined surface, which is the lower surface A**210** of the braille projection A**200**, abuts against the inclined surface of the lower surface A**210** of the braille projection A**200**. In the state where the braille is not projected, the electric current is not supplied to the electromagnets A**400**. In this state, the highest point A**111** of the upper surface A**110** of the rotary member A**100** may be in contact with the highest point A**211** of the lower surface A**210** of the braille projection A**200**, and the lowest point A**112** of the upper surface A**110** of the rotary member A**100** may be in contact with the lowest point of the lower surface A**210** of the braille projection A**200**. At a minimum, the highest point A**111** of the upper surface A**110** of the rotary member A**100** and the highest point A**211** of the lower surface A**210** of the braille projection A**200** lie in a line, and the lowest point A**112** of the upper surface A**110** of the rotary member A**100** and the lowest point of the lower surface A**210** of the braille projection A**200** lie in a line.

Thereafter, when the braille projection A**200** is to be projected, a current is supplied to the electromagnets A**400** which are fixed on the floor A**500**, and an attractive force or a repulsive force acts between the permanent magnet A**100**, which is provided on the lower surface A**120** of the rotary member A**100**, and the electromagnets A**400**, to rotate the rotary member A**100** by 180 degrees.

When the rotary member A**100** is rotated, the direction of the inclined surface formed on the upper surface A**110** is rotated 180 degrees. In this process, as shown in FIG. **5**B, the upper surface A**110** of the rotary member A**100** and the lower surface A**210** of the braille projection A**200** are dislocated from each other so that the inclined surface A**110** of the rotary member A**100** raises the inclined surface A**210** of the braille projection A**200** so that the braille projection A**200** protrudes outwardly. In the state where the braille projection A**200** protrudes, the highest point A**111** of the upper surface A**110** of the rotary member A**100** abuts on the lowest point A**212** of the lower surface A**210** of the braille projection A**200** or is disposed on a straight line. Also, the lowest point A**112** of the upper surface A**110** of the rotary member A**100** is disposed on a straight line with the highest point A**211** of the lower surface A**210** of the braille projection A**200**.

When the rotation is completed, the supply of the electric current to the electromagnets A**400** is cut off. Even when the current supply is cut off, the rotary member A**100** maintains its current state due to the surplus magnetic force remaining in the electromagnets A**400** and the frictional force with the floor A**500**, and the braille projection A**200** also maintains its projecting state by the rotary member A**100**. In addition, even if the user presses the braille projection A**200** from the top to the bottom, the applied pressure is transmitted in the vertical direction, so that the projected state is maintained by the rotary member A**100** which holds the fixed state.

On the other hand, in order to return the protruded braille projection A**200** to the original state as shown in FIG. **5**A again (in order to insert the braille projection inside the housing), a current with an opposite polarity from the one applied when projecting the braille protrusion A**200** is applied to the electromagnets A**400**. Then, the rotary member A**100** rotates in a direction opposite to the direction in which the braille projection A**200** is projected, and the projected braille projection A**200** also falls and returns to the original state as shown in FIG. **5**A.

Thus, according to the present invention, current is supplied only when the state of the braille projection A**200** is changed, that is, when the braille projection A**200** is projected or when the projected braille projection A**200** retreats inside, but current is not supplied so long as the state is maintained. Thus, power consumption can be remarkably reduced as compared with the conventional methodologies.

Meanwhile, according to the preferred embodiment of the present invention, the edge of the upper surface A**110** of the braille projection A**200** and the edge of the lower surface A**210** of the braille projection A**200** may be rounded so that the braille projection A**200** can be smoothly raised while minimizing the frictional force with the braille projection A**200** when the rotary member A**100** rotates.

FIGS. **6**AA and **6**AB are diagrams showing structures of electromagnets A**400** fixed on the floor A**500** and a permanent magnet A**130** installed on a rotary member A**100** according to first and second preferred embodiments of the present invention.

First, the first preferred embodiment of the present invention will be described with reference to FIG. **6**AA. Referring to FIG. **6**AA, the braille projection A**200** and the rotary member A**100** of the present invention are both formed in a cylindrical shape, and the electromagnets A**400** and the permanent magnet A**130** are arranged in a cylindrical shape along a circumferential length of the cross section of the rotary member A**100**. The sum of the circumferential lengths occupied by the electromagnets A**400** and the permanent magnet A**130** is about 50% of the circumferential length of the rotary member A**100**. Therefore, the rotary member A**100** can rotate by 180 degrees.

The electromagnets A**400** of the present invention may comprise two electromagnets A**400** (the first electromagnet A**410** and the second electromagnet A**420**) as shown in FIGS. **6**AB and **6**AC. The first electromagnet A**410** is in contact with the permanent magnet A**130** in a state in which the braille projection A**200** is accommodated inside and is in surface contact with the rotary member A**100** as in the state shown in FIG. **5**A. The second electromagnet A**420** comes into contact with the permanent magnet A**130** in a state where the braille projection A**200** protrudes, as shown in FIG. **5**B.

As shown in FIG. **6**AB, the first electromagnet A**410** and the second electromagnet A**420** are provided with a magnetic core and electric wires wound around the magnetic core, respectively, so that, by controlling the direction of the supplied current to the electromagnets A**400**, they may be driven so that the directions of the magnetic lines of force are opposite to each other (that is, the opposite poles have the same polarity).

As shown in FIG. **6**AC, it is possible that only the magnetic cores of the first electromagnet A**410** and the second electromagnet A**420** are separated from each other, and the electric wires wound around the magnetic cores are common such that only the directions of the magnetic lines of force are opposite to each other.

Hereinafter, an exemplary embodiment implemented using the first electromagnet A**410** and the second electromagnet A**420** shown in FIG. **6**AC will be described. Those skilled in the art will appreciate that the example shown in FIG. **6**AB is similar to the example shown in FIG. **6**AC, except that the polarity is controlled by controlling the direction of the current respectively supplied to the first electromagnet A**410** and the second electromagnet A**420** but is driven using the electromagnets A**400**.

Hereinafter, the second embodiment will be explained with respect to FIGS. **6**BA and **6**BB. Both the braille projection A**200** and the rotary member A**100** are formed in a cylindrical shape, and the permanent magnet A**130** may be formed so that the N-pole and the S-pole may be formed or installed on the entire lower surface of the rotary member A**100** so as to be alternately arranged in a direction perpendicular to the lower surface of the rotary member A**100**.

In the example shown in FIG. **6**BA, four permanent magnets A**130** are formed or installed on the lower surface of the rotary member A**100** so that the polarities thereof are alternately arranged. The floor A**500**, which is in contact with the permanent magnet A**130**, also has four electromagnets A**130** fixed so as to correspond to the polarity of the permanent magnet A**130**.

Also, In the example shown in FIG. **6**BB, two permanent magnets A**130** are formed or provided on the lower surface of the rotary member A**100** so that polarities different from each other are arranged. The floor A**500**, which is in contact with the permanent magnet A**130**, also has two magnet pieces A**130** fixed so as to correspond to the polarity of the permanent magnet A**130** in the contacted floor A**500**.

FIGS. **7**A to **7**D are views for explaining a manner in which the rotary member A**100** of the present invention rotates according to a preferred embodiment of the present invention. Hereinafter, a method of rotating the rotary member A**100** of the present invention will be described with reference to the first embodiment shown in FIGS. **6**AA to **6**AC.

Referring to FIGS. **7**A to **7**D, in the state shown in FIG. **5**A, no electric current is supplied to any of the electromagnets A**400** as shown in FIG. **7**A, so that the electromagnets A**400** do not have any polarity. Also, the permanent magnet A**130** provided on the rotary member A**100** is in contact with the first electromagnet A**410**.

At this time, as shown in FIG. **5**B, in order to raise the braille projection A**200** to project outwardly by rotating the rotary member A**100** by 180 degrees, current should be supplied so that a repulsive force is applied to the contact surface of the first electromagnet A**410** with the permanent magnet A**130** whereas the surface of the second electromagnet A**420** opposite to the contact surface of the first electromagnet A**410** has the same polarity with the contact surface of the first electromagnet A**410** to thereby attract the permanent magnet A**130**.

Referring to FIG. **7**B, since the polarity of the permanent magnet A**130** in contact with the contact surface of the first electromagnet A**410** is the S-polarity, current is supplied so

that the S-polarity is formed on the contact surface of the first electromagnet A**410** to act a repulsive force between the first electromagnet A**410** and the permanent magnet A**130**, and the rotary member A**100** starts to rotate in the direction indicated by the arrow.

The rotating permanent magnet A**130** is attracted by the attracting force between the S-pole of the second electromagnet A**420** and the N-pole of the permanent magnet A**130** so that the N-pole of the permanent magnet A**130** is attracted to the second electromagnet A**420**, and the rotary member A**100** rotates by 180 degrees (see FIG. **7**C).

Finally, when the permanent magnet A**130** comes in contact with the second electromagnet A**420**, that is, when the braille projection A**200** rises and protrudes outwardly, the current supplied to the electromagnets A**400** is cut off, and the projecting state of the projection A**200** is maintained and held by the rotary member A**100** (see FIG. **7**D).

On the other hand, in case when the electric wires are individually wound around the first electromagnet A**410** and the second electromagnet A**420**, respectively, instead of being shared and the polarity is controlled individually, an electric current is supplied so that the S-polarity is formed on the contact surface of the first electromagnet A**410** that contacts the S-pole of the permanent magnet A**130** and another S-polarity is formed on the opposite surface of the second electromagnet A**420** while the braille projection A**200** is accommodated inside, the rotary member A**100** is rotated in the manner as shown in FIG. **3**.

Meanwhile, if the driving circuit for the actuator of the present invention is capable of controlling the current supply in several milliseconds, the operation can be achieved with a single electromagnet A**400**. Specifically, if a single electromagnet A**400** having a combined length of the first electromagnet A**410** and the second electromagnet A**420** is provided in the embodiment shown in FIG. **7**A, a current pulse is instantly applied so that an S-polarity is formed on the contact surface of the electromagnet A**400** with the S-pole of the permanent magnet A**130**. In this case, it is preferable that the magnitude of the current pulse applied at this time is larger than the magnitude of the current shown in FIGS. **7**A to **7**D.

When the S-polarity is instantaneously formed on the contact surface of the electromagnet A**400**, the permanent magnet A**130** starts to rotate by the repulsive force, and even if the duty cycle of the pulse is ended and the polarity formed on the electromagnet A**400** has disappeared, the permanent magnet A**130** continues to rotate by inertia. When the permanent magnet A**130** moves beyond 50% of the entire circumferential length to which the permanent magnet A**130** is supposed to move, the current is supplied in the direction opposite to that previously supplied so that the S-pole acts on the opposite surface of the electromagnet A**400** at the moment. Then, the attraction force acts between the N-pole of the permanent magnet A**130** and the S-pole formed on the opposite side of the electromagnet A**400** so that the N-pole of the permanent magnet A**130** contacts with the opposite surface of the electromagnet A**400**. The permanent magnet A**130** is thus rotated by 180 degrees, and the braille projection A**200** protrudes outwardly. In this example, the magnitude and width of the current pulse initially applied and the time difference for supplying the current in the direction different from the applied current pulse are calculated in advance in consideration of the weight, material, etc. of the rotary member A**100**.

Meanwhile, the second embodiment shown in FIG. **6**B is different from the first embodiment only in the arrangement of the electromagnet A**400** and the permanent magnet A**130**, and the technical idea of rotating the permanent magnet is the same. Therefore, detailed descriptions will be omitted.

Meanwhile, according to the preferred embodiment shown in FIG. **8**, the rotary member A**100** and the braille projection A**200** may additionally have a center shaft A**550** which is formed vertically from the floor A**500** and perpetrates the center of the rotary member A**100** and the braille projection A**200**. The center shaft A**550** is provided to minimize the frictional force caused by the contact of the rotary member A**100** with the side surface of the housing A**300** while the rotary member A**100** is rotating and the frictional force caused by the contact of the braille projection A**200** with the side surface of the housing A**300** while the braille projection A**100** is moving in association with the rotation of the rotary member A**100**. At this time, a lubricant may be preferably applied to the central shaft A**550** so as to minimize the frictional force between the central shaft A**550** and the rotary member A**100** and the braille projection A**200**.

Meanwhile, according to the preferred embodiment shown in FIG. **9**, the rotary member A**100** and the braille projection A**200** may have, at its highest point A**111** of the upper surface A**110** and at its lowest point A**212** of the lower surface A**210**, respectively, cut surfaces A**113**, A**213** which are horizontally plane.

As shown in FIG. **9**, the cut surfaces A**113** and A**213** are formed horizontally at the highest point A**111** of the upper surface A**110** of the rotary member A**100** and the lowest point A**212** of the lower surface A**210** of the braille projection A**200**, which may cause frictional force between the two cut surfaces A**113** and A**213**. Therefore, even when the user slightly touches the braille projection A**200** and the braille projection A**200** slightly rotates, the braille protrusion A**200** is supported by the cut surfaces A**113** and **213** so as to prevent the braille projection A**200** from falling down along the inclined surface. However, in this case, the strength of the electromagnet A**400** should be made stronger than the case where no cut surfaces are provided, considering the frictional force of the cut surface.

FIG. **10** is a view for explaining an installation environment of the braille actuator. Referring to FIG. **10**, the braille learning apparatus according to a preferred embodiment of the present invention may further include a base A**610**, a cover A**620**, and a driver circuit A**630** along with the aforementioned braille actuators.

The base A**610** is provided with a plurality of cells A**612** each having one braille actuator installed according to a preferred embodiment of the present invention, and each of the cells A**612** is provided with one actuator.

A braille groove A**622** is formed on the cover A**620** so that the braille projection A**200** can protrude therefrom. The cover A**620** is coupled with the base A**610** to prevent the braille actuators from falling out externally.

The driver circuit A**630** supplies current to the electromagnet A**400** of the braille actuators each provided in one of the plurality of cells A**612** in accordance with the information to be output to the user to control the braille actuator installed in each cell A**612**. The driver circuit A**630** may be installed inside the base portion A**610** and supply current to the electromagnet A**400** of each braille actuator under the control of the control unit described above.

Meanwhile, the braille learning apparatus according to the embodiment of the present invention may further include a key input unit for receiving user commands for mode selection, confirmation selection, and volume control. The braille learning apparatus may further include a battery remainder display unit for displaying a remaining battery amount of the battery unit, and a charging terminal con-

nected to an external terminal for supplying a charging power source to the battery unit.

FIG. **11** is a diagram for explaining a braille learning method according to the embodiment of the present invention.

Referring to FIG. **11**, a braille learning method performed by the braille learning apparatus according to the embodiment of the present invention will be described.

Since the functions performed in the braille learning method shown in FIG. **11** are all performed by the braille learning apparatus described with reference to FIG. **1** to FIG. **10**, even if no explicit explanation is given, it should be noted that all the functions described above are performed in the braille learning method according to the preferred embodiment of the present invention, and all the functions described with reference to FIG. **11** are performed by the braille learning apparatus according to the preferred embodiment of the present invention.

First, when a learning word is input from the educator to the braille learning information terminal, the braille learning information including the learning word is transmitted from the braille learning information terminal and the braille learning information is received by the communication unit of the master station (S**110**).

Next, the control unit of the master station converts the learning word corresponding to the braille learning information received by the communication unit into braille, and controls the braille actuator to indicate the converted braille (S**120**).

At this time, under the control of the controller, the braille actuator supplies current to the electromagnet of the braille actuator, so that the braille protrusions corresponding to the converted braille are raised to indicate the braille.

Next, after the learner reads the braille and inputs the completion of the learning of the braille through the user input, the control unit of the master station transmits a signal notifying the completion of the learning to the braille learning information terminal through the communication unit (S**130**).

After the operation **130** is completed, the operation **110** may be repeated from the operation **110**.

FIG. **12** is a diagram for explaining a braille learning method according to another embodiment of the present invention.

Referring to FIG. **12**, a braille learning method performed by the braille learning apparatus according to an embodiment of the present invention will be described.

However, since the functions performed in the braille learning method shown in FIG. **12** are all performed by the braille learning apparatus described with reference to FIG. **1** to FIG. **10**, even if no explicit description is given, it should be noted that all the functions described above are performed in the braille learning method according to the preferred embodiment of the present invention, and all the functions described with reference to FIG. **12** are performed by the braille learning apparatus according to the preferred embodiment of the present invention.

First, when the learner dislodges the slave blocks from the master station and the educator inputs a learning word to the braille learning information terminal, the braille learning information including the learning word is transmitted from the braille learning information terminal, which is then received by the communication unit of the master station (S**210**).

Next, the control unit of the master station controls the sound output unit to output a learning word corresponding to the braille learning information (S**220**).

However, it should be noted that step **220** may not be performed separately according to the needs of the user. That is, in case where the educator who guides the braille learning can pronounce the learning word by voice, step **230**, which will be described later, may be performed immediately without outputting sound through the sound output unit.

Then, if the learner inputs the braille corresponding to the learning word into the slave blocks and then mounts the slave blocks in the block station of the master station, the sensing unit of the master station senses the braille inputted to the slave blocks (S**230**).

At this time, the sensing unit is turned on by the braille inputted to the slave blocks, and the control unit of the master station can check the braille inputted to the slave blocks depending on whether the sensing unit is turned on.

Then, the control unit determines whether or not the braille inputted to the slave blocks and the learning word corresponding to the braille learning information match each other (S**240**), and the determination result is transmitted to braille learning information terminal through the communication unit (S**250**).

In other words, the educator can immediately check whether or not the learner has inputted the correct braille corresponding to the learning word, and also can check whether or not the braille is entered incorrectly.

Further, after the operation up to operation **250**, the operation may be repeated from operation **210** described above.

FIG. **13** is a diagram for explaining a braille learning method according to another embodiment of the present invention.

Referring to FIG. **13**, a braille learning method performed by the braille learning apparatus according to another embodiment of the present invention will be described.

Here, the braille learning apparatus according to another embodiment of the present invention can be configured substantially the same as the braille learning apparatus described with reference to FIGS. **1** to **10**. However, the braille learning apparatus according to another embodiment of the present invention differs from the braille learning apparatus in that the braille learning apparatus is configured to directly transmit information on the braille inputted to the slave blocks to the braille learning information terminal.

First, when a learner dislodges the slave blocks from the master station and the educator inputs a learning word into the braille learning information terminal, the braille learning information including the learning word is transmitted from the braille learning information terminal, which is then received by the communication unit of the master station (S**310**).

Next, the control unit of the master station controls the sound output unit to output a learning word corresponding to the braille learning information (S**320**).

However, it should be noted that step **320** may not be performed separately according to the needs of the user. That is, if the educator who guides the braille learning can pronounce the learning word by voice, step **330**, which will be described later, may be performed immediately without outputting sound through the sound output unit.

Then, if the learner inputs the braille corresponding to the learning word into the slave blocks and then mounts the slave blocks in the block station of the master station, the sensing unit of the master station senses the braille inputted into the slave blocks (S**330**).

At this time, the sensing unit is turned on by the braille inputted to the slave blocks, and the control unit of the

master station can confirm the braille inputted to the slave blocks depending on whether the sensing unit is turned on.

Next, under the control of the control unit, the communication unit transmits information on braille inputted to the slave blocks to the braille learning information terminal (S**340**).

The information transmitted to the braille learning information terminal may include information on the braille itself inputted to the slave blocks, or may include information obtained by converting the braille inputted to the slave blocks into a word or a sentence.

Accordingly, the educator can immediately check whether or not the learner has inputted the correct braille corresponding to the learning word, and can also confirm which braille is entered incorrectly. In addition, after the step **340** has been completed, the above-described step **310** may be repeated from step **310** again.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A braille learning apparatus, comprising: a plurality of slave blocks for receiving braille from a learner; and

a master station configured to:

receive braille learning information from an external braille learning information terminal, when the plurality of slave blocks corresponding to a specific braille inputted by the learner are mounted on the master station, determine whether the specific braille inputted to the plurality of slave blocks match a learning word,

wherein each of the plurality of slave blocks comprises:

a block body having a plurality of through holes provided on a front surface and a rear surface thereof, which are opposite to each other; and

a plurality of braille input pins accommodated in the block body, each of the plurality of braille input pins being configured to be pressed by an external force of the learner, wherein one end of each of the plurality of braille input pins are configured to protrude via a through hole at the front surface of the block body when the braille is not inputted, and another end of each of the plurality of braille input pins are configured to protrude via a through hole at the rear surface of the block body when the braille is inputted,

and

transmit a determination result to the external braille learning information terminal.

2. The apparatus of claim **1**, wherein each of the plurality of slave blocks further includes:

a braille input pin fixing member for fixing a braille input state or an uninput state so as not to change until the external force of the learner is applied to each of the braille input pins.

3. The apparatus of claim **2**, wherein the braille input pin fixing member comprises:

a permanent magnet fixedly coupled to a predetermined position of the braille input pin; and

a pair of magnetic bodies spaced apart from each other by a predetermined distance so that the permanent magnet can move inside the block body.

4. The apparatus of claim **1**, wherein the master station comprises:

a block mount unit for providing a predetermined space in which the plurality of slave blocks are mounted; and

a sensing unit which is turned on by pressing a braille input pin protruding from a-the rear surface of each of the plurality of slave blocks when the plurality of slave blocks are mounted on the block mounting unit.

5. The apparatus of claim **4**, wherein the master station further comprises:

a block fixing unit for applying a predetermined attractive force when the plurality of slave blocks are mounted on the block mounting unit to firmly fix the plurality of slave blocks.

6. The apparatus of claim **4**, wherein the master station further comprises:

a communication unit for communicating with the external braille learning information terminal and receiving the braille learning information; and

a controller for checking the braille inputted to the plurality of slave blocks based on whether the sensing unit is turned on and controlling the driving of the master station.

7. The apparatus of claim **6**, wherein the communication unit transmits the braille inputted to the slave blocks to the braille learning information terminal under the control of the controller, or compares the braille inputted to the plurality of slave blocks with the learning word corresponding to the braille learning information by the controller, and transmits the determination result based on the comparison to the braille learning information terminal.

8. The apparatus of claim **1**, wherein the master station further comprises an acoustic output unit for outputting a learning word corresponding to the braille learning information to a sound.

9. The apparatus of claim **1**, wherein the master station further comprises a braille actuator for indicating the learning word corresponding to the braille learning information in braille.

10. The apparatus of claim **9**, wherein the braille actuator comprises:

an electromagnet provided on a lower surface and whose polarity changes according to a current flow;

a rotary member having an inclined upper surface, a permanent magnet provided on a lower surface thereof, and rotated by an attractive force or a repulsive force acting on the electromagnet; and

a braille protrusion formed as an inclined surface such that a bottom surface thereof contacts the inclined surface of the rotary member, and is raised or lowered along the inclined surface of the rotary member when the rotary member is rotated.

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