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(54) Title: INPUT DEVICES WITH MULTIPLE OPERATING MODES

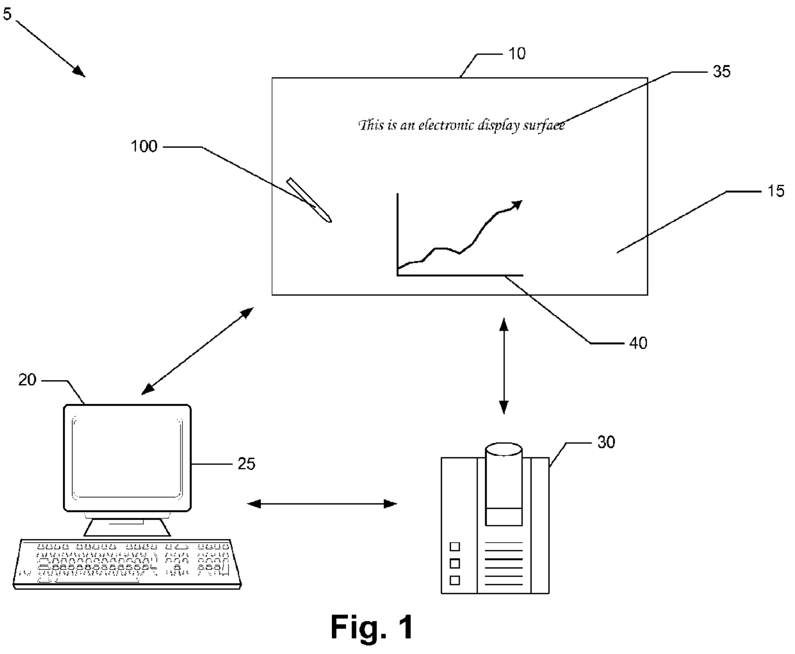

Fig. 1

(57) Abstract: An input device for interacting with a display surface of an electronic display system. The input device can comprise a body, a nib, a sensing system, a cap, and a mode-indicating system. The body can provide structural support for the input device. The nib, which is in communication with the body, can be used to directly interact with the display surface. The sensing system can sense indicia of a posture of the input device with respect to the display surface to facilitate operation of the input device. The cap is securable over the nib, and can be incorporated into the mode-indicating system. When the cap is secured over the nib, the input device can operate in a first operating mode, and when the cap is removed, the input device can operate in a second operating mode.

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INPUT DEVICES WITH MULTIPLE OPERATING MODES

BACKGROUND

Various aspects of the present invention relate to electronic display systems and, moreover, to input devices for electronic display systems.

It is known to digitize handwriting on a surface, such as a piece of paper, by determining how a pen is moved. A position-coding pattern for coding coordinates of points can be provided on the surface. The pen can be provided with a sensor for recording the position-coding pattern locally at the tip of the pen as the pen contacts the surface. For example, a processing unit, which can be disposed within the pen or at a distance therefrom, can decode the recorded position-coding pattern by analyzing the portion of the pattern viewed by the camera. As a result, movement of the pen across the surface can be determined as a series of coordinates.

For example, there exists a method of determining coordinates from a dot matrix position-coding pattern, or dot pattern, on a piece of paper. Each set of six-by-six dots accurately defines a single coordinate. A pen containing a camera can view the dots and, thereby, calculate a coordinate at which the pen is positioned. For example, International Patent Publication No. WO 01/26032 to Pettersson and U.S. Patent No. 7,249,716 to Bryborn describe such dot patterns.

Conventional electronic whiteboard systems provide electronic pens and styli for marking on a whiteboard surface. A stylus may perform as a drawing, writing, or pointing device, and can include a camera for viewing a position-coding pattern, such as a known image. Conventional electronic whiteboard systems do not, however, implement dot matrix position-coding patterns. The stylus of such a system may also include a cap, which can be used to protect the stylus, and to activate or deactivate the stylus. Further, function buttons have been implemented for alternating between various functions of the stylus.

U.S. Patent Application Publication No. 2007/0003168 to Oliver discloses use of a cap to alternate between focal lengths of the included camera, where placement of the cap over the tip of the stylus results in the camera having a different focal length than when the cap is removed. Oliver does not, however, disclose use of the stylus as a pointing device, or use of the camera to view a dot matrix position-coding pattern.

SUMMARY

There is a need in the art for an improved input device, such as a stylus or pen, for an electronic display system, such as an electronic whiteboard system. Exemplarily, such an improved input device can alternate operating modes based on a state of the input device.

Briefly described, various embodiments of the present invention include input devices having multiple operating modes, and electronic display systems implementing such input devices. According to an exemplary embodiment of the present invention, an input device indicates an area of a display surface on which to operate, and can simultaneously indicate a mode of operation. The input device can comprise a body, a nib, a sensing system, and a mode-indicating system.

The body provides structural support for the input device, and can also provide housing and protection for inner components of the input device.

The nib is in communication with the body. The nib is analogous to the tip of a conventional pen. Accordingly, the nib can contact and mark the display surface and, thereby, perform as a conventional marking device.

In one embodiment, the mode-indicating system can include a cap for the input device. The input device can operate in a first operating mode when the cap is secured over the nib, and in a second operating mode when the cap is not secured over the nib. The first operating mode can comprise a marking mode, in which the input device can mark the display surface. The second operating mode can comprise a pointing mode, in which the input device can drive a graphical user interface.

In another embodiment, the mode-indicating system can include a reciprocator for alternately retracting and extending the nib. The input device can operate in a first operating mode when the nib is extended, and in a second operating mode when the nib is retracted.

The sensing system is adapted to sense indicia of a posture of the input device, including a position of the input device, with respect to the display surface. In an exemplary embodiment, the sensing system comprises a camera disposed within the input device and adapted to view the display surface.

These and other objects, features, and advantages of the present invention will become more apparent upon reading the following specification in conjunction with the accompanying drawing figures.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1 illustrates an electronic display system, according to an exemplary embodiment of the present invention.

Fig. 2A illustrates a partial cross-sectional side view of an input device with a cap, according to an exemplary embodiment of the present invention.

Fig. 2B illustrates a partial cross-sectional side view of the input device with the cap removed, according to an exemplary embodiment of the present invention.

Fig. 3 illustrates a close-up partial cross-sectional side view of a portion of the input device, according to an exemplary embodiment of the present invention.

Fig. 4A illustrates a partial cross-sectional side view of the input device without a cap, according to an exemplary embodiment of the present invention.

Figs. 4B-4C illustrate partial cross-sectional side views of the input device with a cap, according to exemplary embodiments of the present invention.

Figs. 5A-5C illustrate various images of a dot pattern, as captured by a sensing device of the input device, according to an exemplary embodiment of the present invention.

Fig. 6A illustrates a partial cross-sectional side view of the input device with a nib retracted, according to an exemplary embodiment of the present invention.

Fig. 6B illustrates a partial cross-sectional side view of the input device with the nib extended, according to an exemplary embodiment of the present invention.

Fig. 7 illustrates a method of using the input device, according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION

To facilitate an understanding of the principles and features of the invention, various illustrative embodiments are explained below. In particular, the invention is described in the context of being an electronic input device for an electronic display system. Embodiments of the invention, however, are not limited to use in electronic display systems. Rather, embodiments of the invention can be used in many electronic systems.

The components described hereinafter as making up various elements of the invention are intended to be illustrative and not restrictive. Many suitable components that would perform the same or similar functions as the components described herein are intended to be embraced within the scope of the invention. Such other components not described herein can include, but are not limited to, for example, similar components that are developed after development of the invention.

Various embodiments of the present invention comprise input devices and electronic display systems. Referring now to the figures, wherein like reference numerals represent like parts throughout the views, embodiments of input devices and electronic display systems will be described in detail.

Fig. 1 illustrates an electronic display system **5**, for example, an electronic whiteboard system, implementing an input device **100**. The electronic display system **5** includes an electronic display device **10**, such as a display board, having a display surface **15**, and further includes a processing device **20** and, optionally, a projector **30**.

The display device **10** is operatively connected to the processing device **20**. The processing device **20** can be an integrated component of the electronic display device **10**, or the processing device **20** can be an external component. Suitable processing devices include a computing device **25**, such as a personal computer.

The projecting device **30**, such as a conventional projector, can project one or more display images onto the display surface **15**. For example and not limitation, the projector **30** can project a graphical user interface or markings created through use of the input device **100**. The projecting device **30** can be in communication with the processing device **20**. Such communication can be by means of a wired or wireless connection, Bluetooth, or by many other means through which two devices can communicate. Like the processing device **20**, the projecting device **30** can, but need not, be integrated into the display device **10**. Alternatively, the projecting device **30** can be excluded if the display device **10** is internally capable of displaying markings and other objects on its surface. For example, the display device **10** can be a computer monitor comprising a liquid crystal display.

The input device **100** can transmit a signal to the processing device **20** that operations are to be performed on the display surface **15** as indicated by the input device **100**. The input device **100** can be activated by many means, such as by an actuator, such as a switch or button, or by bringing the input device **100** in proximity to the surface **15**. While activated, placement or movement of the input device **100** in contact with, or in proximity to, the display surface **15** can indicate to the processing device **20** that certain operations are to occur at indicated points on the display surface **15**. For example, when the input device **100** contacts the display surface **15**, the input device **100** can transmit its coordinates on the display surface **15** to the processing device **20**. Accordingly, the display system **5** can cause an operation to be performed on the display surface **15** at the coordinates of the input device **100**. For example and not limitation, markings can be generated in the path of the input device **100**, or the input device **100** can direct a cursor across the display surface **15**.

Through interacting with the display surface **15**, the input device **100** can generate markings on the display surface **15**, which markings can be physical, digital, or both. For example, when the input device **100** moves across the display surface **15**, the input device **100** can leave physical markings, such as dry-erase ink, in its path. The display surface **15** can be adapted to receive such physical markings. Additionally, movement of the input device **100** can be analyzed to create a digital version of such markings. The digital markings can be stored by the display system **5** for later recall, such as for emailing, printing, or displaying. The display surface **15** can, but need not, display the digital markings at the time of their generation, such that digital markings generally overlap the physical markings.

The complete image displayed on the display surface **15** can comprise both real ink **35** and virtual ink **40**. The real ink **35** comprises the markings, physical and digital, generated by the input device **100** and other marking implements. The virtual ink **40** comprises other objects projected, or otherwise displayed, onto the display surface **15**. These other objects can include, without limitation, a graphical user interface or windows of an application running on the display system **5**. Real ink **35** and virtual ink **40** can overlap, and consequently, real ink **35** can be used to annotate objects in virtual ink **40**.

Figs. 2A-2B illustrate partial cross-sectional side views of the input device **100**. The input device **100** can comprise a body **110**, a nib **118**, a sensing system **120**, a communication system **130**, and a cap **140**. Further, the input device **100** has two or more states, and each state corresponds to an operating mode of the input device **100**.

The body **110** can provide structural support for the input device **100**. The body **110** can comprise a shell **111**, as shown, to house inner-workings of the input device **100**, or alternatively, the body **110** can comprise a primarily solid member for carrying components of the input device **100**. The body **110** can be composed of many materials. For example, the body **110** can be plastic, metal, resin, or a combination thereof, or many materials that provide protection to the components or the overall structure of the input device **100**. The body **110** can further include a metal compartment for electrically shielding some or all of the sensitive electronic components of the device. The input device **100** can have many of shapes consistent with its use. For example, the input device **100** can have an elongated shape, similar to the shape of a conventional writing instrument, such as a pen, or a thicker design, such as a dry-erase marker.

The body **110** can comprise a first end portion **112**, which is a head **114** of the body **110**, and a second end portion **116**, which is a tail **119** of the body **110**. The head **114** is interactable with the display surface **15** during operation of the input device **100**.

The nib **118** can be positioned at the tip of the head **114** of the input device **100**, and can be adapted to be placed in proximity to, contact, or otherwise indicate, a point on the display surface **15**. For example, as a user writes with the input device **100** on the display surface **15**, the nib **118** can contact the display surface **15**, as the tip of a pen would contact a piece of paper. While contact with the display surface **15** may provide for a comfortable similarity to writing with a conventional pen and paper, or whiteboard and dry-erase marker, contact of the nib **118** to the display surface **15** need not be required for operation of the input device **100**. For example, once the input device **100** is activated, the user can hover the input device **100** in proximity to the display surface **15**, or point from a distance, as with a laser pointer.

The nib **118** can comprise a marking tip, such as the tip of a dry-erase marker or pen. Accordingly, contact or proximity of the nib **118** to the display surface **15** can result in physical marking of the display surface **15**.

The sensing system **120** is adapted to sense indicia of the posture of the input device **100**. The input device **100** has six degrees of potential movement. In the two-dimensional coordinate system of the display surface **15**, the input device **100** can move in the horizontal and vertical directions. The input device **100** can also move normal to the display surface **15**, and can rotate about the horizontal, vertical, and normal axes. These rotations are commonly referred to, respectively, as the roll, yaw, and tilt of the input device **100**. The sensing system **120** can sense all, or many combinations of, these six degrees of movement.

The term "tipping" as used herein, refers to angling of the input device **100** away from normal to the display surface **15**, and, therefore, includes rotations about the horizontal and vertical axes, *i.e.*, the roll and the yaw of the input device **100**. On the other hand, "orientation," as used herein, refers to rotation parallel to the plane of the display surface **15** and, therefore, about the normal axis, *i.e.*, the tilt of the input device **100**.

The sensing system **120** can be coupled to, and in communication with, the body **110**. The sensing system **120** can have many implementations adapted to sense indicia of the posture of the input device **100** with respect to the display surface **15**. For example, the sensing system **120** can sense data indicative of the distance of the input device **100** from the display surface **15**, as well as the position, orientation, tipping, or a combination thereof, of the input device **100** with respect to the display surface **15**.

As shown, the sensing system can include a first sensing device **122** and a second sensing device **124**. Each sensing device **122** and **124** can be adapted to sense indicia of the posture of the input device **100**. Further, each sensing device **122** and **124** can individually detect data for determining the posture of the input device **100** or, alternatively, can detect such data in conjunction with other components, such as another sensing device.

The first sensing device **122** can be a surface sensing device for sensing the posture of the input device **100** based on properties of the display surface **15**. The surface sensing device **122** can be, or can comprise, a camera. The surface sensing device **122** can detect portions of a pattern **200** (see **Figs. 5A-5C**) on the display surface **15**, such as a dot pattern or a dot matrix position-coding pattern. Detection by the surface sensing device **122** can comprise viewing, or capturing an image of, a portion of the pattern **200**.

Additionally or alternatively, the sensing system **120** can comprise an optical sensor, such as that conventionally used in an optical mouse. In that case, the sensing system **120** can comprise light-emitting diodes and photodiodes, or a CMOS camera, to detect movement relative to the display surface **15**.

The surface sensing device **122** can be in communication with the body **110** of the input device **100**, and can have many positions and orientations with respect to the body **110**. For example, the surface sensing device **122** can be housed in the head **114**, as shown. Additionally or alternatively, the surface sensing device **122** can be positioned on, or housed in, many other portions of the body **140**.

The second sensing device **124** can be a contact sensor. The contact sensor **124** can sense when the input device **100** contacts a surface, such as the display surface **15**. The contact sensor **124** can be in communication with the body **110** and, additionally, with the nib **118**. The contact sensor **124** can comprise, for example and not limitation, a switch that closes a circuit when a portion of the input device **100**, such as the nib **118** contacts a surface with predetermined pressure. Accordingly, when the input device **100** contacts the display surface **15**, the display system **5** can determine that an operation is indicated.

To facilitate analysis of data sensed by the sensing system **120**, the input device **100** can further include a communication system **130** adapted to transmit information to the processing device **20** and to receive information from the processing device **20**. For example, if processing of sensed data is conducted by the processing device **20**, the communication system **130** can transfer sensed data to the processing device **20** for such processing. The communication system **130** can comprise, for example, a transmitter, a receiver, or a transceiver. Many wired or wireless technologies can be implemented by the communication system **130**. For example, the communication system **130** can implement Bluetooth or 802.11b technology.

The cap **140** can be releasably securable to the body **110** in one or more predetermined positions relative to the body **110**. For example, and not limitation, the cap can be securable to the head **114** of the body **110**, such as to cover the nib **118**. The cap **140** can be adapted to protect the nib **118** and components of the input device **100** proximate the head **114**, such as the surface sensing device **122**. The cap **140** can also be securable to the tail **119** of the body, such as for storage of the cap **140** while the nib **118** interacts with the display surface **15**.

Use of the cap **140** can result in at least two states of the input device **100**. For example, the input device **100** can have a cap-on state, in which the cap **140** is secured to the head **114**, and a cap-off state, in which the cap **140** is not secured to the head **114**. In some embodiments, a cap-stored state can result when the cap **140** is secured to the tail **119** of the input device **100**. Alternatively, no cap-stored state need exist, and securing the cap **140** to the tail **119** can result in a cap-off state.

The input device **100** can detect presence of the cap **140** in a predetermined position in many ways. For instance, the cap **140** can include electrical contacts that interface with corresponding contacts on the body **110**, or the cap **140** can include geometric features that engage a detente switch of the body **110**. Also, presence of the cap **140** can be indicated manually or detected by a cap sensor **142** (see **Fig. 3**), by distance of the nib **118** from the display surface **15**, or by the surface sensing device **122**.

The user can manually indicate to the whiteboard system that the input device **100** is in a cap-on state. For example, the input device can comprise an actuator **105**, such as a button or switch, for the user to actuate to indicate the state of the input device **100** with respect to the cap **140**.

Fig. 3 illustrates a close-up cross-sectional side view of the head **114** of the input device **100**. As shown in **Fig. 3**, the input device **100** can comprise a cap sensor **142**. The cap sensor **142** can comprise, for example, a pressure switch, such that when the cap **140** is secured over the nib **118**, the switch closes a circuit, thereby indicating that the cap **140** is secured. Further, the cap sensor **142** can be a pressure sensor and can sense when the cap is on and contacting a surface, such as the display surface **15**. A first degree of pressure at the cap sensor **142** can indicate presence of the cap **140** over the nib **118**, while a higher degree of pressure can indicate that the cap is on and in contact with, or pressing against, a surface. The cap sensor **142** can be positioned in the body **110**, as shown, or in the cap **140**.

Whether the input device **100** is in cap-on mode can be further determined from the distance of the nib **118** to the display surface **15**. When the cap **140** is removed, the nib is able to contact the display surface **15**, but when the cap **140** is in place, the nib **118** cannot reach the display surface **15** because the cap **140** obstructs this contact. Accordingly, when the nib **118** contacts the display surface **15**, it can be determined that the cap **140** is off. Further, there can exist a predetermined threshold distance **D** such that, when the nib **118** is within the threshold distance **D** from the display surface, the input device **100** is determined to be in a cap-off state. On the other hand, if the nib **118** is outside of the threshold distance **D**, the cap may be secured over the nib **118**.

Additionally or alternatively, the surface sensing device **122** can detect the presence or absence of the cap **140** over the nib **118**. When secured over the nib **118**, the cap **140** can be within the range, or field of view **FOV**, of the surface sensing device **122**. Therefore, the surface sensing device can sense the cap **140** when the cap **140** is over the nib **118**, and the display system **5** can respond accordingly.

One or more states of the input device **100**, such as cap-on and cap-off states, can correspond to one or more operating modes of the input device **100**. Securing of the cap **140** over the nib **118** can indicate to the display system **5** that the operating mode has changed. The input device **100** can have many operating modes, including, without limitation, a marking mode and a pointing mode.

In the marking mode, the input device **100** can mark the display surface **15**, digitally, physically, or both. For example, the input device **100** can be used to write or draw on the display surface **15**. In the pointing mode, the input device **100** can perform in a manner similar to that of a computer mouse. The input device **100** can, for example, drive a graphical user interface, or direct a cursor about the display surface **15** to move and select displayed elements for operation. Accordingly, the input device **100** comprises a mode-indicating system **180**, which incorporates the cap **140**.

Referring now back to **Figs. 2A-2B**, if the surface sensing device **122** is housed in, or proximate, the head **114**, it is desirable that the cap **140** not obstruct sensing when the cap **140** is secured over the nib **118**. To facilitate sensing of indicia of the posture of the input device **100** when the cap **140** is secured over the nib **118**, the cap **140** can comprise a translucent or transparent portion **145**.

Alternatively, the surface sensing device **122** can be positioned such that the display surface **15** is visible to the surface sensing device **122** regardless is whether the cap **140** is secured over the nib **118**. For example, the surface sensing device **122** can be carried by the body **110** at a position not coverable by the cap **140**, such as at position **128**.

Figs. 4A-4C illustrate another embodiment of the input device. As shown in **Fig. 4A**, in addition to the above features, the input device can further comprise a marking cartridge **150**, an internal processing unit **160**, memory **165**, a power supply **170**, or a combination thereof. The various components can be electrically coupled as necessary.

The marking cartridge **150** can be provided to enable the input device **100** to physically mark the display surface **15**. The marking cartridge **150**, or ink cartridge or ink well, can contain a removable ink, such as conventional dry-erase ink. The marking cartridge **150** can provide a comfortable, familiar medium for generating handwritten strokes on the display surface **15** while movement of the input device **100** generates digital markings.

The internal processing unit **160** can be adapted to calculate the posture of the input device **100** from data received by the sensing system **120**, including determining the relative or absolute position of the input device **100** in the coordinate system of the display surface **15**. The internal processing unit **160** can also execute instructions for the input device **100**. The internal processing unit **160** can comprise many processors capable of performing functions associated with various aspects of the invention.

The internal processing unit **160** can process data detected by the sensing system **120**. Such processing can result in determination of, for example: distance of the input device **100** from the display surface **15**; position of the input device **100** in the coordinate system of the display surface **15**; roll, tilt, and yaw of the input device **100** with respect to the display surface **15**, and, accordingly, tipping and orientation of the input device **100**.

The memory **165** can comprise RAM, ROM, or many types of memory devices adapted to store data or software for controlling the input device **100** or for processing data.

The power supply **170** can provide power to the input device **100**. The power supply **170** can be incorporated into the input device **100** in any number of locations. If the power supply **170** is replaceable, such as one or more batteries, the power supply **170** is preferably positioned for easy access to facilitate removal and replacement of the power supply **170**. Alternatively, the input device **100** can be coupled to alternate power supplies, such as an adapter for electrically coupling the input device **100** to a car battery, a wall outlet, a computer, or many other power supplies.

The cap **140** can comprise many shapes, such as the curved shape depicted in **Fig. 4B** or the faceted shape of **Fig. 4C**. The shape of the cap **140**, however, is preferably adapted to protect the nib **118** of the input device **100**.

The cap **140** can further comprise a stylus tip **148**. The stylus tip **148** of the cap **140** can be interactable with the display surface **15**. When the stylus tip **148** contacts or comes in proximity to the display surface **15**, the input device can operate on the display surface **15**, for example, by directing a cursor across the display surface **15**.

Multiple caps **140** can be provided, and securing of each cap **140** over the nib **118** can result in a distinct state of the input device **100**. Further, in addition to indicating a change in operating mode of the input device **100**, a cap **140** can provide additional functionality to the input device **100**. For example, the cap **140** can provide one or more lenses, which can alter the focal length of the surface sensing device **122**. In another example, the cap **140** can be equipped with a metal tip, such as the stylus tip **148**, for facilitating resistive sensing, such that the input device **100** can be used with a touch-sensitive device.

As shown, the surface sensing device **122** need not be coverable by the cap **140**. Placement of the surface sensing device **122** outside of the range of the cap **140** can allow for more accurate detection of the display surface **15**. Further, such placement of the surface sensing device **122** results in the cap **140** providing a lesser obstruction to the surface sensing device **122** when the cap **140** is secured over the nib **118**.

Referring back to the sensing system **120**, the contact sensor **124**, if provided, can detect when a particular portion of the input device **100**, such as the nib **118**, contacts a surface, such as the display surface **15**. The contact sensor **124** can be a contact switch, such that when the nib **118** contacts the display surface **15**, a circuit closes, indicating that the input device **100** is in contact with the display surface **15**. The contact sensor **124** can also be a force sensor, which can detect whether the input device **100** presses against the display surface **15** with a light force or a hard force. The display system **5** can react differently based on the degree of force used. If the force is below a certain threshold, the display system **5** can, for example, recognize that the input device drives a cursor. On the other hand, when the force is above a certain threshold, which can occur when the user presses the input device **100** to the board, the display system **5** can register a selection, similar to a mouse click. Further, the display system **5** can vary the width of markings generated by the input device **100** based on the degree of force with which the input device **100** contacts the display surface **15**.

Additionally, the surface sensing device **122** can include, for example, a complementary metal oxide semiconductor (CMOS) image sensor, a charge-coupled device (CCD) image sensor, or many other types of sensors for receiving image information. The surface sensing device **122** can be a CMOS or CCD image-sensor array having a size of, for example, 128 by 100, 128 by 128, or larger. The sensing system **120** enables the input device **100** to generate digital markings by detecting posture and movement of the pen with respect to the display surface **15**. For example and not limitation, the surface sensing device **122** can capture images of the display surface **15** as the pen is moved, and through image analysis, the display system **5** can detect the posture and movement of the input device **100**.

The display surface **15** can include many types of image data indicating relative or absolute positions of the input device **100** in the coordinate system of the display surface **15**. For example, the display surface **15** can comprise a known image, which can include alphanumeric characters, a coding pattern, or many discernable patterns of image data capable of indicating relative or absolute position. The implemented pattern can indicate either the position of the input device **100** relative to a previous position, or can indicate an absolute position of the input device **100** in the coordinate system of the display surface **15**.

Determining a point on the display surface **15** indicated by the input device **100** can require determining the overall posture of the input device **100**. The posture of the input device **100** can include the position, orientation, tipping, or a combination thereof, of the input device **100** with respect to the display surface **15**. In marking mode, it may be sufficient to determine only the position of the input device **100** in the coordinate system of the display surface **15**. When pointing is required, however, as in pointer mode, the orientation and tipping of the input device **100** can be required to determine the indicated point on the display surface **15**.

As such, various detection systems can be provided in the input device **100** for detecting the posture of the input device **100**. For example, a tipping detection system **190** can be provided in the input device **100** to detect the angle and direction at which the input device **100** is tipped with respect to the display surface **15**. An orientation detection system **192** can be implemented to detect rotation of the input device **100** in the coordinate system of the display surface **15**. Additionally, a distance detection system **194** can be provided to detect the distance of the input device **100** from the display surface **15**.

These detection systems **190**, **192**, and **194** can be incorporated into the sensing system **120**. For example, the position, tipping, orientation, and distance of the input device **100** with respect to the display surface **15** can be determined, respectively, by the position, skew, rotation, and size of the appearance of the pattern **200** on the display surface **15**, as viewed from the surface sensing device **122**. For example, **Figs. 5A-5C** illustrate various views of an exemplary dot pattern **200** on the display surface **15**. The dot pattern **200** serves as a position-coding pattern in the display system **5**.

Fig. 5A illustrates an image of the pattern **200**, which is considered a dot pattern. It is known that certain dot patterns can provide indication of an absolute position in a coordinate system of the display surface **15**. In the image of **Fig. 5A**, the dot pattern **200** is viewed at an angle normal to the display surface **15**. This is how the dot pattern **200** could appear from the surface sensing device **122**, when the surface sensing device **122** is directed normal to the display surface **15**. In the image, the dot pattern **200** appears in an upright orientation and not angled away from the surface sensing device **122**. As such, when the surface sensing device **122** captures such an image, the display system **5** can determine that the input device **100** is normal to the display surface **15** and, therefore, points approximately directly into the display surface **15**.

As the input device **100** moves away from the display surface **15**, the size of the dots, as well as the distance between the dots, in the captured image decreases. Analogously, as the input device **100** moves toward the display surface **15**, the size of the dots, along with the distance between the dots, appears to increase. As such, in addition to sensing the tipping and orientation of the input device **100**, the surface sensing device **122** can sense the distance of the input device **100** from the display surface **15**.

Fig. 5B illustrates a rotated image of the dot pattern **200**. A rotated dot pattern **200** indicates that the input device **100** is rotated about a normal axis of the display surface **15**. For example, when a captured image depicts the dot pattern **200** rotated at an angle of 30 degrees clockwise, it can be determined that the input device **100** is oriented at an angle of 30 degrees counter-clockwise. As with the image of **Fig. 5A**, this image was taken with the surface sensing device **122** oriented normal to the display surface **15**, so even though the input device **100** is rotated, the input device **100** still points approximately directly into the display surface **15**.

Fig. 5C illustrates a third image of the dot pattern **200** as viewed by the surface sensing device **122**. The flattened image, depicting dots angled away from the surface sensing device **122**, indicates that the surface sensing device **122** is not normal to the display surface **15**. Further, the rotation of the dot pattern **200** indicates that the input device **100** is rotated about the normal axis of the display surface **15** as well. The image can be analyzed to determine the tipping angle and direction as well as the orientation angle. For example, it may be determined that the input device **100** is tipped downward 45 degrees, and then rotated 25 degrees. These angles determine to which point on the display surface **15** the input device **100** is directed.

Accordingly, by determining the angles at which an image received from the surface sensing device **122** was captured, the display system **5** can determine points indicated by the input device **100**.

Figs. 6A-6B illustrate partial cross-sectional side views of an embodiment of the input device **100**, a retractable input device **300**, implementing a retractable nib **318**. **Fig. 6A** illustrates the retractable input device **300** with a nib **318** retracted, while **Fig. 6B** shows the retractable input device **300** with the nib **318** extended.

Like the embodiment of the input device **100** described above, the retractable input device **300** comprises a body **310**, a nib **318**, a sensing system **320**, and a communication system **330**, and can further comprise a marking cartridge **350**, an internal processing unit **360**, memory

365, a power supply **370**, a tipping detection system **390**, an orientation detection system **392**, a distance detection system **394**, or a combination thereof, all as described above.

Additionally, as shown, the retractable input device **300** can comprise a reciprocator **340**. The reciprocator **340** can comprise an actuator **342**, such as a button, adapted to extend and retract the nib **318**. Alternate presses of the button **342** result in alternate positions of the nib **318**. For example, when the button **342** is depressed a first time, as in **Fig. 6B**, the nib **318** extends, and when the button **342** is depressed a second time, as in **Fig. 6A**, the nib **318** retracts.

Like the cap **140**, the reciprocator **340** can be incorporated in the mode-indicating system **380**. The reciprocator **340** can define states of the retractable input device **300**. For example, the retractable input device **300** can be in a retracted state or in an extended state, based on, respectively, whether the nib **318** is retracted or extended. Each state can correspond to an operating mode. For example and not limitation, when the retractable input device **300** is in the retracted state, the retractable input device **300** can operate in pointing mode. In contrast, when the retractable input device **300** is in the extended state, the retractable input device **300** can operate in marking mode. In marking mode, the nib **318** can be used as a marker and can generate both digital and physical markings.

Fig. 7 illustrates a method of using the input device **100** in the display system **5**. At a moment in time, the display surface **15** can display an image communicated from the processing device **20**. If a projector **30** is provided, a portion of such image can be communicated from the processing device **20** to the projector **30**, and then projected by the projector **30** onto the display surface **15**. The display image can include real ink **35**, such as physical and digital markings produced by the input device **100**, as well as virtual ink **40**.

In an exemplary embodiment, a user **90** can initiate further marking by bringing a portion of the input device **100** in sufficient proximity to the display surface **15**, or by placing a portion of the input device **100** in contact with the display surface **15**. To mark the display surface **15** in marking mode, the user **90** can move the input device **100** along the display surface **15**. This movement can result in real ink **35**, which can be represented digitally and physically on the display surface **15**. Alternatively, in pointing mode, movement of the input device **100** along the surface **15** can result in, for example, movement of a cursor. Such movement can be similar to movement of a mouse cursor across a graphical user interface of a personal computer.

As the input device **100** travels along the display surface **15**, the sensing system **120** periodically senses data indicating the changing posture of the input device **100** with respect to the display surface **15**. This data is then processed by the display system **5**. In one embodiment, the internal processing unit **160** of the input device **100** processes the data. In another embodiment, the data is transferred to the processing device **20** by the communication system **130** of the input device **100**, and the data is then processed by the processing device **20**. Processing of such data can result in determining the posture of the input device **100** and, therefore, can result in determining areas of the display surface **15** on which to operate. If processing occurs in the internal processing unit **160** of the input device **100**, the results are transferred to the processing device **20** by the communication system **130**.

Based on determination of relevant variables, the processing device **20** produces a revised image to be displayed onto the display surface **15**. In marking mode, the revised image can incorporate a set of markings not previously displayed, but newly generated by use of the input device **100**. Alternatively, the revised image can be the same as the previous image, but can appear different because of the addition of physical markings. Such physical markings, while not necessarily projected onto the display surface **15**, are recorded by the processing device **20**.

In pointing mode, the revised image can incorporate, for example, updated placement of the cursor. The display surface **15** is then refreshed, which can involve the processing device **20** communicating the revised image to the optional projector **30**. Accordingly, operations and digital markings indicated by the input device **100** can be displayed through the electronic display system **5**. In one embodiment, this occurs in real time.

While the invention has been disclosed in exemplary forms, many modifications, additions, and deletions can be made without departing from the spirit and scope of the invention and its equivalents, as set forth in the following claims.

CLAIMS

What is claimed is:

1. An input device for interacting with a display surface of an electronic display system, the input device comprising:

a body;

a cap securable to the body in one or more predetermined positions relative to the body, wherein the input device operates in pointer mode when the cap is secured to the body in a first position, and in marking mode when the cap is not secured to the body in the first position; and

a sensing system carried by the body for sensing a posture of the input device relative to the display surface.

2. The input device of Claim 1, the sensing system comprising a camera for viewing a portion of the display surface.

3. The input device of any of the preceding claims, the sensing system further configured to detect a posture of the input device relative to the display surface.

4. The input device of any of the preceding claims, the sensing system further configured to detect a portion of the coding pattern on the display surface.

5. The input device of Claim 4, further comprising an internal processing unit configured to determine a position of the input device in a coordinate system of the display surface based on the detected portion of the dot pattern.

6. The input device of any of the preceding claims, wherein an operating mode of the input device is determined based on a state of the cap.

7. The input device of any of the preceding claims, wherein the input device is adapted to generate digital markings on the display surface when the cap is not secured to the body in the first position.

8. The input device of any of the preceding claims, wherein the input device is adapted to drive a graphical user interface when the cap is secured to the body in the first position.

9. The input device of any of the preceding claims, wherein the input device is adapted to drive a cursor when the cap is secured to the body in the first position.

10. The input device of any of the preceding claims, further comprising a nib for interacting with the display surface, wherein the cap is secured to the body in the first position when the cap is secured to the body to cover the nib.

11. The input device of any of the preceding claims, further comprising a marking cartridge for physically marking on the display surface.

12. The input device of any of the preceding claims, the sensing system further configured to detect six degrees of movement.

13. The input device of any of the preceding claims, further comprising a tipping detection system for detecting rotations of the input device about the horizontal and vertical axes of the display surface.

14. The input device of any of the preceding claims, further comprising an orientation detection system for detecting a rotation of the input device in a coordinate system of the display surface.

15. The input device of any of the preceding claims, further comprising a distance detection system for detecting a distance between the input device and the display surface.

16. The input device of any of the preceding claims, further comprising a communication device for communicating a posture of the input device relative to the display surface to an external processing device.

17. An input device for interacting with a display surface of an electronic display system, the input device comprising:

a body;

a nib in communication with the body;

a reciprocator adapted to retract and extend the nib, wherein the input device operates in a first operating mode when the nib is extended, and in a second operating mode when the nib is retracted; and

a sensing system carried by the body, for sensing a position of the nib relative to the display surface.

18. The input device of Claim 17, wherein the first operating mode is a marking mode.

19. The input device of either of Claims 17 or 18, wherein the second operating mode is a pointing mode is a pointing mode.

20. The input device of any of Claims 17-19, the sensing system comprising a camera adapted to view the display surface.

21. The input device of any of Claims 17-20, further comprising an internal processing unit adapted to determine a position of the input device in a coordinate system of the display surface based on data received from the sensing system.

22. The input device of any of Claims 17-21, the sensing system adapted to sense at least one of the roll, yaw, and tilt of the input device.

23. The input device of any of Claims 17-22, the sensing system further configured to detect six degrees of movement of the input device.

24. An input device for operating at a target point on a display surface of an electronic display system, the input device comprising:

a body;

a sensing device carried by the body for detecting a portion of the display surface;

an internal processing unit configured to identify coordinates of the target point on the display surface based the detected portion of the display surface; and

a cap securable to the body in one or more predetermined positions for indication of an active operating mode of the input device.

25. The input device of Claim 24, the internal processing unit configured to decode a coding pattern on the display surface.

26. The input device of Claim 25, the coding pattern on the display surface being a dot pattern.

27. The input device of any of Claims 24-26, further comprising a communication device for communicating the active operating mode and the coordinates of the target point to an external processing device.

28. The input device of any of Claims 24-27, further comprising a cap sensor for detecting whether the cap is secured to the body in a first predetermined position.

29. The input device of Claim 28, the cap sensor comprising a switch.

30. The input device of either of Claims 28 or 29, the cap sensor comprising a camera.

31. The input device of Claim 30, the camera being positioned to capture an image of at least a portion of the cap when the cap is secured in the first predetermined position.

32. The input device of either of Claims 30 or 31, the camera being configured to detect a distance of the input device from the display surface, wherein the cap is deemed unsecured to the body when the distance is below a predetermined threshold.

33. The input device of any of Claims 24-32, wherein the active operating mode is a marking mode when the cap is secured to a head portion of the body.

34. The input device of any of Claims 24-33, wherein the active operating mode is a pointing mode when the cap is not secured to a head portion of the body.

35. The input device of any of Claims 24-34, wherein the active operating mode determines an operation performed at the target point on the display surface.

36. The input device of any of Claims 24-35, further comprising a contact sensor for detecting whether the input device is in contact with the display surface.

37. An electronic display system comprising:

a display surface comprising an alterable display image; and

an input device adapted to interact with the display surface, the input device comprising:

a body;

a nib in communication with the body;

a sensing system adapted sense a posture of the input device; and

a mode-indicating system adapted to alter an operating mode of the input device based on a state of the input device.

38. The electronic display system of Claim 37, the display surface being a whiteboard surface.

39. The electronic display system of either of Claims 37 or 38, further comprising a processing device configured to alter the display image based on interaction of the input device with the display surface.

40. The electronic display system of any of Claims 37-39, the input device further comprising a communication device for transmitting data to the processing device.

41. The electronic display system of any of Claims 37-40, further comprising a projector for projecting the display image onto the display surface.

42. The electronic display system of any of Claims 37-41, the display surface comprising a coding pattern thereon for encoding coordinates on the display surface.

43. The electronic display system of Claim 42, the coding pattern on the display surface being a dot pattern.

44. The electronic display system of either of Claims 42 or 43, the sensing system of the input device comprising a sensing device for detecting a portion of the coding pattern.

45. The electronic display system of Claim 44, wherein the input device identifies its coordinates on the display surface based on the detected portion of the coding pattern.

46. The electronic display system of either of Claims 44 or 45, the sensing device of the input device being camera.

47. The electronic display system of any of Claims 37-46, the sensing system configured to detect a distance of the input device from the display surface.

48. The electronic display system of any of Claims 37-47, the sensing system configured to detect an orientation of the input device relative to the display surface.

49. The electronic display system of any of Claims 37-48, the mode-indicating system comprising a cap, wherein the input device operates in a different operating mode when the cap is secured over the nib than when the cap is not secured over the nib.

50. The electronic display system of any of Claims 37-49, the mode-indicating system comprising a reciprocator for retracting and extending the nib, wherein the input device operates in a different operating mode when the nib is retracted than when the nib is extended.

51. The electronic display system of either of Claims 49 or 50, the operating modes comprising a marking mode and a pointing mode.

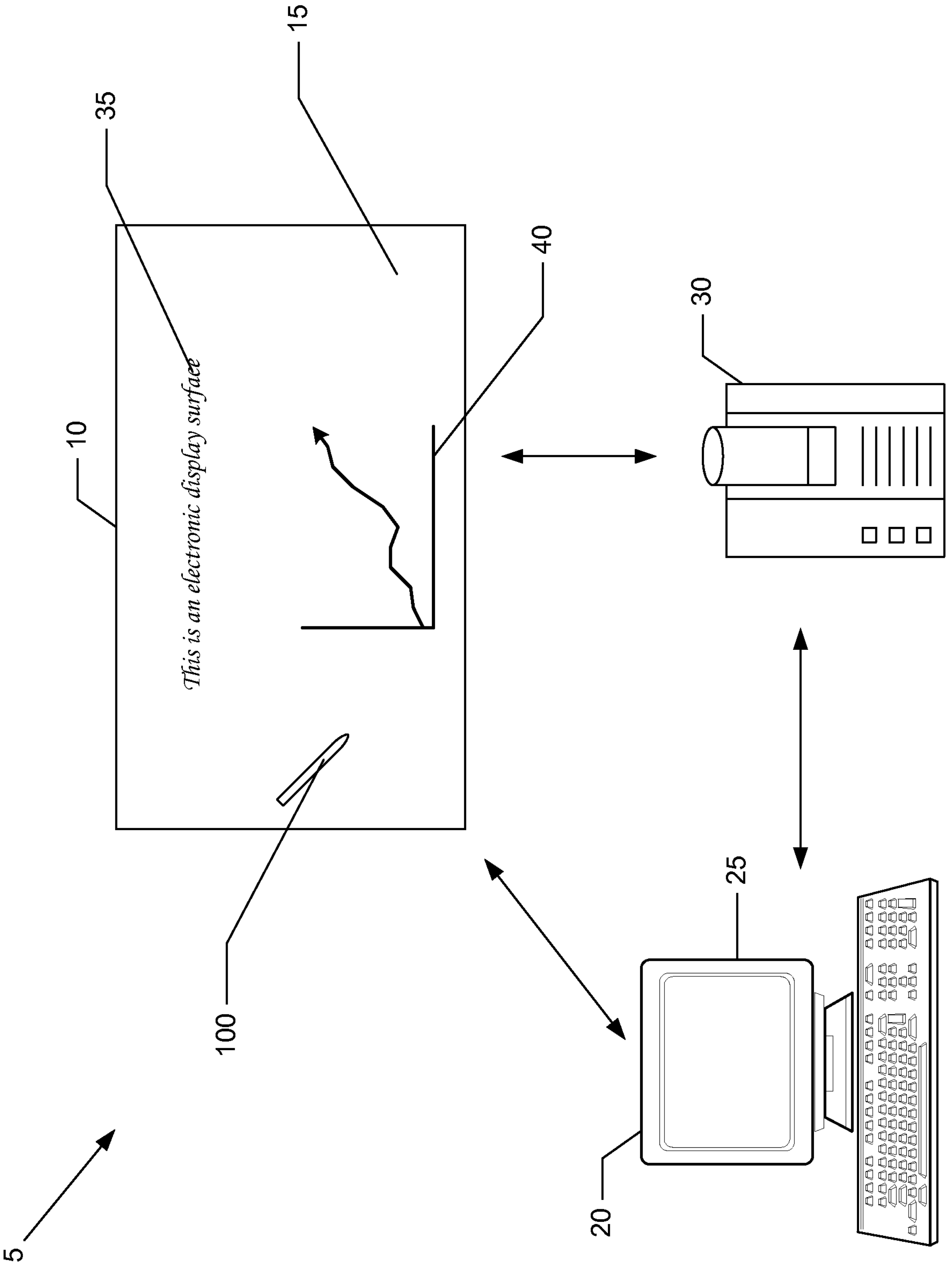
5
10
15
20
25
30
35
40
100
This is an electronic display surfaee

Fig. 1

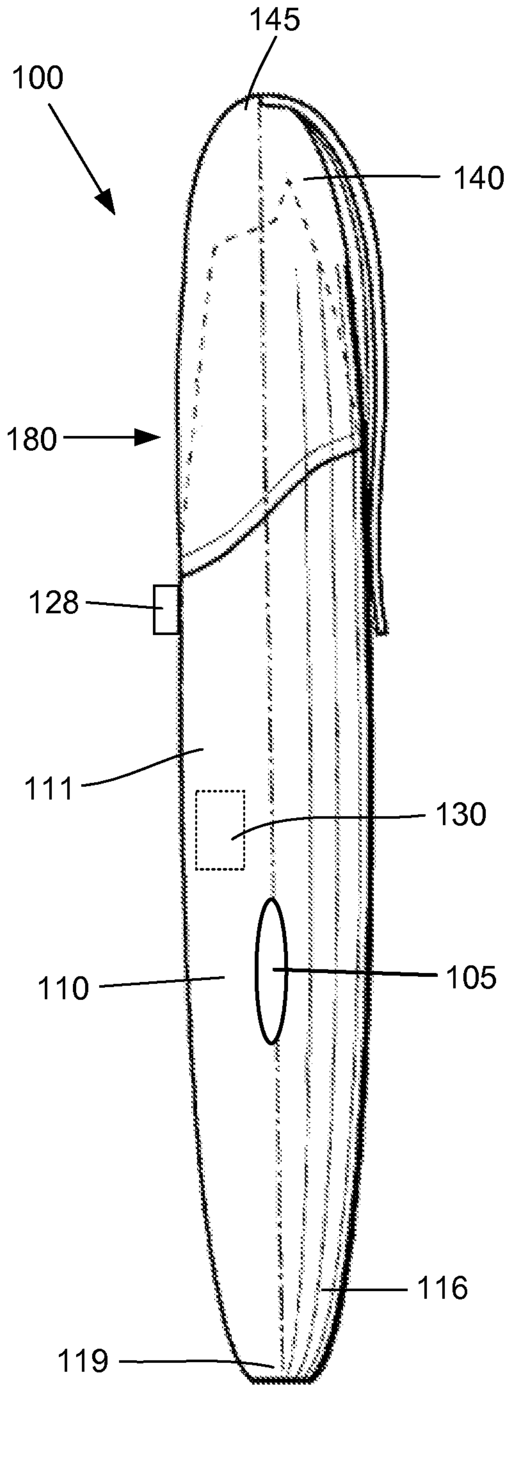
145
100
140
180
128
111
130
110
105
116
119

Fig. 2A

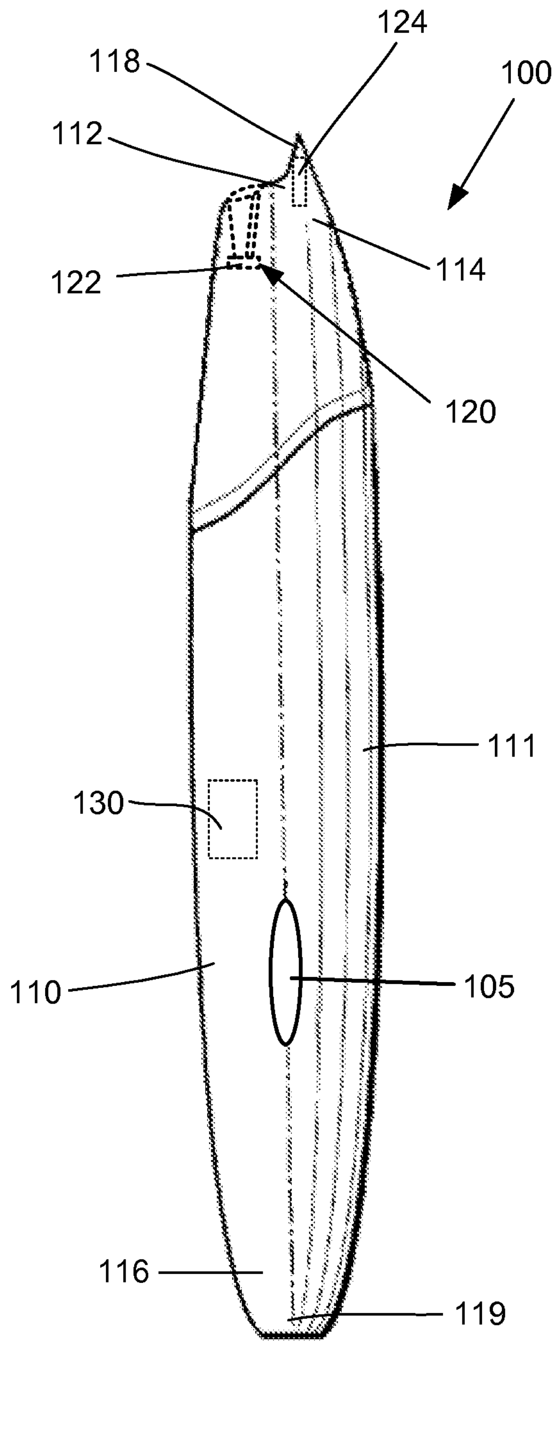
124
118
100
112
114
122
120
111
130
110
105
116
119

Fig. 2B

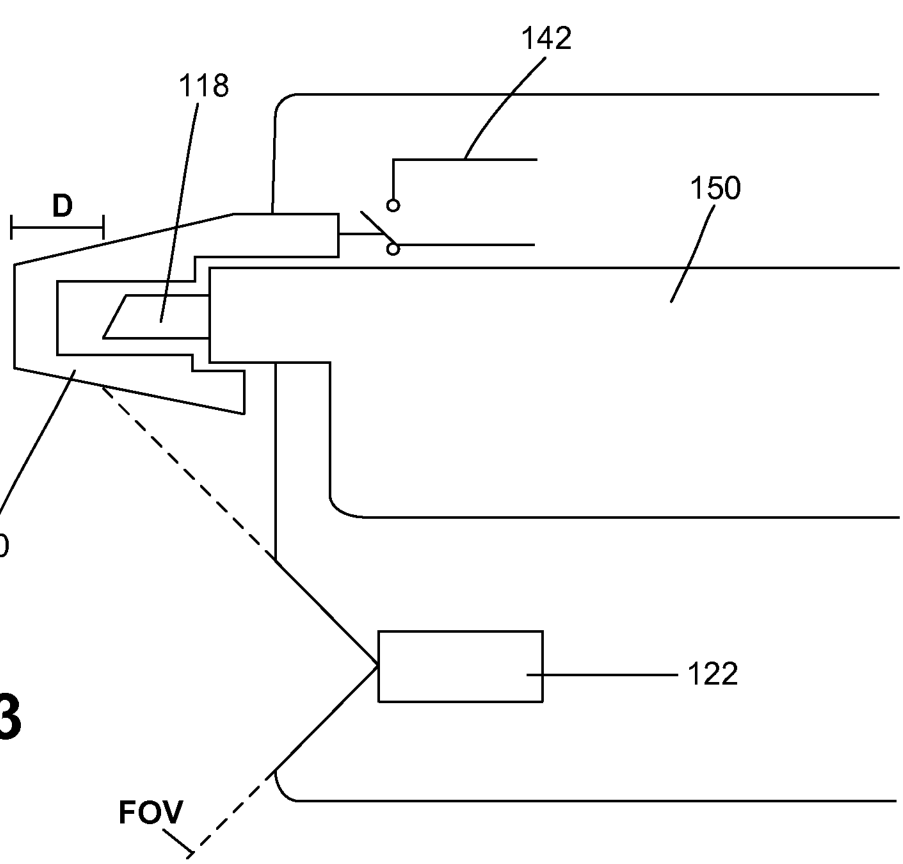
100
142
118
150
D
140
122
FOV

Fig. 3

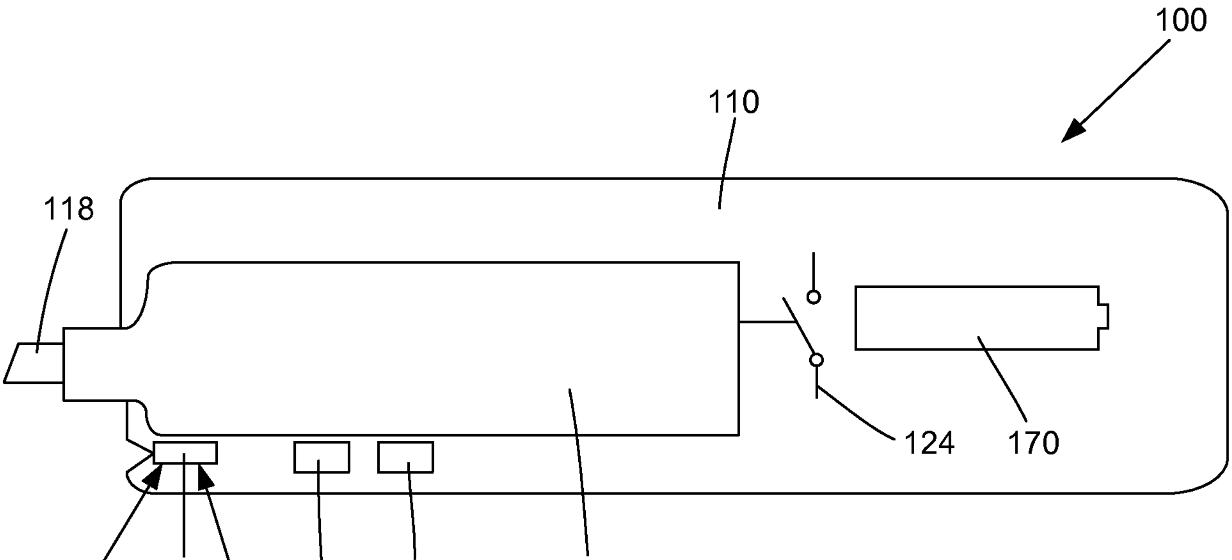
100
110
118
124
170
120
122
190
192
194
160
165
150

Fig. 4A

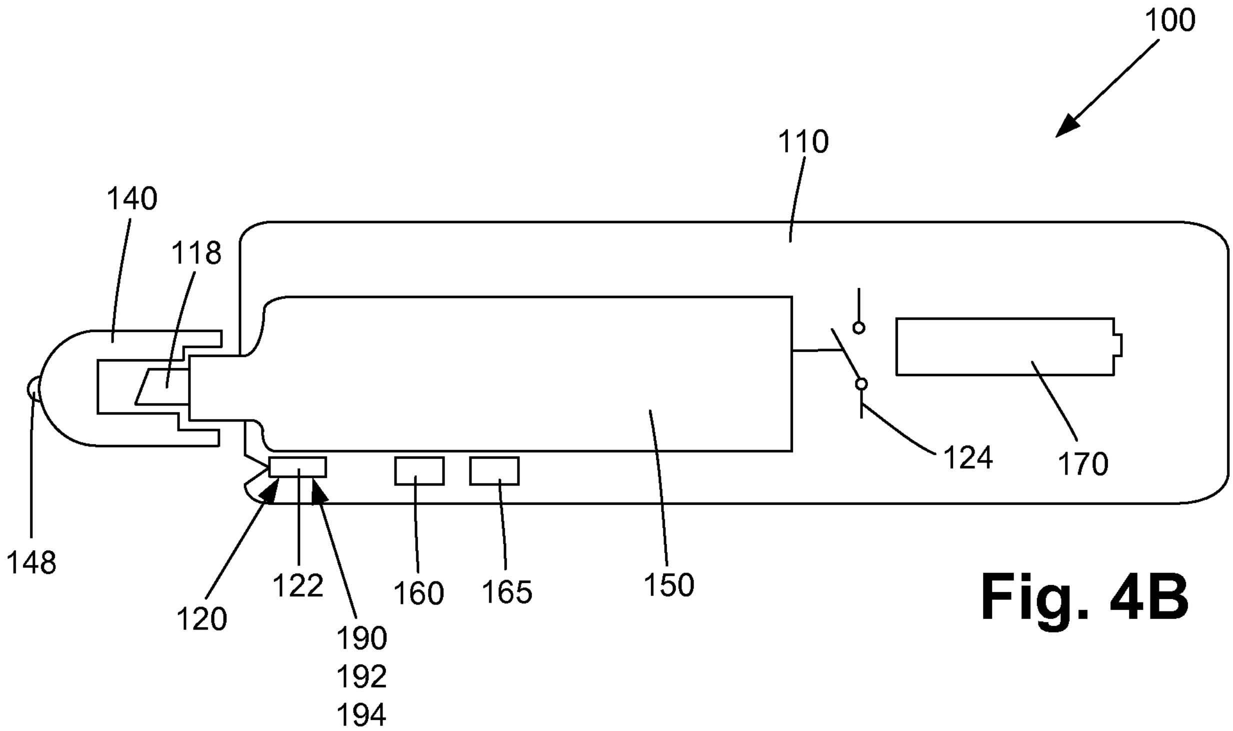
100
110
140
118
124
170
148
122
160
165
150
120
190
192
194

Fig. 4B

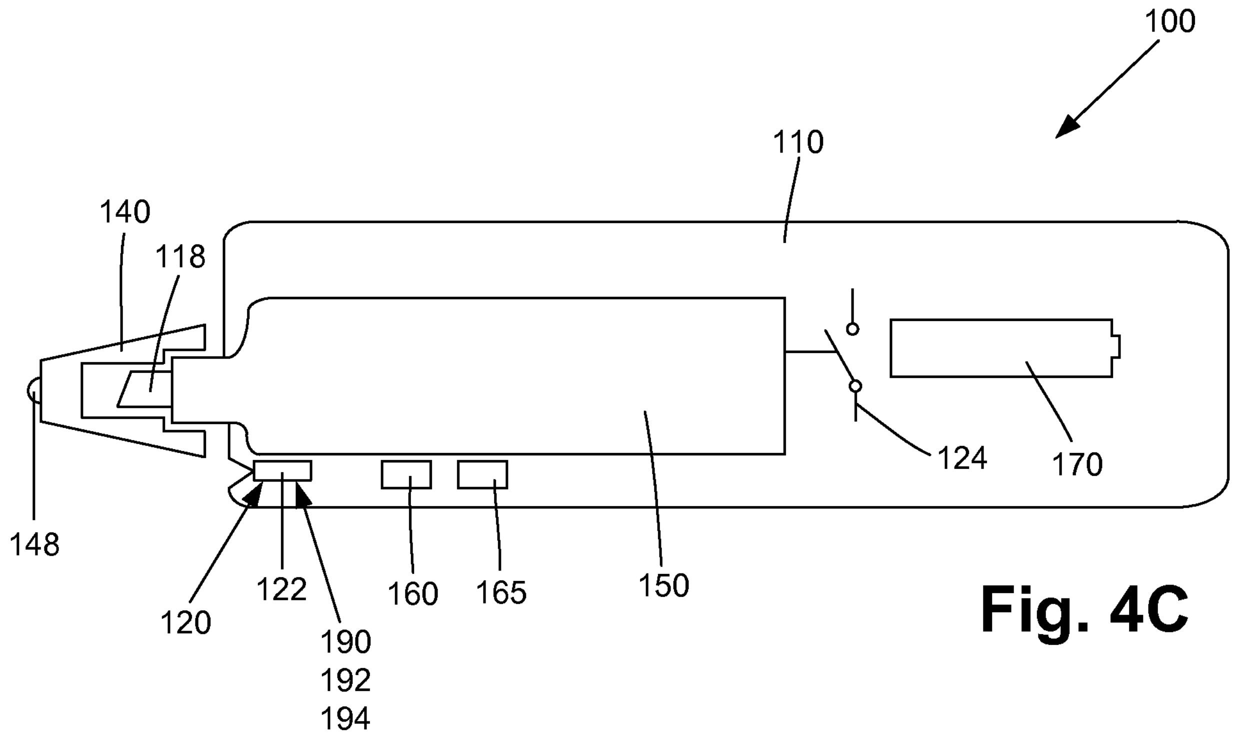
100
110
140
118
124
170
148
122
160
165
150
120
190
192
194

Fig. 4C

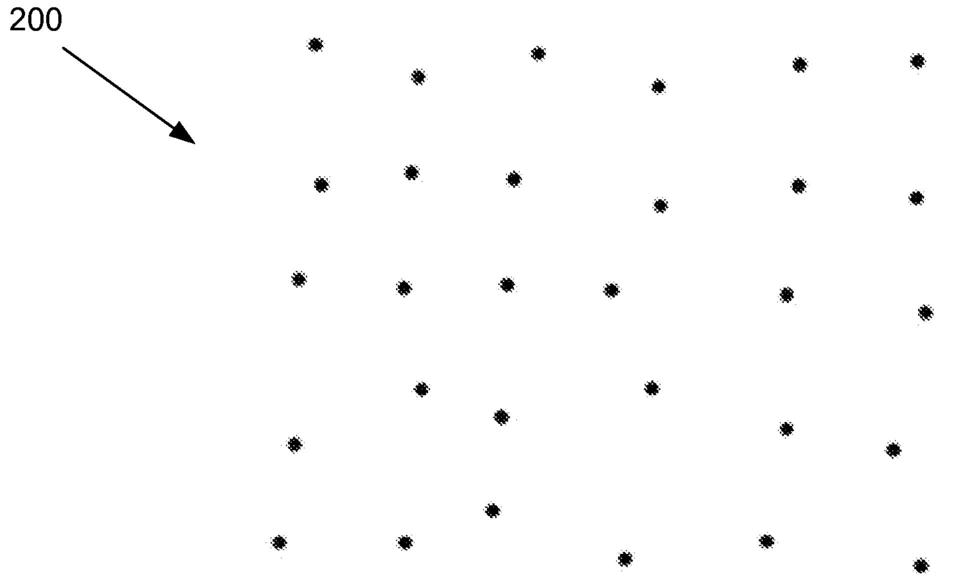

Fig. 5A

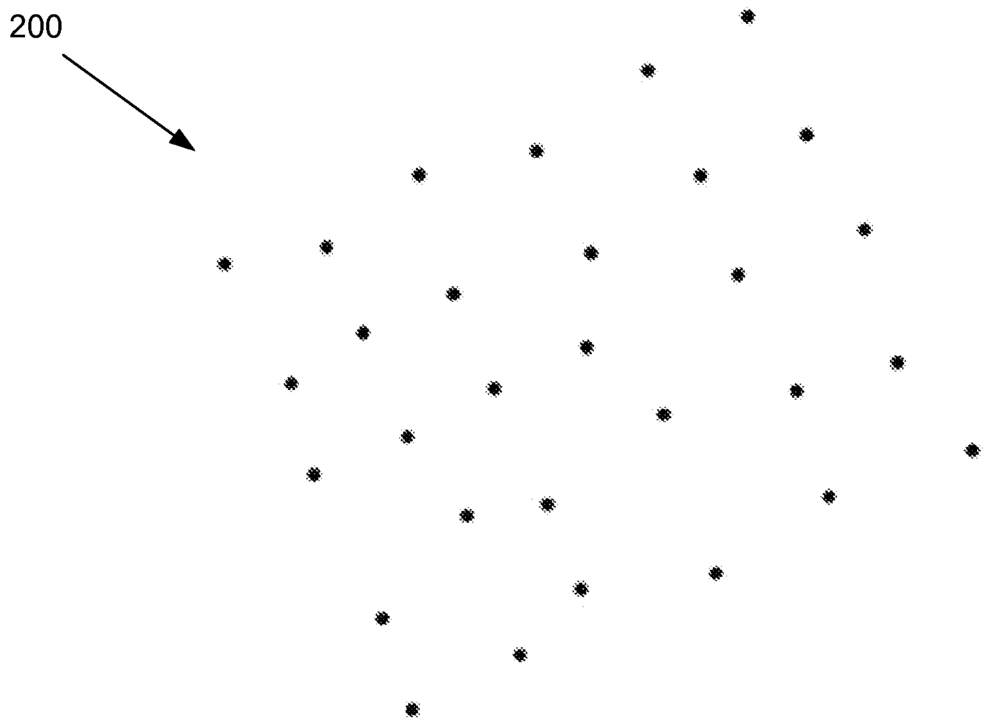

Fig. 5B

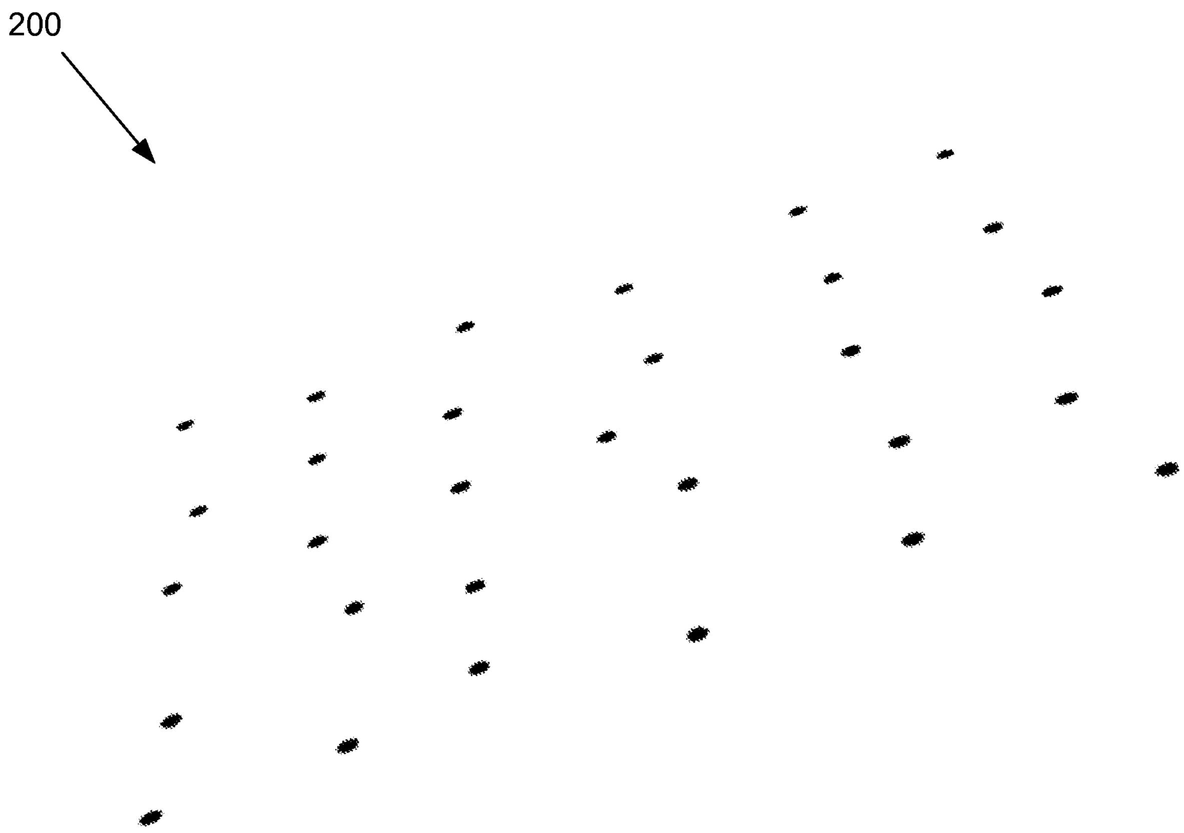

Fig. 5C

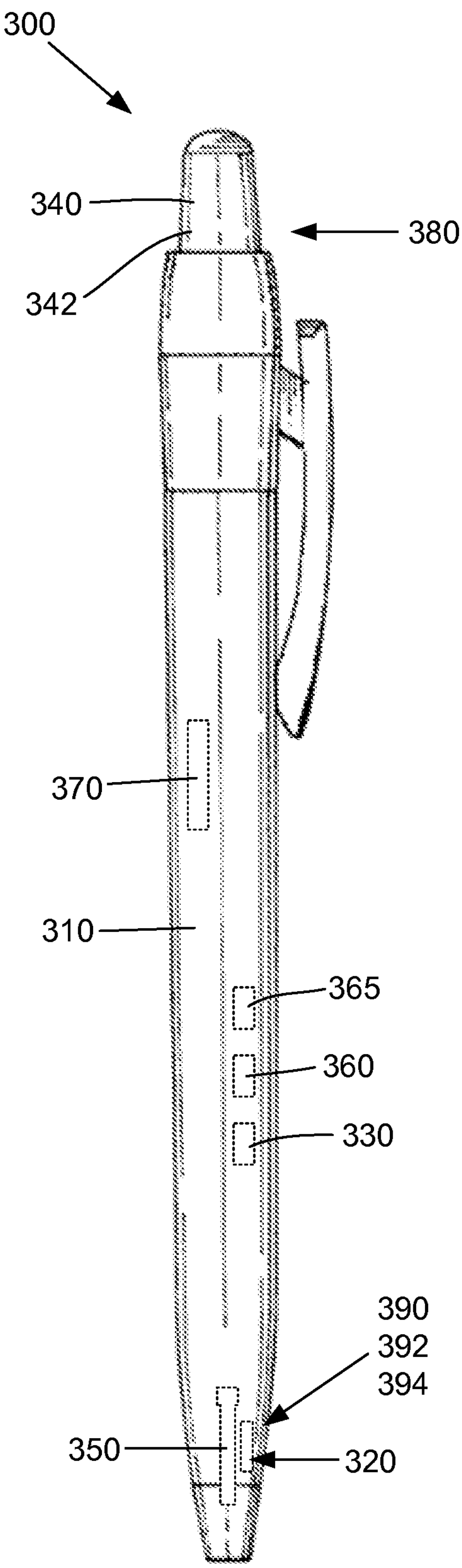
300
340
342
380
370
310
365
360
330
390
392
394
350
320

Fig. 6A

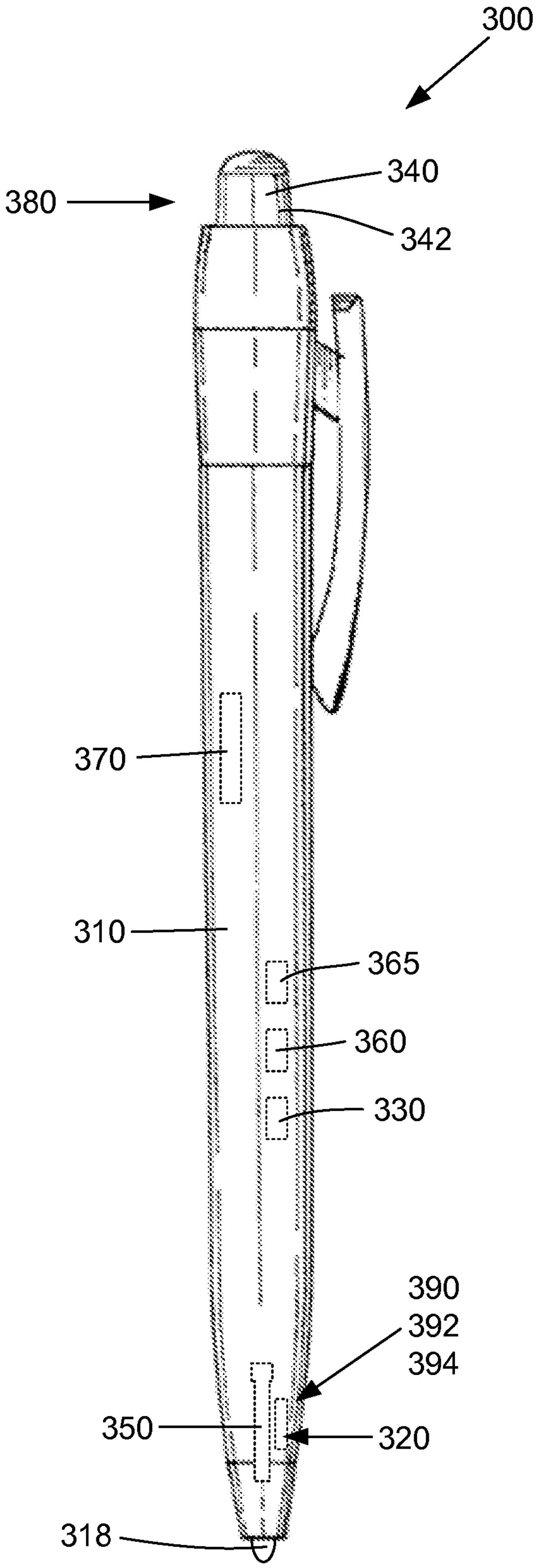
300
380
340
342
370
310
365
360
330
390
392
394
350
320
318

Fig. 6B

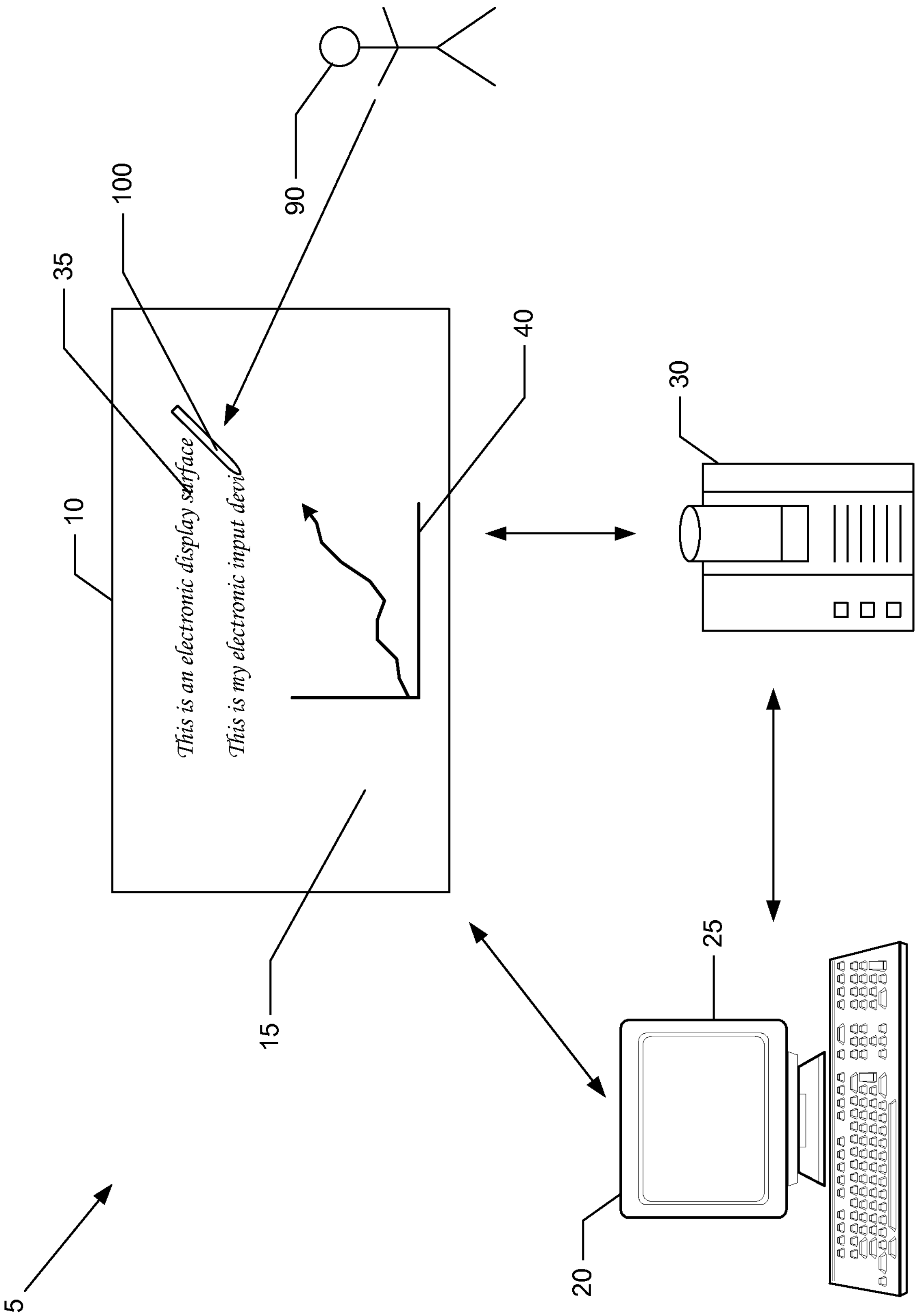
5
10
15
20
25
30
35
40
90
100
This is an electronic display surface
This is my electronic input devi

Fig. 7