A mobile communication device adapted to provide a dynamic display arrangement

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(54) **Title**: A MOBILE COMMUNICATION DEVICE ADAPTED TO PROVIDE A DYNAMIC DISPLAY ARRANGEMENT

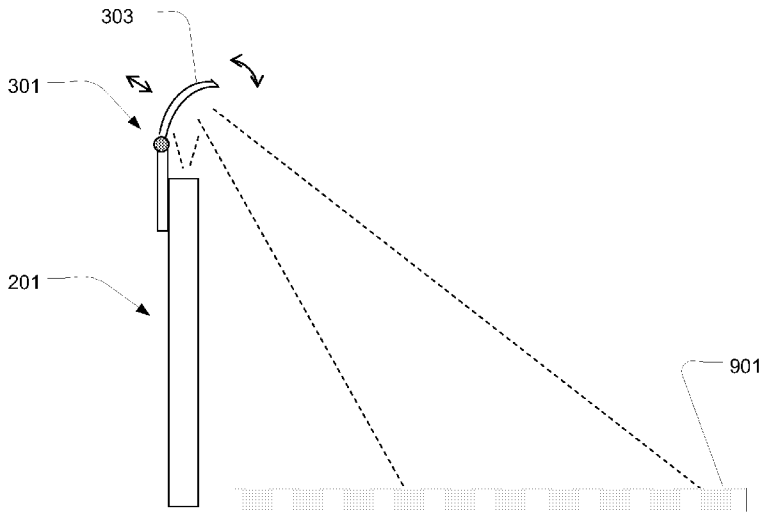

Fig. 9

(57) **Abstract**: The invention relates to a mobile communication device comprising a light projector adapted to project a multi-coloured image onto a surface; a hinged mirror comprising a first mirror part adapted to be tilted around the hinge into the light path of the light projector; wherein the first mirror part comprises means for correcting a skew angle in the multi-coloured image projected onto a surface. Thereby is achieved that the mobile communication device is able to provide RGB full colour dynamic image projection which is preferred over monochromatic laser projection because it is a speckle free and eye-friendly projection.

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A mobile communication device adapted to provide a dynamic display arrangement

The invention relates to a mobile communication device configured to provide a dynamic display arrangement. The invention further relates to a corresponding system.

There is today a large demand on dynamic display keyboards in which the symbols (i.e. e.g. characters, labels, etc.) of the keys of the keyboard may be dynamically changed such as for example one day to provide a set of Cyrillic characters and the next day a set of Chinese characters.

A problem of the existing dynamic display keyboards is their lack of colour display and/or tactile feedback.

It is an object of the present invention to, among other things, solve the abovementioned problem. The abovementioned problem is solved by a mobile communication device comprising a light projector comprising a first light projector, the first light projector being configured to project a first multi-coloured image onto a first surface; and a hinged mirror comprising a first mirror part configured to be tilted around the hinge into the light path of the first light projector, wherein the first mirror part is configured for correcting a skew angle in the first multi-coloured image projected onto the first surface. The first mirror part may comprise a flexible first mirror part which may be bent such as to correct a skew angle in the first multi-coloured image projected onto the first surface.

The above-mentioned problem is furthermore solved by a system comprising a mobile communication device as described above and a second device comprising a plurality of diffuse reflecting parts onto which the mobile communication device is configured to project the first multi-coloured image

via the first mirror part when the first mirror part is tilted into the light path of the first light projector.

An advantage of the present invention is that it provides RGB full colour dynamic image projection, which is preferred over monochromatic laser projection because it is a speckle free and eye-friendly projection.

A further advantage of the present invention is that it provides full-field colour image projection, e.g. each projected element (i.e. e.g. a symbol) can be a dynamic colour image projection, as compared to monochromatic laser contour-line projection.

In an embodiment, the projected element may be projected onto a flat reflecting surface. Alternatively, the projected element may be projected onto a mechanical device comprising a plurality of reflecting surfaces such as a keyboard with reflecting surfaces on the keys, which keyboard and/or keys may be without pre-printed characters.

An example of a projected element is a key-value of a keyboard or a gaming piece of a game such as a chess piece.

In an embodiment, the projected element may be projected onto a gaming surface such as a chessboard or a backgammon board or the like wherein the gaming surface comprises a reflecting surface for reflecting the projected element.

In an embodiment, the gaming surface may be included in the projection.

Other embodiments and advantages are provided below in the detailed description, in the claims and in the drawings.

Brief description of the drawings

Figure 1 a) illustrates an embodiment of a system comprising a keyboard and a projector.

Figure 1 b) illustrates an embodiment of a circular cross-sectional form along the X-X axis illustrated on Fig. 1 of a dome element.

Figure 1 c) illustrates an embodiment of a square cross-sectional form along the X-X axis illustrated on Fig. 1 of a dome element.

Figure 2 a) illustrates an embodiment of a mobile communication device comprising a smart phone and comprising a light projector.

Figure 2 b) illustrates a top view of a mobile communication device comprising a light projector.

Figure 3 a) illustrates a front view of a smart phone comprising a hinged mirror.

Figure 3 b) illustrates a rear view of a smart phone comprising a hinged mirror.

Figure 3 c) illustrates a side view of a smart phone comprising a hinged mirror in a slid-in state.

Figure 3 d) illustrates a side view of a smart phone comprising a hinged mirror in a slid-out state.

Figure 4 illustrates an embodiment of a keyboard comprising a first layer in which the key elements are included.

Figure 5 illustrates an embodiment in which a key element of the keyboard is in a depressed state.

Figure 6 a) illustrates a system comprising a mobile communication device comprising a light projector and further comprising a device comprising a docking bay.

Figure 6 b) illustrates a system comprising a mobile communication device comprising a light projector and further comprising a device comprising a docking bay, wherein the mobile communication device is docked in the docking bay.

Figure 7 a) illustrates a front view of a smart phone in which the top of the smart phone comprises a pico-projector.

Figure 7 b) illustrates a side view of a smart phone in which a mirror redirects the light from the pico-projector.

Figure 7 c) illustrates a rear view of a smart phone comprising a switch for switching the mirror in and out of the pico-projector light projection.

Figure 8 a) illustrates the effect of skew angles which may occur when projecting a dynamic RGB colour image from a pico-projector onto the surface in front of the smart phone using a mirror.

Figure 8 b) illustrates projection of a dynamic RGB colour image from a pico-projector onto the surface in front of the smart phone using a mirror for correcting skew angle.

Figure 9 illustrates an embodiment of a smart phone comprising a hinged mirror with a flexible and bendable first mirror part.

Figure 10 illustrates an embodiment of a smart phone comprising a hinged mirror with a thin phase shifting or lensing material coating included in the first mirror part.

Figure 11 illustrates a perspective view of an embodiment of a mobile communication device.

Figure 12 illustrates a side view of the embodiment of figure 11.

Figure 13 illustrates a front view of the embodiment of figure 11.

Figure 14 illustrates a top view of the embodiment of figure 11.

Figure 15 illustrates a side view of an embodiment of a mobile communication device.

Figure 16 illustrates a front view of the embodiment of figure 15.

Figure 17 illustrates a top view of the embodiment of figure 15.

Detailed description of the invention

Figure 1 a) illustrates a system 100 according to an embodiment. The system 100 comprises a keyboard 197 (a second device) and a key-value generating unit 196

The keyboard comprises a plurality of key elements 101. In an embodiment, each of the key elements 101 comprises a reflecting part 102 capable of reflecting at least a part of light incident on the reflecting part 102. In yet an alternative embodiment, a part (e.g. 50 % of the key elements 101) of the key elements 101 comprises a reflecting part 102.

In embodiments where at least a part of the key elements 101 comprises respective reflecting parts, the reflecting part 102 may comprise a diffuse reflecting layer. In the above and below, a diffuse-reflecting layer may be a reflecting layer for reflecting and/or scattering electromagnetic radiation in all directions (i.e. e.g. substantially in all possible directions). Diffuse reflection may be a reflection of light from a surface such that an incident ray is reflected at many angles rather than at just one angle as in the case of specular (i.e. mirror-like) reflection. In an embodiment, the reflected electromagnetic radiation is visible to a human being i.e. the wavelength range may be within approximately 380 nm (violet light) to approximately 750 nm (red light).

The reflecting parts 102 may be positioned at the top of the key elements 101 as indicated in figure 1 a). The reflecting parts 102 may be fixedly connected to the key element 101 via glue, vulcanization, or the like.

The keyboard 197 (the second device) may further comprise a mat 105 that may be made of and/or may comprise an elastic and flexible material such as rubber. The rubber mat 105 may comprise a plurality of elevated elements such as dome elements 106, 107, 109 capable of providing a tactile feedback. The dome elements 106, 107, 109 may be made in the same material as the mat 105. The mat 105 comprising the dome elements 106, 107, 109 may in one embodiment be cast in one piece. The dome elements 106, 107, 109 may be open in both ends 117, 118 and hollow such as to enable passage of light.

Each key element 101 may be fixedly coupled to at least one dome element 106. As seen in figure 1 a), key element 101 is fixedly coupled to one dome element 107, and key element 108 is fixedly coupled to two dome elements 106 and 109. The number of dome elements 106, 107, 109 fixedly coupled to

a key element 101, 108 may depend on the size of the key element such that a large key (e.g. a space key) may be connected to a plurality of dome elements and a small key (e.g. a character key) may be connected to a single dome element.

In a computer keyboard, for example, a SHIFT key may be fixedly coupled to two dome elements, an alpha-numeric key may be fixedly coupled to one dome element, and the spacebar may be fixedly coupled to four dome elements.

The term fixedly coupled are to be understood as the key element may be resting on the dome element and/or it may be glued or vulcanized to the dome element and/or welded to the dome element.

In an embodiment, the dome elements 106, 107, 109 provide control of the dimensions in which the key elements 101, 108 may move in. The dome elements 106, 107, 109 may in an embodiment restrict the direction in which the key elements 101, 108 may move. In an embodiment, the direction in which the key elements may move, may be the direction 110 perpendicular to the rubber mat 105 or substantially perpendicular to the rubber mat 105, e.g. 90 degrees +/- 5 degrees.

In order to deform the dome element, an external force provided by a user 103 pressing the associated key element is required. The dome elements may be made of and/or may comprise a soft plastic or rubber or any other material capable of deforming substantially along the direction of movement 110 when an external force having a component in the direction of movement 110 is applied to the key element 101.

In an embodiment, the dome element 106 may be constructed such that it requires a threshold force in the direction of movement 110 before deforming

the dome element. This provides a tactile response to a user applying a force to the key element 101 and enables the dome element to sustain the weight of the key element 101 without any substantial deformation in the direction of movement 110 of the key element when an external force is not applied. Thereby, the dome element 106, 107, 109 is able to provide a tactile feedback in response to a user action e.g. a user pressing the key element.

The key element 101 may be made of and/or may comprise a material harder than the dome element. For example, the key element 101 may be made of and/or may comprise melamine resin.

Additionally, the keyboard 197 (the second device) may be communicatively coupled to the key-value generating unit 196 via a communication link 193. In an embodiment, the communication link 193 is established via a short-range radio transmitter/receiver included in the keyboard and the key-value generating unit 196. The communication link 193 may be established between a Bluetooth 195 transmitter and receiver in the keyboard 197 and a similar transmitter and receiver 194 in the key-value generating unit 196. In an embodiment, the communicatively coupling comprises a data-cable, such as a USB cable or the like, providing connection between the keyboard 197 and the key-value generating unit 196.

Figure 1 b) illustrates a circular cross-sectional view along the X-X axis of a dome element 106, 107, 109.

Figure 1 c) illustrates a square cross-sectional view along the X-X axis of a dome element 106, 107, 109.

The dome element 106, 107, 109 may be open in both ends i.e. the end 117 facing the key element 101, 108 and the end 118 facing (or at) the rubber mat 105.

In an embodiment, the keyboard 197 may additionally comprise a printed circuit board (PCB) 115 comprising a plurality of pads 119 for determining whether a key element 101, 108 has been pressed.

Each pad 119 comprises a first and a second pad part, where the first pad part is electrically isolated from the second pad part. When a key element 101 is depressed, a conductive element 120 (fixedly connected to the mat 105 in proximity to the key element 101) is brought into contact with the first and second pad parts thereby short circuiting the first and second pad parts of at least one pad 119. This enables detection of the depressed key element 101.

As seen in figure 1 a), the elastic and flexible mat 105 may be positioned between the PCB 115 and the plurality of key elements 101, 108. Thus, the PCB 115 may be placed below the flexible mat 105, e.g. during normal operation of the keyboard, i.e. in a situation where the keyboard is situated on a horizontal surface with the key elements facing upwards for operation by a user.

The PCB circuit may be communicatively coupled to the short-range radio transmitter/receiver 195 via a wireless and/or wired communication link such as Bluetooth or cable. The value of a detected depressed key element 101 may be transmitted from the PCB circuit to the processing unit 1001 for further processing.

The key-value generating unit 196 comprises a short-range radio transmitter/receiver 194 as disclosed above.

Additionally, the key-value generating unit 196 may comprise a light projecting unit 192. The light projector 192 (i.e. the first light projector) is

adapted to project a key-value (e.g. an alpha-numeric value) onto at least one of the key elements 101 of the keyboard 197. The light projector 192 may for example provide the key-values of all the key elements 101 of the keyboard 197 by projecting the key-values onto the key-elements.

In an embodiment, the key-value generating unit 196 may comprise a mobile communication device, such as a mobile telephone, wherein the light projector comprised in the mobile communication device comprises a dynamic RGB colour image projector.

In an embodiment, the key-value generating unit 196 may comprise a processing unit 1001. The processing unit 1001 may be communicatively coupled to the short-range radio transmitter/receiver 194 via a wire. The processing unit 1001 may thus receive data about which key elements have been depressed.

Additionally or alternatively, the processing unit 1001 may be communicatively coupled to the light projector 192 via a wire to thereby determine which characters are to be displayed on which key elements 101 by the light projector 192. The processing unit 1001 may provide a plurality of control signals to the light projector 192 to control the key-values transmitted to the respective key elements 101.

Thereby, the key-value generating unit 196 controls the alpha-numeric value displayed on each key element 101 and the processing unit 1001 may keep track of which alpha-numeric value is associated with which key element 101. In so doing, the processing unit 1001 may keep track of the key elements that are depressed together with the alpha-numeric value represented by the key element 101 at the time of depression.

In an embodiment, the key-value generating unit 196 comprises a power-providing unit such as a connection to a power grid and/or a battery.

In an embodiment, the keyboard comprises a power-providing unit such as a connection to a power grid and/or a battery.

In the embodiment of figure 1 a) in which the key elements 101 comprises a reflecting part 102, the key-value generating unit 196 may (e.g. during use of the keyboard) be positioned approximately perpendicular to and above the plane of the keyboard 197 i.e. at an angle of 90 degrees +/- 5 degrees and such that light from the light projector 192 of the key-value generating unit 196 may be incident on the reflecting part 102 of the key elements 101.

In an embodiment, the reflecting part 102 may comprise a diffuse-reflecting layer. In the above and below, a diffuse-reflecting layer is a reflecting layer reflecting electromagnetic radiation in all directions. Thereby, the light projector 192 may project light onto the reflecting parts 102 which reflecting parts may diffusely reflect the light incident from the light projector 192. At least a part (see dotted lines on Fig. 1 a)) of the diffusively-reflected light may be reflected towards a user 103.

In the embodiment of figure 1 a) comprising key elements 101 comprising reflecting part 102, the PCB may be cast in one piece without perforations.

Figure 4 illustrates an embodiment 400 of the keyboard 197 comprising a first layer 401 in which the key elements 101 are included.

The embodiment 400 comprises a rubber mat 105 comprising fixators 205 to which the key elements 101 may be fixated e.g. by gluing, vulcanization, welding or the like. The distance between to opposing inner sides of the fixators 205 may correspond to the size of the reflective part 102 in the

respective dimensions of the plane containing the reflective part 102. The fixators 205 may be made of and/or may comprise a hard plastic or rubber material such as to provide a stable platform on which the key element 101 may be placed.

In an embodiment, the fixators 205 are able to conduct an electric current. For example, the hard plastic or rubber may be doped with a metallic powder such as iron or the like. Alternatively or additionally, the fixators 205 may contain an electric wire providing an electrically closed loop.

The keyboard may comprise a detection unit 111 which as disclosed above may be a PCB. Alternatively or additionally, the detection unit 111 may be a capacitive detection unit comprising openings 299 defined by an electrically insulating layer 206, such as a plastic or rubber, deposited on the detection unit 111 comprising fields corresponding to the fixators 205 of the respective key elements 101. Thereby, when a key element 101 is depressed, the capacitive detection unit 111 may detect the depression due to changes in the electric field corresponding to the opening 299 of the respective depressed key element 101.

Thereby, the keyboard of figure 4 may be used in connection with capacitive detection of which key elements have been depressed. This may be an alternative to the PCB detection or an additional key element depression detection method.

The first layer 401 may comprise a collar/ridge 402. The collar/ridge 402 may be made of and/or may comprise an elastic and flexible material such as rubber. Additionally, the first layer 401 may comprise a rigid part 404 made of and/or comprising a hard and non-flexible plastic.

Between the rigid part 404 and the mat 105 (in the direction 110), supporting elements 403 may be positioned i.e. between the dome elements 201 of the mat 105 (in the direction 405). The supporting elements 403 support the first layer 401. The supporting elements 403 may be glued or vulcanized or welded to the rigid part 404 and the mat 105.

The key elements 101 may be glued or vulcanized or welded to the collar/ridge 402.

In an embodiment, the collar/ridge 402 may be made of and/or may comprise an elastic and flexible material. The material may be transparent or reflective.

Figure 5 illustrates an embodiment in which a key element 101 of the keyboard 400 is in a depressed state. In the depressed state, the dome element 201 of the depressed key element 101 and the collar/ridge 402 of the depressed key 101 are flexing to provide the tactile feedback of the key element 101.

Figure 6 a) illustrates a system 600 comprising a mobile communication device 601 such as a mobile telephone comprising a light projector 602. The system 600 comprises a device 197 (a second device) comprising a plurality of diffuse reflecting parts 101.

The device 197 (the second device) may comprise a docking bay 603 for a mobile communication device 601, such as a mobile telephone, a portable digital assistant or the like, comprising a processor. The docking bay 603 may be in the plane of the device 197 and/or may be comprised in the device 197.

In an embodiment, the device 197 comprises a keyboard as described under figure 1 a) comprising a diffuse reflecting layer in the key elements 101. The

keyboard 197 comprises the docking bay 603 into which the mobile communication device 601 may be placed. The docking bay 603 may comprise a socket such as a USB or mini-USB socket enabling communicative coupling with a mobile communication device 601 placed in the docking bay 603.

In an embodiment, the device 197 comprises a planar surface capable of reflecting incident light. The planar surface may be a plate of plastic or metal comprising a diffuse reflecting surface. A detector unit may be included in the planar surface enabling detection of which part of the planar surface that is touched by a user.

In an embodiment, the detector unit comprises an IR light source providing (e.g. during use of the keyboard) an IR plane above and parallel to the planar surface. The IR plane may be 1 mm above the planar surface. When a user touches a part of the planar surface, IR light is reflected from the IR plane and some of the reflected IR light is collected by a CMOS or CCD detector. Based on the detected light, the position of the touched part of the planar surface may be determined by a processing unit.

In an embodiment, the detector unit comprises two metallic and electrically conductive layers separated by a narrow gap and positioned on the planar surface. When an object, such as a finger, presses down on a point on the planar surface, the two metallic layers become connected at that point: the conductive layers then behave as a pair of voltage dividers with connected outputs. This causes a change in the electrical current which is registered as a touch event and sent to a controller for processing.

In an embodiment, the detector unit comprises a Surface Acoustic Wave (SAW) generator positioned in connection with the planar surface such that ultrasonic waves pass over the planar surface. When an object such as a

finger touches the planar surface, a portion of the SAW is absorbed. This change in the ultrasonic waves enables registration of the position of the touch event and this information may be sent to the controller for processing.

In an embodiment, the detector unit comprises an insulator such as glass, coated with a transparent conductor such as indium tin oxide (ITO) and positioned on the planar surface. As the human body is a conductor, a finger touching the planar surface results in a distortion of the finger's electrostatic field, measurable as a change in capacitance. Different technologies may be used to determine the location of the touch. The location can be passed to a processing unit adapted to calculate where the user's touch is positioned on the planar surface.

When placed in the docking bay 603, as illustrated in figure 6 b), the mobile communication device 601 may be communicatively coupled to the device 197 via the socket. Thereby, the mobile communication device 601 may be communicatively coupled via a data bus to the PCB of the keyboard and/or via a data bus to the IR detector of the planar surface. Thus, detection of which key elements 101 of the keyboard are depressed or which parts of the planar surface that are touched may be determined by the mobile communication device 601.

Additionally, the light projector 602 of the mobile communication device 601 may illuminate the reflecting layer 102 and thus may define the value of the key elements 101 of the keyboard 197 or the value of one or more parts of the planar surface. Thereby the light projector 602 may provide the values of the key elements 101 in keyboard 197 e.g. alpha-numeric values, or the values of the parts of the planar surface e.g. alpha-numeric values or gaming piece values or gaming board or the like.

The mobile communication device 601 may further keep track of which key elements or parts of the planar surfce are provided with which values. This may be achieved via the docking bay 603 which may be communicatively coupled to the PCB 115 of the keyboard or to the IR detector of the planar surface. When connected to the docking bay 603, the mobile communication 601 may be communicatively coupled via the docking bay 603 to the PCB 115 or the IR detector. Further, the mobile communication device 601 controls the light projector included in the mobile communication device 601. In an embodiment, the mobile communication device 601 may be communicatively coupled directly to the PCB 115 or the IR detector via the data bus. The communicative coupling may be established using Bluetooth or a data cable or the like.

The mobile communication device 601 may thus perform the role of the processing unit 1001 in figure 1 a) by controlling the light projector 602 and by detecting (i.e. e.g. at least processing a detection of) the touched value of a key element 101 or a part of the planar surface via its communicative coupling to the PCB 115 or the IR detector. Thus, the mobile communication device may control which values are associated with which key elements 101 or which parts of the planar surface. Further, the mobile communication device 601 may keep track of which key elements 101/parts of the planar surface, a user 103 depresses and thus the value represented by the key element 101/part of the planar surface at the time of depression. This may be done via the communicational link to the PCB 115 or the IR detector via the data bus.

Thereby, the mobile communication device 601 may provide the processing power of the system 600 together with the values of the key elements 101 in the keyboard 197 or the parts of the planar surface.

In an embodiment, the keyboard 197 or the planar surface may comprise a power source such as a battery pack. Thereby, the mobile communication device 601 may be recharged when placed in the docking bay 603 during which the light projector 602 may provide the values of the key elements 101 or the parts of the planar surface.

In an embodiment, a first mobile communication device 601 placed in a docking bay of a first planar surface device 197 is communicatively coupled to a second mobile communication device 601 placed in a docking bay of a second planar surface device 197 via a communication link such as Bluetooth, LAN, WAN, cable or the like. For this embodiment, the pico projector of each of the communication devices may be adapted to project a common gaming surface (e.g. a Chess board) and a first set of gaming pieces associated with the first mobile communication device and a second set of gaming pieces associated with the second mobile communication device. Thereby, a user of the first mobile communication device and a user of the second mobile communication device may play a game against each other without having to be in close proximity to each other. The first and second mobile communication devices may exchange information regarding position or other parameters of the gaming pieces via the communication link.

Figure 2 illustrates an embodiment of a mobile communication device 200 comprising a smart phone 201 as seen in figure 2 a) where the smart phone 201 is seen from the front. The smart phone 201 comprises a display 203 such as a touch sensitive display, and a number of e.g. optionally keys 204 which may be activated manually by a user e.g. by pressing a key.

The smart phone 201 comprises a pico-projector aperture 202 (a circular aperture) as seen in figure 2 b) where the smart phone is seen from the top.

The smart phone comprises a pico-projector and a built-in lens enabling the pico-projector to project out through the aperture 202.

Figure 3 illustrates the smart phone 200 of figure 2 further comprising a hinged mirror 301. The hinged mirror may 301 slide along the back side (opposite to the display 203 side of the smart phone) of the smart phone such that the hinged mirror 301 may be in a slid-out state as seen figures 3 a) and 3 d), and in a slid-in state as seen in figures 3 b) and 3 c). In an embodiment, the hinged mirror 301 may slide along a rail or the like. The hinged mirror 301 may be slid between the slid-in state and the slid-out state by a user's thumb or the like. Both in the slid-in state and in the slid-out state, the hinged mirror 301 may be clicked in place such as to prevent the hinged mirror 301 to move from its present state without the appliance of an external force such as provided by the user's thumb or the like. Thereby, the hinged mirror 301 may remain in the slid-in state or the slid-out state until a user provides a force to it.

The hinged mirror 301 may comprise a first mirror part 303, a hinge 302 and a second mirror part 304. The first mirror part 303 may be the outer part of the hinged mirror 301, i.e. the part fixedly connected to the hinge 302, and the second mirror part 304 may be the inner part of the hinged mirror 301. i.e. the part fixedly connected to the hinge 302 and the smart phone 201. The first mirror part 303 is able to rotate with respect to the hinge 302 as seen in figure 3 d) such that it may be placed at a non-parallel angle with respect to the light emitted from the pico-projector. Thereby, the first mirror part 303 of the hinged mirror 301 may be able to redirect a dynamic RGB colour image projection from the pico-projector onto a surface in front of the smart phone 200. The projected dynamic RGB colour image may be projected onto a keyboard such as disclosed with respect to figures 1, 4, or 5, or onto a planar surface such as disclosed with respect to figure 6.

As indicated by the line with double arrows in figure 3 d), the first mirror part 304 of the hinged mirror 301 may be tilted at an arbitrary angle around the hinge 302.

In an embodiment, the smart phone 201 comprises a contact 305 positioned in the sliding path of the hinged mirror 301 such that the contact is activated (depressed) when the hinged mirror 301 is in its slid-in state as indicated in figure 3 c) and un-activated (un-pressed) when the hinged mirror 301 is in its slid-out state as indicated in figure 3 d). When the contact 305 is un-activated i.e. when the hinged mirror 301 is in its slid-out state, then the pico-projector of the smart phone 201 automatically switches on such that a dynamic RGB colour image is projected onto the surface in front of the smart phone 201.

When the contact 305 is activated, then the pico-projector may be switched off or its on/off state may be controlled by e.g. the user or a program or the like.

Figure 7 a) illustrates a front view of the smart phone 201 in which the top of the smart phone 201 comprises a pico-projector as also seen in figure 2 b). Figure 7 c) illustrates the back (the side opposite of the display) of the smart phone which comprises a mechanical switch for redirecting the dynamic RGB colour image projection emitted by the pico-projector. When the switch is in a first position e.g. position A, then the smart phone may project a dynamic RGB colour image out from the top of the smart phone as seen in figure 7 a). When the switch is in a second position e.g. position B, a mirror may be slid in front of the aperture 202 of the smart phone 201 such that the dynamic RGB colour image may be projected onto a surface in front of the smart phone 201 as seen in figure 7 b).

Figure 8 a) illustrates the effect of skew angles 801 which may occur when projecting the dynamic RGB colour image from the pico-projector onto the

surface in front of the smart phone 201 using a mirror 301. Projected light on the surface is indicated with dotted lines. The smart phone 201 is seen from the top as e.g. illustrated in figure 2 b). The surface may be perpendicular to the display plane of the smart phone.

Figure 9 illustrates an embodiment of a smart phone 201 comprising a hinged mirror 301. In this embodiment, the first mirror part 303 of the hinged mirror 301 is made of and/or may comprise a flexible material, such as mirror-coated flexible polymer material, which may be bent. Thereby, the first mirror part 303 may be bent e.g. by the user in order to correct the skew angle 801 and thereby to produce an un-skewed projection 802 on the surface 901 (i.e. the first surface). In the embodiment, the projected light is indicated by dashed lines.

Figure 10 illustrates an embodiment of a smart phone 201 comprising a hinged mirror 301. In this embodiment, the first mirror part 303 of the hinged mirror 301 comprises a thin phase shifting or lensing material coating 1011 such that the first mirror part 303 may correct for the skew angles that is encountered when projecting the dynamic RGB colour image from the pico-projector onto the surface 901. The thickness of the phase shifting coating may be less than 1 mm. The projected light is indicated with dashed lines.

In an embodiment, the phase shifting or lensing material coating 1011 may be implemented as one or more of the following: a thin phase shifting transmission material superposed the first part mirror 303; tiny mechanical deformations of the first mirror part 303 e.g. by electrical induced stress in the first mirror part by an electrode; a meta-material designed for broadband illumination; a sub-wavelength processed first mirror part 303 surface, and/or a computer-generated diffractive structure.

In an embodiment, the first mirror part 303 may be made of and/or may comprise a flexible material which may be bent and it may comprise a thin phase shifting or lensing material coating 1011. Thereby, the thin phase shifting or lensing material coating 1011 may correct for skew angles and if required, a user may fine tune the correction by bending the first mirror part 303.

Figure 8 b) illustrates projection of a dynamic RGB colour image from the pico-projector onto the surface 901 in front of the smart phone 201 using a hinged mirror 301 comprising a first mirror part 303 correcting the skew angle 801 (see Fig. 8 a)) thereby resulting in an un-skewed projection.

Figs. 15 - 17 illustrate a side view, a front view, and a top view, respectively, of an embodiment 501 of a mobile communication device. The embodiment 501 is similar to the embodiments 201 of Figs. 2 and 3. Thus, the same reference numbers are assigned to similar or identical parts.

The mobile communication device 501 illustrated in Figs. 15 - 17 comprises a light projector and a hinged mirror 301. The light projector comprises a first light projector. The first light projector is configured to project a first multi-coloured image onto a first surface 901. The hinged mirror 301 comprises a first mirror part 303 configured to be tilted around the hinge into the light path of the first light projector.

The first mirror part 303 may comprise a flexible first mirror part which may be bent such as to correct a skew angle in the first multi-coloured image projected onto the first surface 901.

The light projector, i.e. the first light projector, is configured to project a second multi-coloured image onto a second surface 902. The hinged mirror

comprises a secondary mirror part 306 configured to be tilted around the hinge into the light path of the first light projector.

The secondary mirror part 306 may comprise a flexible secondary mirror part which may be bent such as to correct the skew angle in the second multi-coloured image.

Figure 11 illustrates a perspective view of an embodiment 701 of a mobile communication device. In Figs. 12 - 14, a side view, a front view and a top view of the embodiment of figure 11 are respectively illustrated. The embodiment 701 is similar to the embodiments of Figs. 2 and 3 as well as to the embodiment 501 of Figs. 15 - 17. Thus, the same reference numbers are assigned to similar or identical parts.

The mobile communication device 701 illustrated in Figs. 11 - 14 comprises a light projector and a hinged mirror 301. The light projector comprises a first light projector. The first light projector is configured to project a first multi-coloured image onto a first surface 901. The hinged mirror 301 comprises a first mirror part 303 configured to be tilted around the hinge into the light path of the first light projector.

The first mirror part 303 may comprise a flexible first mirror part which may be bent such as to correct a skew angle in the first multi-coloured image projected onto the first surface 901.

The hinged mirror comprises a secondary mirror part 306 configured to be tilted around the hinge into the light path of the light projector. The light projector includes a second light projector 307 configured to project the second multi-coloured image onto the second surface 902 via the secondary mirror part 306.

The secondary mirror part 306 may comprise a flexible secondary mirror part which may be bent such as to correct the skew angle in the second multi-coloured image.

The embodiment 701 comprises a second pico-projector aperture 307 (a circular aperture), a second pico-projector and a built-in lens enabling the pico-projector to project out through the aperture 307.

In Fig. 11 sliding means (provided by edges of the second mirror part 304, which edges engages a part of the mobile communication device 701) enabling the hinged mirror 301 to slide along a side of the mobile communication device 701 from a first position in which the first mirror part 303 may be tilted into the light path of the first light projector to a second position in which the hinged mirror is positioned along a side of the mobile communication device 701 is illustrated.

In Fig. 11, circular arrows indicate possible rotations and the straight arrow indicates possible translation.

For any of the embodiments illustrated in Figs. 11 - 14 and Figs. 15 - 17, respectively, a device is provided that may enable projection of labels of a keyboard on the first surface 901 and projection of a screen on the second surface 902. The first surface 901 may be an input device, such as a keyboard disclosed in Figs. 4 - 5.

In any of the above embodiments, the light projector may be a pico projector e.g. a handheld projector. In an embodiment, the pico projector may be included in a portable device such as mobile telephone, a PDA or the like.

Although some embodiments have been described and illustrated in detail, the invention is not restricted to them, but may also be embodied in other

ways within the scope of the subject matter defined in the following claims. In particular, it is to be understood that other embodiments may be utilised and structural and functional modifications may be made without departing from the scope of the present invention.

In device claims enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims or described in different embodiments does not indicate that a combination of these measures cannot be used to advantage.

It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

Items

1. A mobile communication device comprising
   - a light projector 602 adapted to project a multi-coloured image onto a surface;a hinged mirror 301 comprising a first mirror part 303 adapted to be tilted around the hinge into the light path of the light projector;
   - wherein the first mirror part 303 comprises means for correcting a skew angle in the multi-coloured image projected onto a surface.

2. A mobile communication device according to item 1, wherein the means for correcting a skew angle comprises a flexible first mirror part 303 which may be bent such as to correct the skew angle.

3. A mobile communication device according to item 1 or 2, wherein the means for correcting a skew angle comprises a phase shifting material coating 1011 included in the first mirror part 303.

4. A mobile communication device according to any of the preceding items, the mobile communication device further comprises sliding means enabling the hinged mirror 301 to slide along a side of the mobile communication device from a first position in which first mirror part may be tilted into the light path to a second position in which the hinged mirror is positioned along a side of the mobile communication device.

5. A mobile communication device according to item 4, wherein the mobile communication device further comprises a contact controlling the light projector and activated when the hinged mirror is in the first position such that the light projector is activated.

6. A system comprising a mobile communication device comprising a light projector 602 adapted to project a multi-coloured image onto a surface; a hinged mirror 301 comprising a first mirror part 303 adapted to be tilted around the hinge into the light path of the light projector; wherein the first mirror part 303 comprises means for correcting a skew angle in the multi-coloured image projected onto a surface; wherein the system further comprises a device 197 comprising a plurality of diffuse reflecting parts 101 onto which the multi-coloured image is projected onto via the first mirror part 303 when the first mirror part 303 is tilted into the light path of the light projector 602.

7. A system according to item 6, wherein the device 197 further comprises a docking bay 603 into which the mobile communication device may be placed.

8. A system according to item 7, wherein the mobile communication device is communicatively coupled to the device 197 when placed in the docking bay 603.

9. A system according to item 7 or 8, wherein the device 197 further comprises a power source such that the mobile communication device is recharged when placed in the docking bay.

10. A system according to any of items 6 to 9, wherein the device 197 further comprises
    - a plurality of key elements 101, each key element 101 comprises a part 102 comprising the diffuse reflecting part capable of providing a key-value based on projected light from the light projector 192, 602;
    - a mat 105 comprising a plurality of elevated elements 106, 107, 109, 201, 202 capable of providing a tactile feedback;
    - wherein each key element 101 is fixedly connected to at least one respective elevated element 106, 107, 109, 201, 202.

11. A system according to item 10, wherein the device 197 further comprises a PCB 115 adapted to detect a depressed key element 101, and wherein the PCB 115 is communicatively coupled to a processing unit 1001 contained in the mobile communication device.

12. A system according to any of items 10 to 11, wherein the device 197 further comprises a layer 401 comprising a collar 402 for each key element 101 and wherein each key element 101 is fixedly connected to a respective collar 402.

13. A system according to item 12, wherein the system further comprises at least one supporting element 403 positioned between the layer 401 and the PCB 115.

Claims

1. A mobile communication device comprising
   - a light projector comprising a first light projector, the first light projector being configured to project a first multi-coloured image onto a first surface; and
   - a hinged mirror comprising a first mirror part configured to be tilted around the hinge into the light path of the first light projector; wherein the first mirror part comprises a flexible first mirror part which may be bent such as to correct a skew angle in the first multi-coloured image projected onto the first surface.

2. A mobile communication device according to claim 1, wherein the light projector is configured to project a second multi-coloured image onto a second surface, and wherein the hinged mirror comprises a secondary mirror part configured to be tilted around the hinge into the light path of the light projector.

3. A mobile communication device according to claim 2, wherein the secondary mirror part comprises a flexible secondary mirror part which may be bent such as to correct the skew angle in the second multi-coloured image.

4. A mobile communication device according to claim 2 or 3, wherein the light projector includes a second light projector configured to project the second multi-coloured image onto the second surface via the secondary mirror part.

5. A mobile communication device according to any of the preceding claims, wherein the first mirror part comprises a phase shifting material coating configured for correcting a skew angle in the first multi-coloured image projected onto the first surface.

6. A mobile communication device according to any of the preceding claims as dependent on claim 2, wherein the secondary mirror part comprises a phase shifting material coating configured for correcting a skew angle in the second multi-coloured image projected onto the second surface.

7. A mobile communication device according to any of the preceding claims, comprising sliding means enabling the hinged mirror to slide along a side of the mobile communication device from a first position in which the first mirror part may be tilted into the light path of the first light projector to a second position in which the hinged mirror is positioned along a side of the mobile communication device.

8. A mobile communication device according to claim 7, comprising a contact controlling the light projector, the contact being activated when the hinged mirror is in the first position such that at least the first light projector is activated.

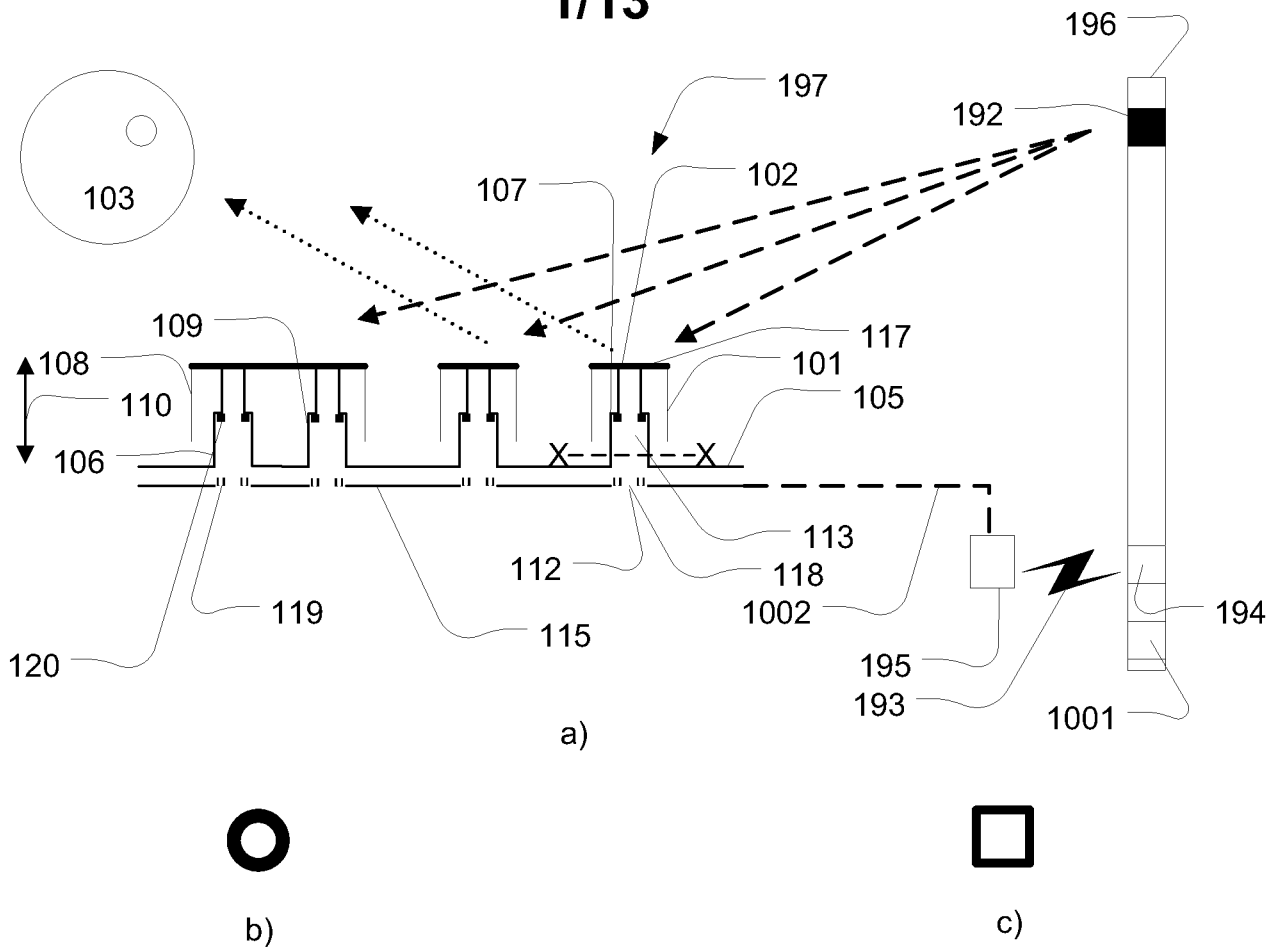

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Fig. 1

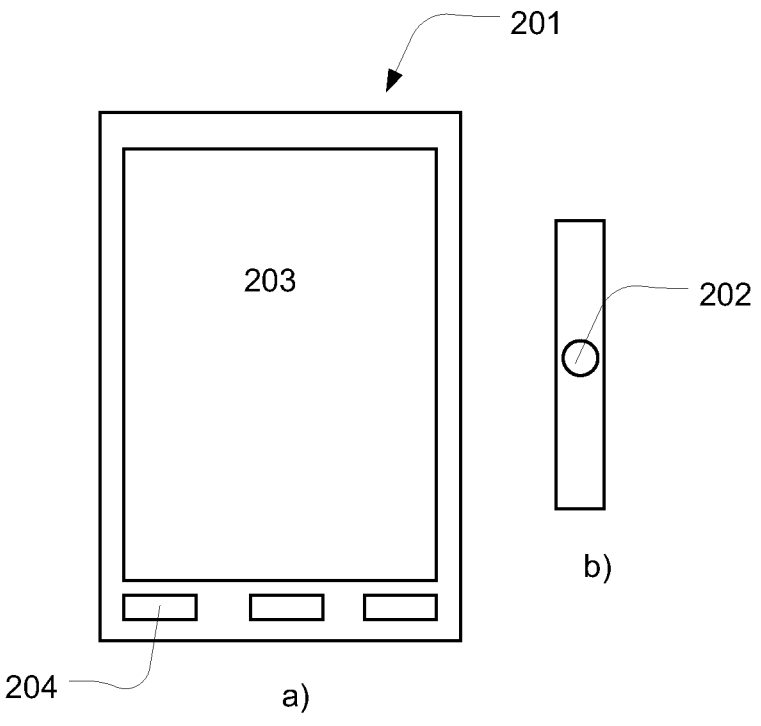

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Fig. 2

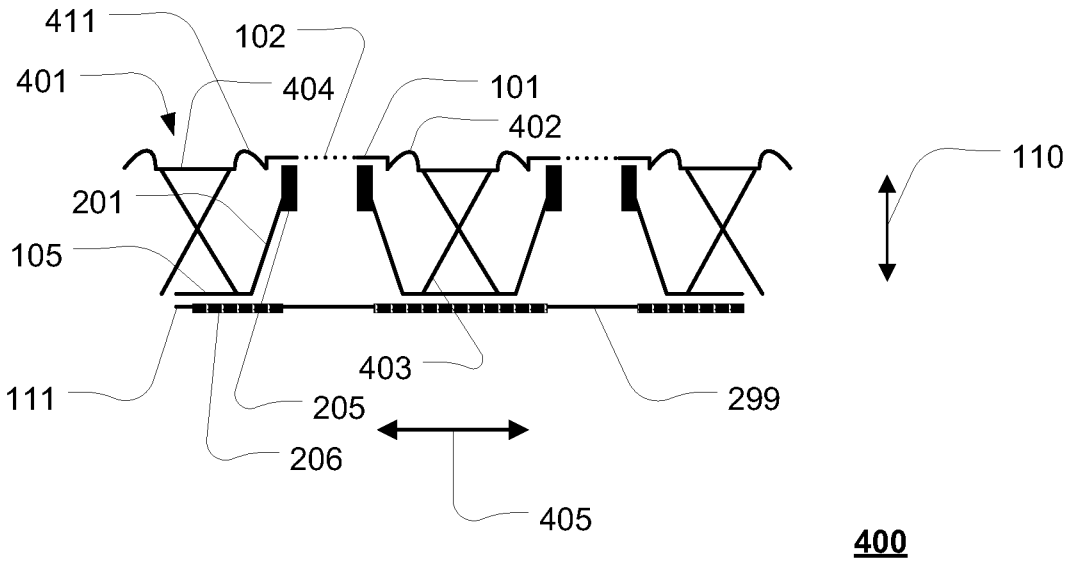
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Fig. 4

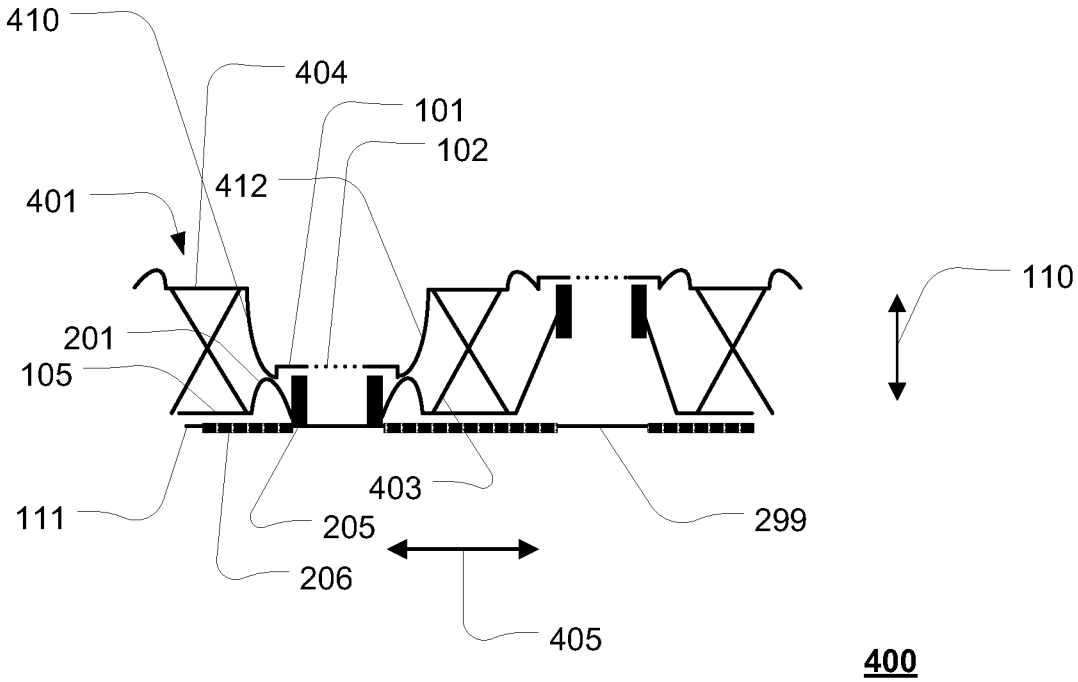
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Fig. 5

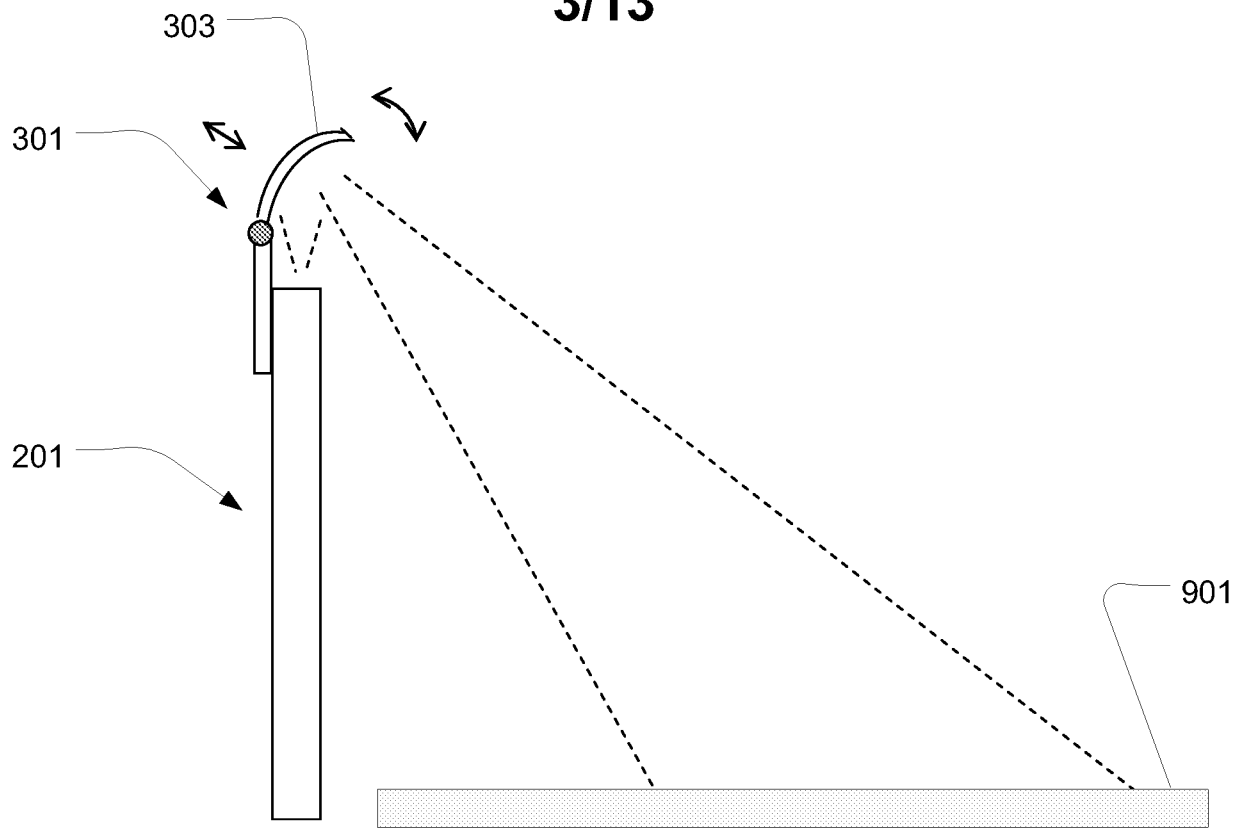

Fig. 9

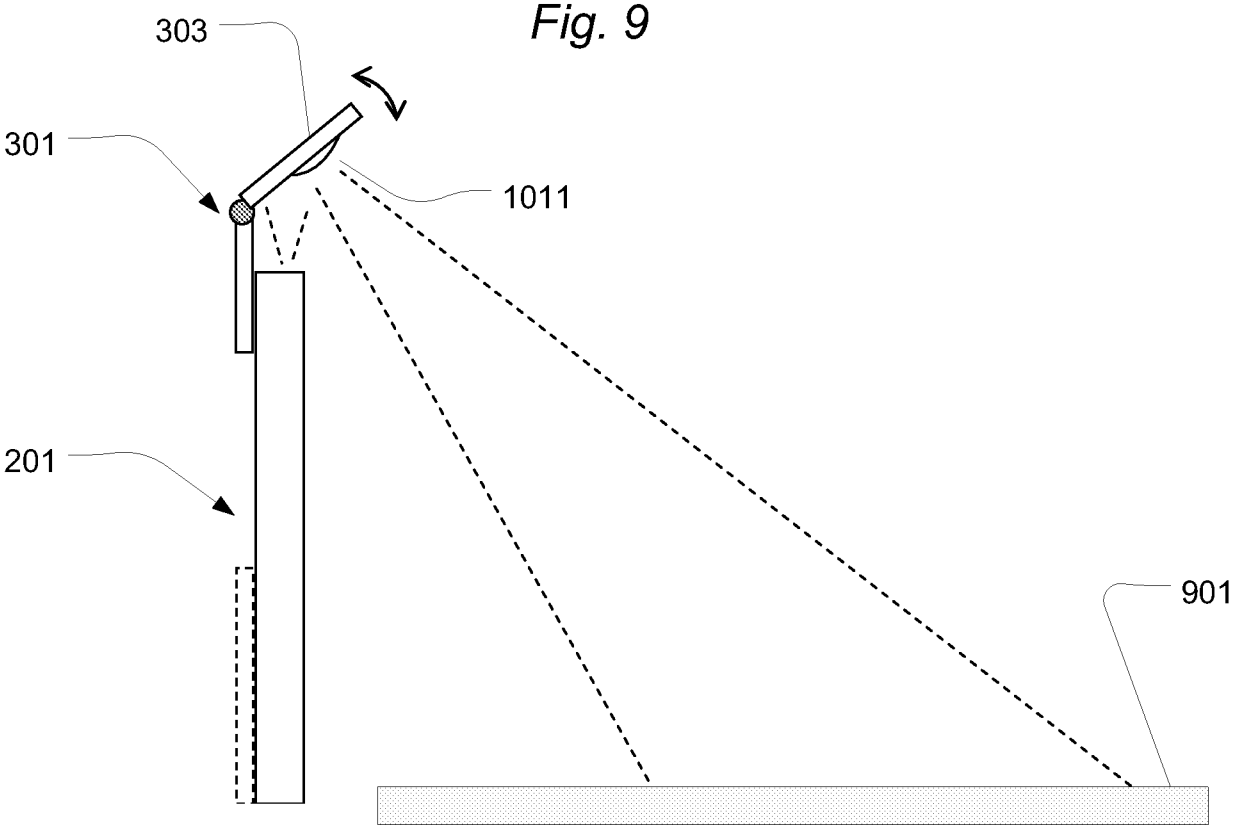

Fig. 10

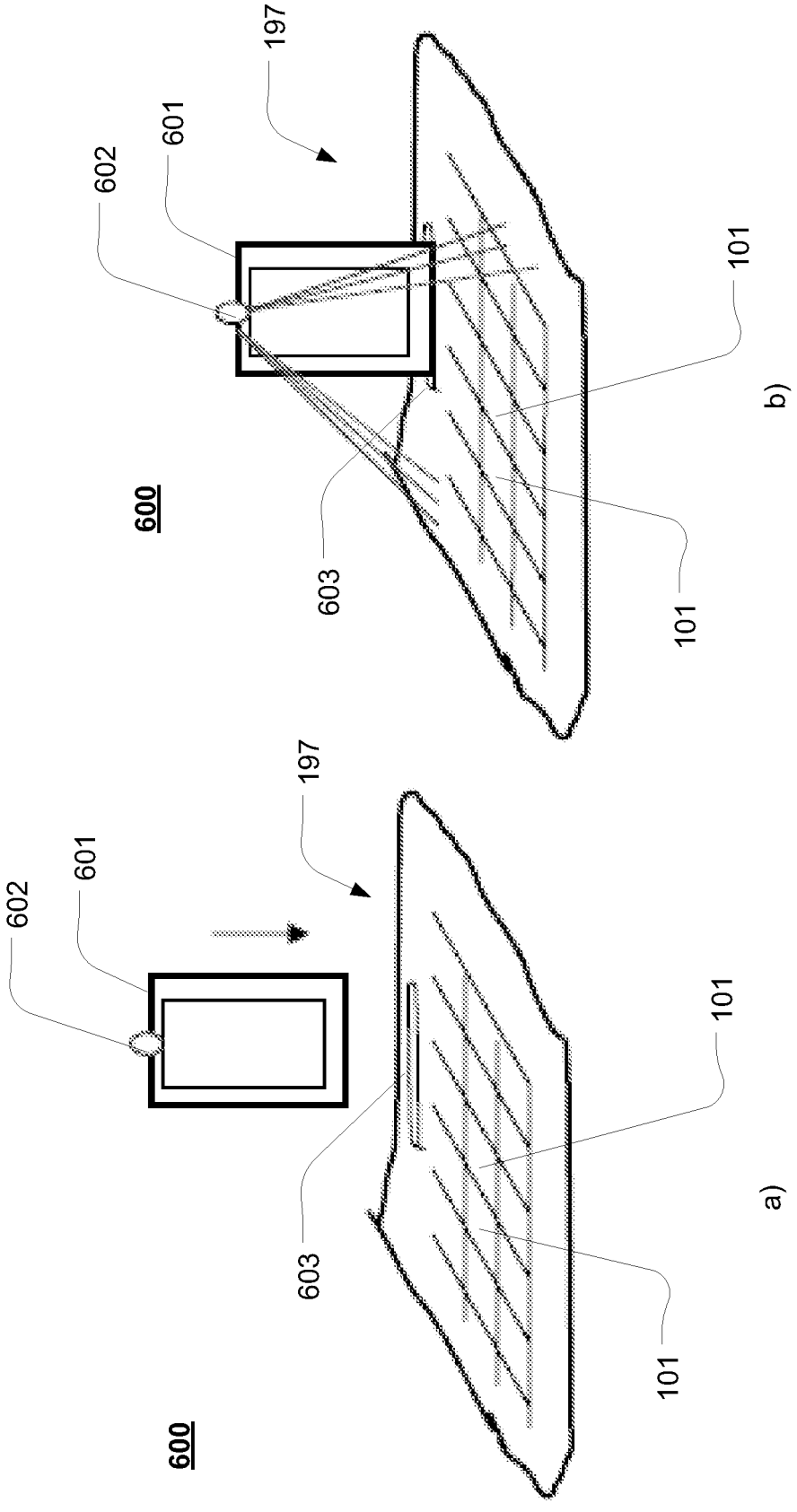

Fig. 6

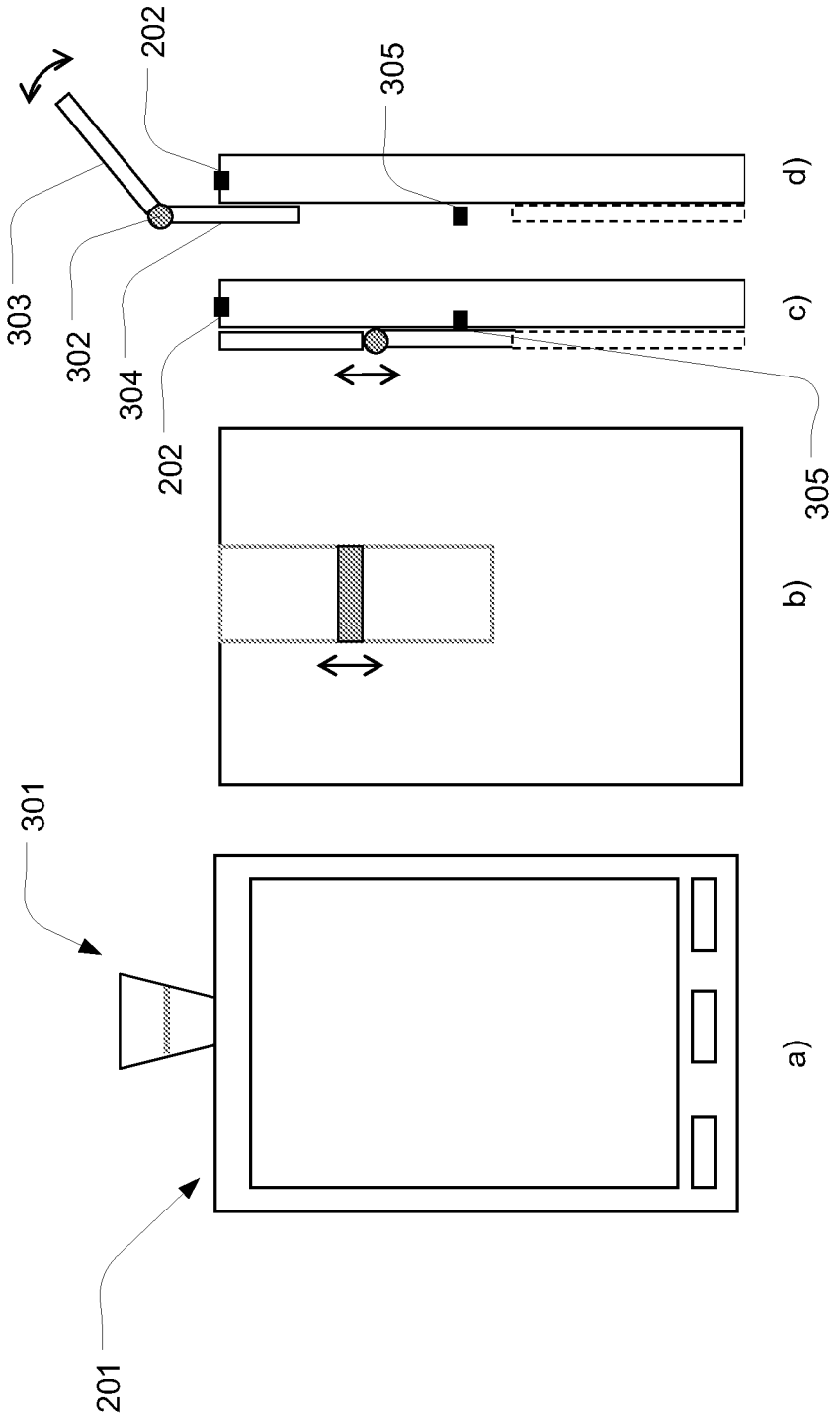

Fig. 3

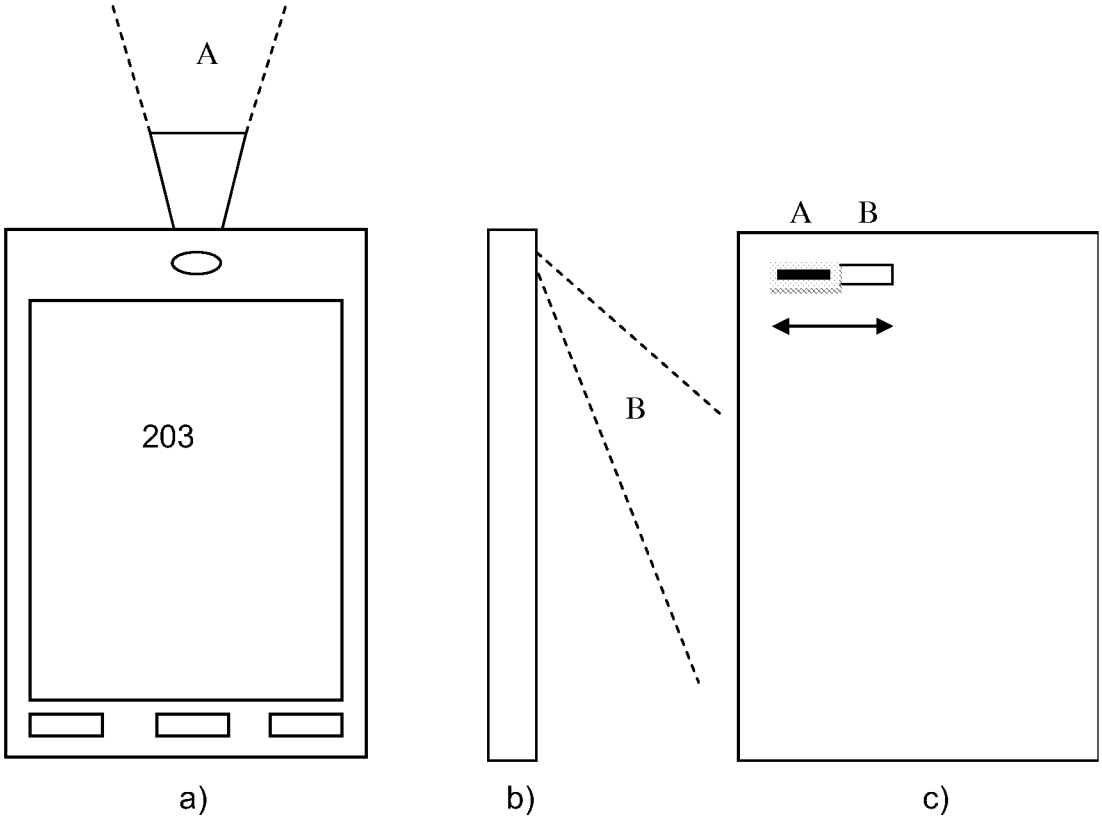

Fig. 7

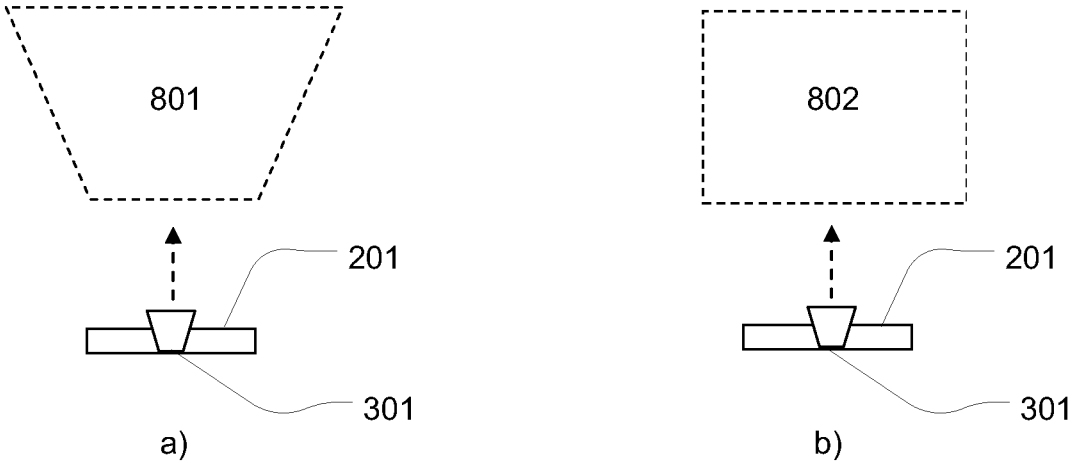

Fig. 8

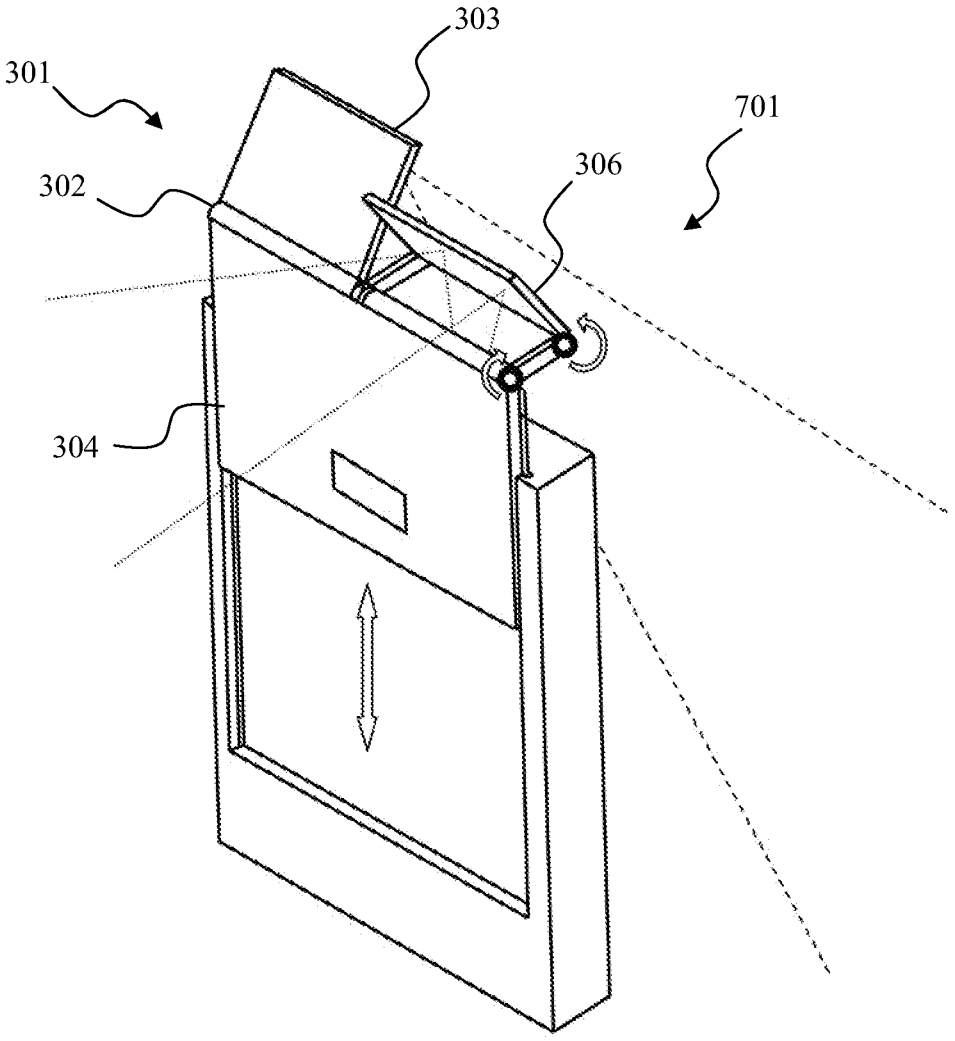

Fig. 11

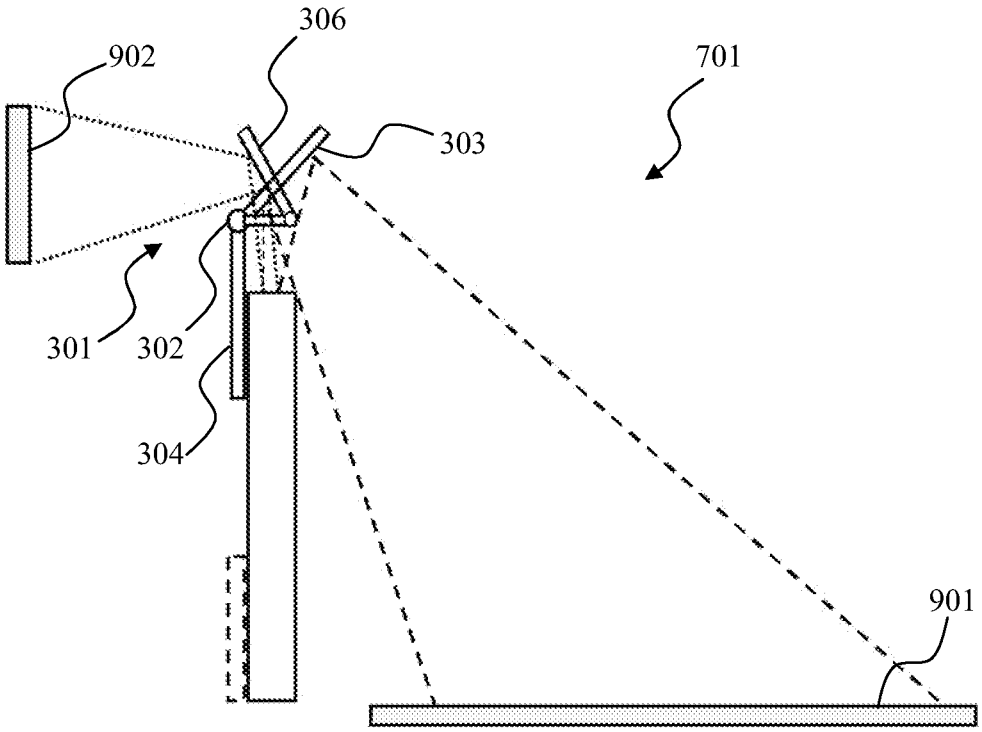

Fig. 12

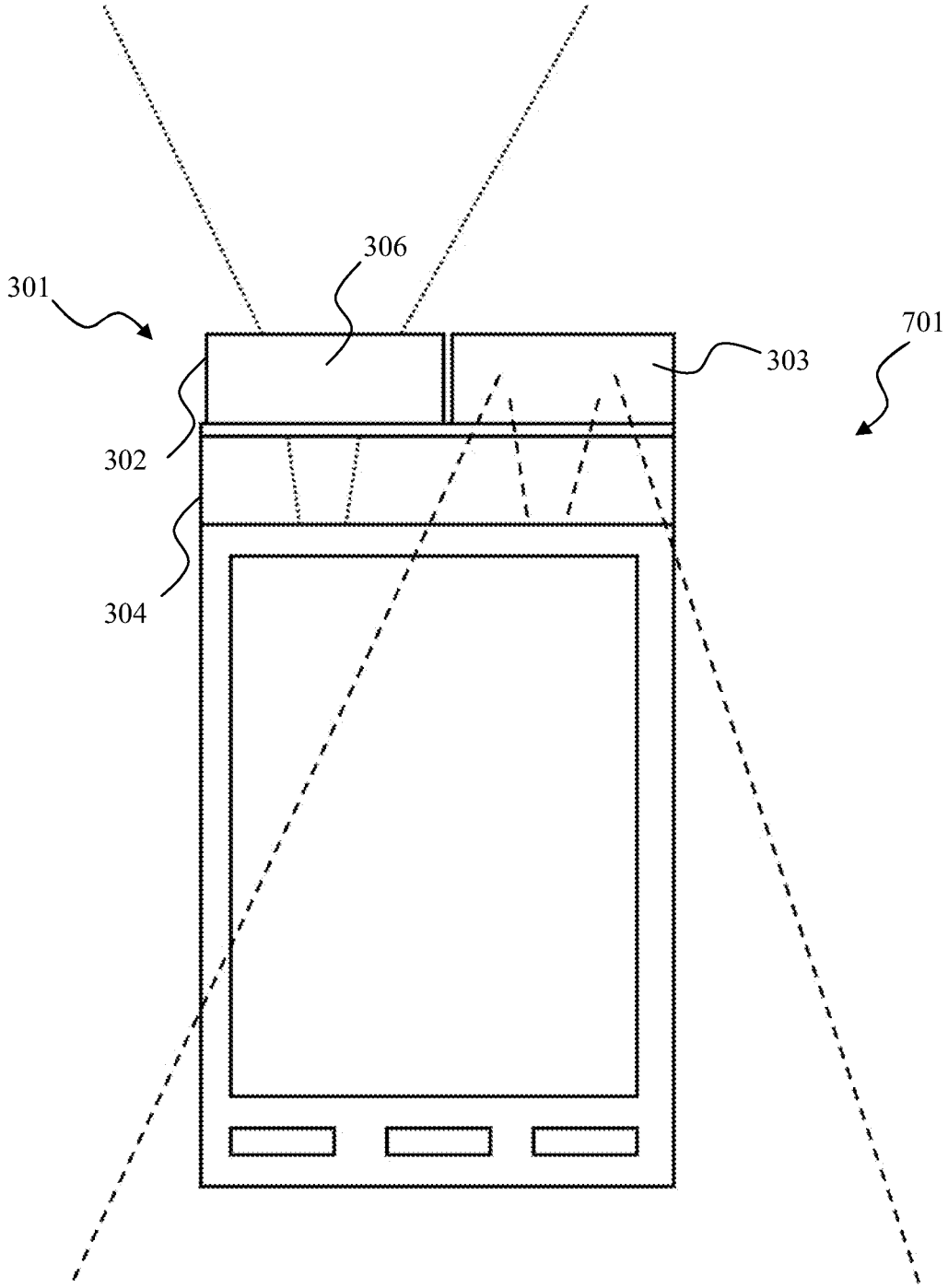

Fig. 13

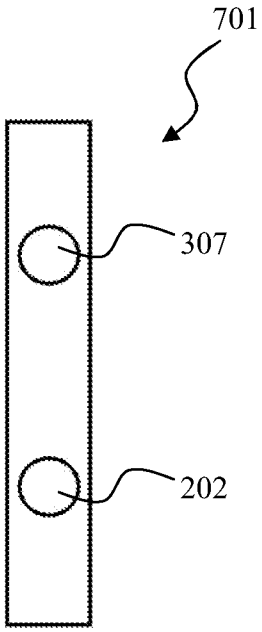

Fig. 14

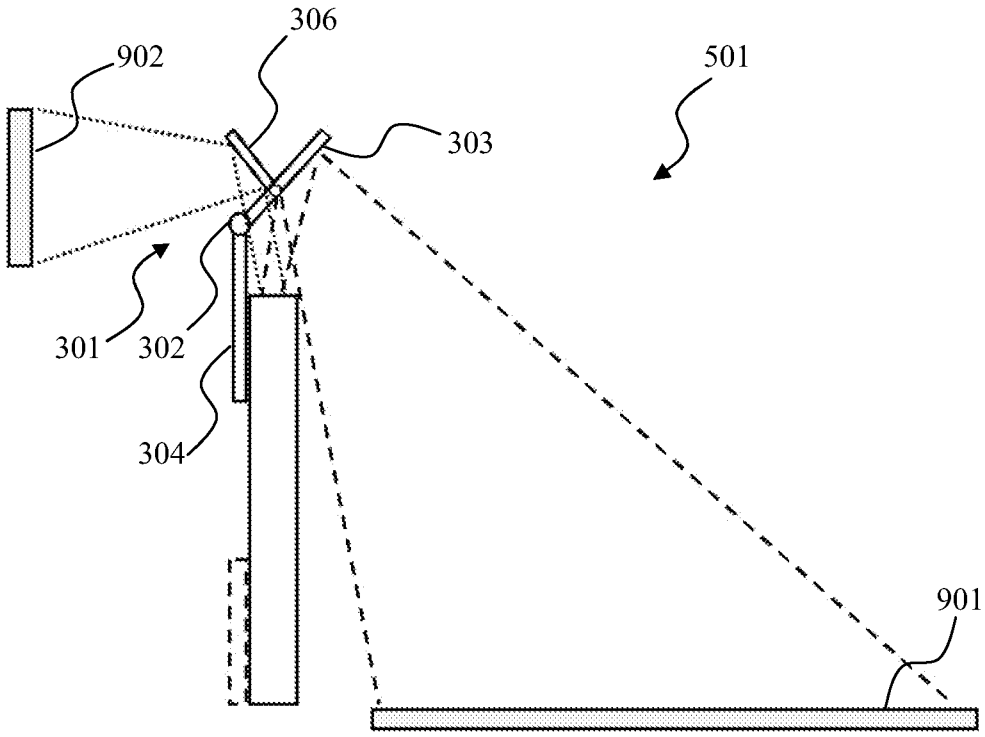

Fig. 15

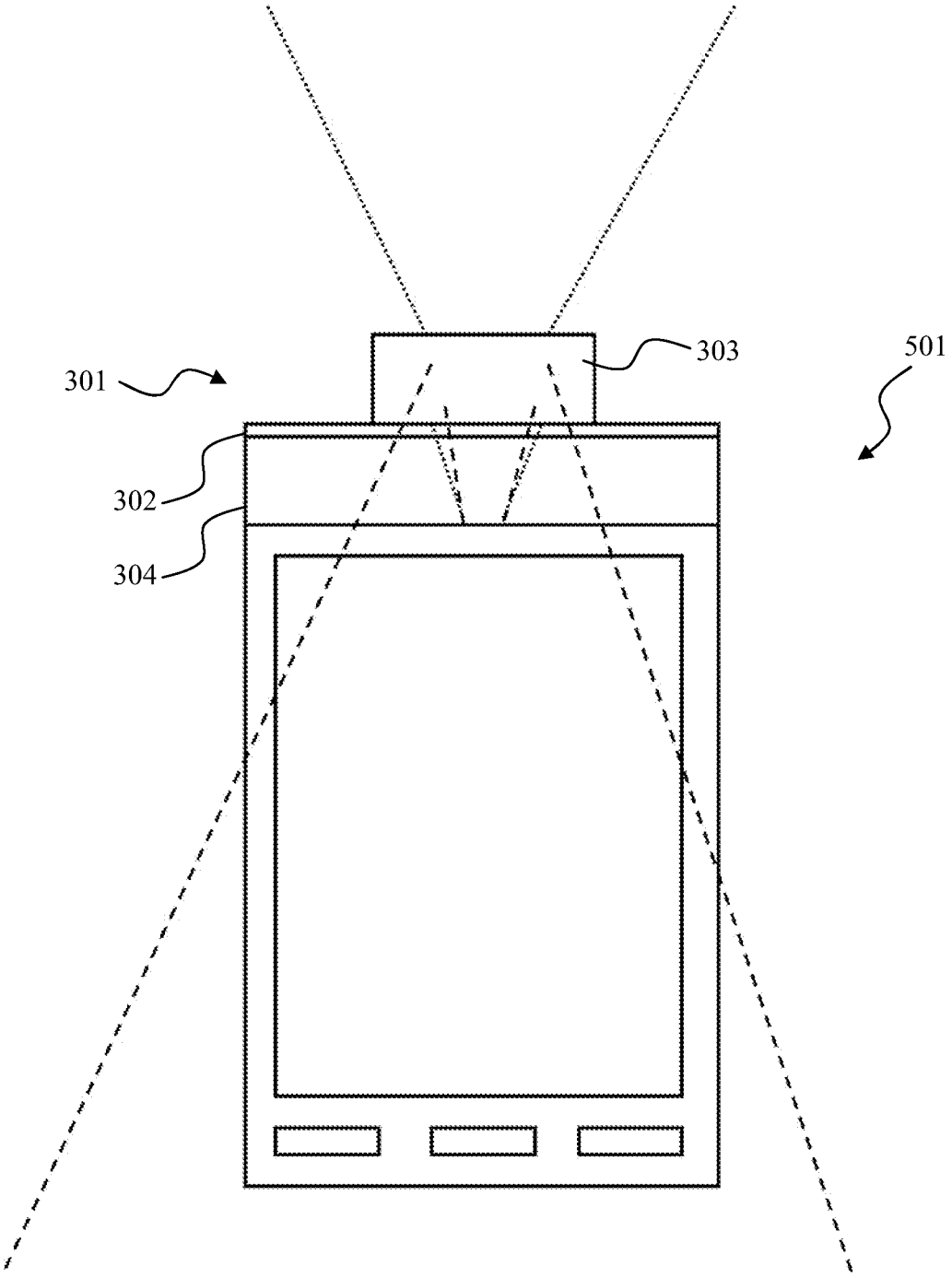

Fig. 16

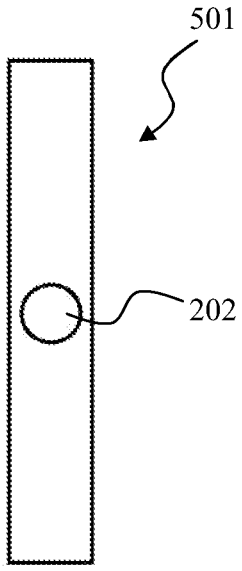

Fig. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/055065

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F1/16 H04M1/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 103 57 726 B3 (SIEMENS AG [DE]) 11 August 2005 (2005-08-11) the whole document -----	1-8
A	WO 2006/067640 A2 (REINHORN SILVIU [IL]) 29 June 2006 (2006-06-29) page 5, line 20 - page 9, line 6; figures 1-3 page 13, line 18 - page 14, line 5; figure 7 ----- -/--	1,7,8

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 April 2011	10/05/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Charcos Lloréns, V

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2007/060666 A1 (EXPLAY LTD [IL]; MANOR GOLAN [IL]; GOLUB MICHAEL [IL]) 31 May 2007 (2007-05-31) abstract page 6, lines 27-30 page 7, lines 20-33 page 11, lines 9-17 page 12, lines 12-28 page 13, lines 16-23; figure 2C page 17, lines 3-25; figures 8-10 -----	1,7

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/055065

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10357726 B3	11-08-2005	NONE	
WO 2006067640 A2	29-06-2006	NONE	
WO 2007060666 A1	31-05-2007	NONE	