United States Patent Application Publication	20250266220
Kind Code	A1
Publication Date	August 21, 2025
Inventor(s)	KUWAHARA; Masato et al.

KEY ASSEMBLY, CONTROLLER, AND INFORMATION PROCESSING SYSTEM

Abstract

A key assembly includes; a substrate having an electrode and at least two contacts on an upper surface, which is a surface on a first direction side, thereof; a moving part arranged on the first direction side of the substrate and being non-conductive; and a first conductor electrically connected to the electrode. The moving part includes a first surface spaced from and facing the upper surface in a natural state, a second surface provided on a side opposite of the first surface, and a through hole penetrating the moving part in the first direction between the first and second surfaces. A second conductor is provided on the first surface at a position which contacts the contacts simultaneously when the moving part moves from the natural state in a second direction opposite to the first direction. The first conductor extends to the second surface through the through hole.

Inventors: **KUWAHARA; Masato (Kyoto-shi, JP), KAWAI; Kochi (Kyoto-shi, JP)**

Applicant: **NINTENDO CO., LTD.** (Kyoto-shi, JP)

Family ID: **1000008589255**

Appl. No.: **19/201485**

Filed: **May 07, 2025**

Related U.S. Application Data

parent WO continuation PCT/JP2022/042407 20221115 PENDING child US 19201485

Publication Classification

Int. Cl.: **H01H13/14** (20060101); **H01H13/20** (20060101)

U.S. Cl.:

CPC **H01H13/14** (20130101); **H01H13/20** (20130101);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] The present application is a continuation of International Patent Application No. PCT/JP2022/042407 filed on Nov. 15, 2022, which is incorporated herein by reference in their entirety.

FIELD
[0002] The present disclosure relates to a key assembly, a controller, and an information processing system including the key assembly.
BACKGROUND
[0003] Key assemblies which include a plurality of contacts arranged on a substrate and a conductor arranged to face these contacts, and which are configured to detect the presence or absence of electrical continuity between the contacts when the conductor comes into contact with both contacts, have conventionally been known (for example, JP 2012-129214 A).
SUMMARY
[0004] In the key assembly described in JP 2012-129214 A, though the presence or absence of pressing of the key assembly can be detected by detecting the presence or absence of electrical continuity between the contacts due to the conductor coming into contact with both contacts, it is not possible to detect whether an object such as a finger of a user approaches or touches the key assembly. Furthermore, in order to enable detection of whether an object such as a finger of a user approaches or touches the key assembly, the structure of the key assembly may be complicated.
[0005] The gist of the present disclosure is as follows.
[0006] (1) A key assembly, comprising:
[0007] a substrate comprising an electrode and at least two contacts on an upper surface, which is a surface on a first direction side, thereof,
[0008] a moving part which is arranged on the first direction side of the substrate and which is non-conductive, and
[0009] a first conductor which is electrically connected to the electrode, wherein
[0010] the moving part comprises a first surface which is spaced from and faces the upper surface of the substrate in a natural state, a second surface which is provided on a side opposite of the first surface, and a through hole which penetrates the moving part in the first direction between the first surface and the second surface,
[0011] a second conductor is provided on the first surface of the moving part at a position which contacts the at least two contacts simultaneously in response to a movement of the moving part from the natural state in a second direction opposite to the first direction, and
[0012] the first conductor extends to the second surface through the through hole.
[0013] (2) The key assembly according to above (1), wherein the first conductor comprises an elastic member which biases an end of the first conductor on the second direction side in the first direction.
[0014] (3) The key assembly according to above (1) or (2), wherein the first conductor covers the second surface of the moving part.
[0015] (4) The key assembly according to above (3), wherein the first conductor covers an entirety of the second surface of the moving part.
[0016] (5) The key assembly according to above (3) or (4), wherein the first conductor comprises an upper body which covers the second surface and which is rigid.
[0017] (6) The key assembly according to above (5), wherein the first conductor comprises a lower body which is provided between the substrate and the upper body and which biases the upper body

in the first direction.

[0018] (7) The key assembly according to above (6), wherein the upper body is partially positioned in the through hole of the moving part.

[0019] (8) The key assembly according to above (7), wherein a portion of the upper body which is positioned in the through hole is in radial contact with an inner surface of the moving part, which defines the through hole.

[0020] (9) The key assembly according to above (8), wherein the lower body is a coil spring and is arranged so as to surround a periphery of a portion of the upper body on the second direction side more than a portion of the upper body in contact with the inner surface of the moving part.

[0021] (10) The key assembly according to any one of above (6) to (9), further comprising an clastic member which comprises the moving part and a biasing part which biases the moving part in the first direction toward a position in the natural state when the moving part moves from the natural state in the second direction, wherein

[0022] when the moving part moves from the natural state in the second direction, a force by which the biasing part biases the moving part in the first direction is greater than a force by which the lower body biases the upper body in the first direction.

[0023] (11) The key assembly according to any one of above (3) to (10), wherein at least one of the at least contacts is connected to a ground, and the moving part is formed such that a distance between the first surface and the second surface decreases as a pressing force increases when the first conductor is pressed in the second direction after the second conductor has come into contact with the at least two contacts.

[0024] (12) The key assembly according to above (11), wherein at least one of the at least two contacts is connected to a ground, and the first conductor is arranged on the first direction side of the second conductor so as to at least partially overlap the second conductor when viewed in the first direction.

[0025] (13) The key assembly according to any one of above (1) to (12), wherein the second conductor extends so as to surround the through hole.

[0026] (14) The key assembly according to above (12), wherein two of the contacts are provided on the substrate, and two of the contacts are arranged so as to be co-annular and positioned radially inward and radially outward relative to each other.

[0027] (15) The key assembly according to any one of above (1) to (14), further comprising a key top which is provided further on the first direction side than the moving part and the first conductor, wherein the key top is adhered to a surface of the first conductor on the first direction side via an adhesive, and at least one of the key top and the adhesive is non-conductive.

[0028] (16) The key assembly according to any one of above (1) to (15), wherein one of the two contacts is connected to a ground, and the first conductor is arranged on a first direction side of the contact which is connected to the ground so as to at least partially overlap the contact which is connected to the ground when viewed in the first direction.

[0029] (17) A controller, comprising the key assembly according to any one of above (1) to (16), and a detection circuit, wherein the detection circuit is configured so as to be capable of detecting a value of a parameter which changes in accordance with a presence or absence of current between the contacts and a capacitance of a circuit including the electrode.

[0030] (18) A controller, comprising the key assembly according to above (11) or (12) and a detection circuit, wherein

[0031] the detection circuit is configured so as to be capable of detecting a capacitance which changes in accordance with a distance between the second conductor, which is in contact with the contact which is connected to the ground, and the first conductor.

[0032] (19) An information processing system, comprising the key assembly according to any one of above (1) to (16), and one or a plurality of processors, wherein the processors perform processing based on a value of a parameter which changes in accordance with a presence or absence of current between the contacts and a capacitance of a circuit including the electrode.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0033] Embodiments of the present disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

[0034] FIG. **1** is a cross-sectional view of a key assembly taken along a cross section passing through an axis of the key assembly.

[0035] FIG. **2** is an exploded perspective view of the key assembly.

[0036] FIG. **3** is a plan view of a substrate.

[0037] FIG. **4** is a plan view of the substrate.

[0038] FIG. **5** is a view schematically detailing the substantial circuit configuration of a controller including the key assembly.

[0039] FIG. **6** is a cross-sectional view of the key assembly similar to FIG. **1**, when a finger approaches a key top.

[0040] FIG. **7** is a view similar to FIG. **5**, schematically showing a substantial circuit configuration, when a finger approaches the key top as shown in FIG. **6**.

[0041] FIG. **8** is a cross-sectional view of the key assembly **1** similar to FIG. **1**, when a finger presses the key top downward and a conductor comes into contact with contacts.

[0042] FIG. **9** is a view similar to FIG. **5**, schematically showing a substantial circuit configuration, when the conductor touches the contacts as shown in FIG. **8**.

[0043] FIG. **10** is a cross-sectional view of the key assembly **1** similar to FIG. **1**, when the key top is pressed to a bottom-most end.

[0044] FIG. **11** is a view showing the relationship between a position of the finger of a user and the presence or absence of capacitance and conduction between the contacts.

[0045] FIG. **12** is a view schematically showing the system configuration of an information processing system including a controller.

[0046] FIG. **13** is a cross-sectional view similar to FIG. **1**, showing a key assembly according to a modified example.

[0047] FIG. **14** is a cross-sectional view similar to FIG. **1**, showing a key assembly according to a modified example.

DESCRIPTION OF EMBODIMENTS

[0048] The embodiments will be described in detail with reference to the drawings. In the following description, identical elements have been assigned the same reference signs.

Key Assembly Configuration

[0049] The overall configuration of a key assembly **1** provided in a controller according to an embodiment will be described with reference to FIGS. **1** and **2**. The controller having the key assembly **1** is configured to output a signal in response to a key operation by a user. In particular, in the present embodiment, the controller is configured to detect whether the key assembly **1** is pressed by the user, the degree by which an object for operating the key assembly **1** (for example, the finger of the user) is approaching the key assembly **1** when a finger of a user is approaching the key assembly **1**, and the degree by which the key assembly **1** is pressed.

[0050] FIG. **1** is a cross-sectional view of the key assembly **1** taken along a cross-section passing through an axis X of the key assembly **1**. FIG. **2** is an exploded perspective view of the key assembly **1**. As shown in FIGS. **1** and **2**, the key assembly **1** includes a substrate **10**, an elastic member **20**, a conductive assembly **30**, an adhesive **40**, a key top **50**, and a cover **60**. As shown in FIGS. **1** and **2**, the elastic member **20**, the conductive assembly **30**, the adhesive **40**, and the key top **50** are arranged so as to overlap each other such that the centers thereof are positioned on the axis X.

[0051] In the present description, the direction from the substrate **10** to the key top **50** along the axis X is referred to as the upward direction, and the direction from the key top **50** to the substrate **10** (i.e., the direction opposite to the upward direction) is referred to as the downward direction. Note that the upward and downward directions are used for convenience of explanation, and the key assembly I need not necessarily be used in the manner wherein the upward direction corresponds to the vertical upward direction, and the key assembly **1** can be used in any direction. Thus, the key assembly **1** can be used, for example, such that the axis X extends horizontally, or such that the axis X extends in various different directions during use. Therefore, the upward direction can be considered as a first direction, and the downward direction can be considered as a second direction opposite to the first direction. Furthermore, the direction perpendicular to the axis X radially away from the axis X is referred to as the outward direction, and the direction perpendicular to the axis X toward the axis X (i.e., the direction opposite to the outward direction) is referred to as the inward direction. Furthermore, in the present description, a state in which no external forces are applied to the key assembly **1** by the finger of a user or the like is referred to as a natural state.

Substrate

[0052] Next, the substrate **10** will be described with reference to FIGS. **1** to **3**. FIG. **3** is a plan view of the substrate **10**. The substrate **10** is a plate-like member on which electronic components are arranged. The substrate **10** is, for example, a printed circuit board. The substrate **10** may be a rigid substrate or may be an FPC. The substrate **10** has a substrate upper surface **11** provided on an upper side thereof, and a substrate lower surface **12** provided on a lower side thereof. Thus, the substrate lower surface **12** is a surface provided on a side opposite to the substrate upper surface **11**.

[0053] In the present embodiment, as shown in FIGS. **1** to **3**, one electrode **13** and two contacts **14**, **15** are provided on the substrate upper surface **11**. The one electrode **13** has a circular shape and is arranged such that the center thereof is positioned on the axis X. Note that the electrode **13** may have a shape other than a circle, and may be arranged so as to be offset from the axis X. However, the electrode **13** has a shape and is arranged so as to be capable of coming into contact with a coil spring **31** of a conductive assembly **30**, which will be described later.

[0054] In the present embodiment, the contacts **14**, **15** have an annular shape as shown in FIGS. **2** and **3**. In the present embodiment, the contacts **14**, **15** are arranged on the inner side and the outer side of each other. In particular, in the present embodiment, the contacts **14**, **15** are formed in a concentric circle shape.

[0055] One of the contacts **14**, **15** is connected to the ground, and the other is connected to a power source **17** (see FIG. **5**), having a higher potential than the ground, via an electrical resistance **16** (refer to FIG. **5**) (hereinafter, these are referred to as the ground contact **15** and the high potential contact **14**, respectively). Thus, when a conductor **25** is in contact with both of the contacts **14**, **15**, a current flows from the high potential contact **14** to the ground contact **15**. Though the inner contact is the high potential contact **14** and the outer contact is the ground contact **15** in the present embodiment, the high potential contact **14** and the ground contact **15** may be arranged in reverse, with the inner and outer sides reversed. The electrical resistance **16** and the power source **17** may be provided on the substrate **10**, or may be provided on a member separate from the substrate **10**.

[0056] The contacts **14**, **15** may be formed in a manner different from that of the present embodiment as long as they can be electrically connected by the conductor **25**, which will be described later. Thus, the contacts **14**, **15** may not be formed in a concentric shape, but may be formed in an annular shape such as an ellipse or a polygon such as a rectangle. The contacts **14**, **15** may not be formed in an annular shape, but may be formed in any shape such as a semicircular

shape as shown in FIG. **4**. Though the two contacts **14**, **15** are provided on the substrate upper surface **11** in the present embodiment, three or more contacts may be provided. In the example shown in FIG. **4**, four pairs of semicircular high potential contacts **14** and semicircular ground contacts **15** are provided at 90° intervals in the circumferential direction, whereby a total of eight contacts are provided. Thus, at least two contacts are provided on the substrate upper surface **11**.
[0057] When three or more contacts are provided, some of the contacts are formed as high potential contacts **14**, and the remaining contacts are formed as ground contacts **15**. The high potential contacts **14** and the ground contacts **15** are arranged adjacent to each other.
Elastic Member
[0058] Next, the clastic member **20** will be described with reference to FIGS. **1** and **2**. The elastic member **20** is formed of a non-conductive elastic material, for example, a synthetic rubber such as silicone rubber. The clastic member **20** is arranged on the upper side of the substrate **10**. The clastic member **20** is arranged so that the axis thereof is positioned on the axis X of the key assembly **1**.
[0059] The elastic member **20** includes a moving part **21** which moves in the upward and downward directions, and a biasing part **22** which is connected to the moving part **21**. Both the moving part **21** and the biasing part **22** are arranged on the upper side of the substrate **10**. In the present embodiment, the inner periphery of the biasing part **22** is connected to the outer periphery of the moving part **21**. Though the moving part **21** and the biasing part **22** are integrally formed in the present embodiment, they may be formed as separate components.
[0060] The moving part **21** is a member which moves in the direction of the axis X, i.e., in the upward-downward directions, when the key assembly **1** (in particular, the key top **50**) is pressed by an object such as a finger of a user. In particular, the moving part **21** is positioned at the uppermost position within the movable range when in a natural state. Conversely, the moving part **21** can move downward until the conductor **25**, which is arranged below the moving part **21** and which moves together with the moving part **21**, comes into contact with the substrate **10**, and in particular, the contacts **14**, **15** on the substrate **10**.
[0061] The moving part **21** has a moving part upper surface **23** provided on the upper side, a moving part lower surface **24** provided on the lower side, and a through hole **26** extending through the moving part **21** in the upward-downward directions between the moving part upper surface **23** and the moving part lower surface **24**. Thus, the moving part upper surface **23** is provided on the side of the moving part **21** opposite to the moving part lower surface **24**. Furthermore, the through hole **26** is open in both the moving part upper surface **23** and the moving part lower surface **24**. In the present embodiment, the through hole **26** is formed so that the axis thereof is positioned on the axis X of the key assembly **1**. Furthermore, in the present embodiment, the moving part **21** is solidly formed except for the through hole **26**.
[0062] In the present embodiment, the moving part upper surface **23** is formed so that the center thereof is positioned on the axis X. Likewise, the moving part lower surface **24** is formed so that the center thereof is positioned on the axis X. In the present embodiment, both the moving part upper surface **23** and the moving part lower surface **24** have a circular shape. However, the moving part upper surface **23** and the moving part lower surface **24** may have any shape other than circular.
[0063] The moving part lower surface **24** is arranged so as to be spaced apart from the substrate upper surface **11** in the natural state and so as to face the substrate upper surface **11**. In particular, in the present embodiment, the moving part lower surface **24** is arranged so as to be parallel to the substrate upper surface **11** in the natural state.
[0064] Furthermore, the moving part **21** is formed of an elastic material. Thus, when a force is applied between the moving part upper surface **23** and the moving part lower surface **24**, the moving part **21** is compressed such that the distance between the moving part upper surface **23** and the moving part lower surface **24** decreases as the force increases. In particular, the moving part **21** is formed of an elastic material which can be compressed while maintaining contact between the conductor **25** and the contacts **14**, **15** when the moving part upper surface **23** is pressed downward

after the conductor **25** comes into contact with the contacts **14**, **15**. Moreover, the moving part **21** may be formed of a material having a high relative permittivity.

[0065] Furthermore, as shown in FIG. **1**, a flat conductor **25** is arranged on the moving part lower surface **24**. The conductor **25** is affixed to the moving part lower surface **24** by any means such as an adhesive, and moves along with the movement of the moving part **21**. The conductor **25** is an example of a second conductor provided on the moving part lower surface **24**. The conductor **25** is formed of an electrically conductive material, such as a metal or a carbon-based material. Note that the conductor **25** need not be a flat member affixed to the moving part lower surface **24** by an adhesive or the like, as long as it is a conductive material arranged on the moving part lower surface **24**. Thus, for example, the conductor **25** may be a conductive coating applied to the moving part lower surface **24**.

[0066] The conductor **25** extends around the through hole **26** so as to surround the through hole **26**. In particular, in the present embodiment, the conductor **25** has a shape which is substantially identical to the shape of the moving part lower surface **24** (a toroidal shape excluding the opening of the through hole **26**). Thus, the conductor **25** is formed so as to cover the entire moving part lower surface **24**. Since the conductor **25** covers the entire moving part lower surface **24** in this manner, the corner between the upper surface and the outer peripheral surface of the conductor **25** is not positioned on the moving part lower surface **24**, whereby the exertion of a large load on a part of the moving part lower surface **24** by such a corner is suppressed. The conductor **25** may be formed so as to cover the entire moving part lower surface **24** and so as to be larger than the moving part lower surface **24**. Alternatively, the conductor **25** may be formed so as to be smaller than the moving part lower surface **24**.

[0067] Furthermore, the conductor **25** is formed so as to overlap both of the two contacts **14**, **15** when viewed in the upward-downward direction. In particular, in the present embodiment, as indicated by the dashed line in FIG. **3**, the conductor **25** has an inner diameter which is smaller than the outer shape of the inner contact **14** and an outer diameter which is larger than the inner diameter of the outer contact **15**. Further, in the present embodiment, the conductor **25** is arranged above the ground contact **15**, and the distance between the conductor **25** and the ground contact **15** changes in accordance with the movement of the moving part **21** in the upward-downward directions. When the moving part **21** moves downward to its limit, the conductor **25** comes into contact with both contacts **14**, **15** simultaneously, and as a result, the two contacts **14**, **15** are electrically connected to each other.

[0068] In the example shown in FIG. **4**, four conductors **25** are provided so as to overlap the respective pairs of contacts **14**, **15** when viewed in the upward-downward directions. Each conductor **25** is formed to have the same radius as the semicircular contacts **14**, **15**. In the example shown in FIG. **4**, when the moving part **21** moves downward to its limit, cach conductor **25** contacts both contacts **14**, **15** simultaneously, and as a result, conduction is established between the contacts **14**, **15**. When the moving part **21** moves downward while the moving part lower surface **24** is inclined, one or more of the four conductors **25** may contact both contacts **14**, **15** simultaneously.

[0069] The conductor **25** may be provided in any manner as long as it contacts both contacts **14**, **15** simultaneously when the moving part **21** moves downward. Thus, it may be provided separately at two locations around the through hole **26** on both sides of the through hole **26**, or it may be provided at only one location around the through hole **26**. Furthermore, when the conductor **25** is formed of an elastic material, it need not necessarily be provided at a position where it overlaps both contacts **14**, **15** when viewed in the upward-downward directions when the conductor **25** is not in contact with the contacts **14**, **15**, as long as it is in a position where it contacts both contacts **14**, **15** when the moving part **21** moves downward and the conductor **25** is compressed between the contacts **14**, **15** and the moving part lower surface **24**, causing the surface area thereof to expand.

[0070] The biasing part **22** biases the moving part **21** toward a position in the natural state when the moving part **21** moves downward from the natural state. The biasing part **22** includes a base part **27** arranged on the substrate upper surface **11** and a skirt part **28** extending between the moving part **21** and the base part **27**.

[0071] The base part **27** is arranged on the substrate upper surface **11** so as not to move. In particular, in the present embodiment, the base part **27** is interposed between the substrate **10** and a guide member **61** of the cover **60**, and is affixed to the substrate upper surface **11** by the substrate **10** and the guide member **61** so as not to move. Note that this affixation method is one example, and any appropriate method can be adopted.

[0072] The skirt part **28** is a plate-like member having a truncated conical shape, and the upper circular edge thereof is connected to the outer periphery of the moving part **21**, while the lower circular edge thereof is connected to the base part **27**. The skirt part **28** deforms when the moving part **21** moves downward from the natural state, and biases the moving part **21** upward by the elastic force thereof.

Conductive Assembly

[0073] Next, the conductive assembly **30** will be described with reference to FIGS. **1** and **2**. The conductive assembly **30** is an example of a first conductor which is electrically connected to the electrode **13** of the substrate **10**. The conductive assembly **30** is used to detect the degrees to which an object such as a finger of a user is approaching the key assembly **1** and the degree to which the key assembly is being pressed.

[0074] As shown in FIGS. **1** and **2**, the conductive assembly **30** includes a coil spring **31** which is arranged on the relatively lower side and a conductive member **32** which is arranged on the relatively upper side. The conductive member **32** is an example of an upper body which is arranged so as to cover the moving part upper surface **23**. The conductive member **32** is arranged on the relatively upper side in the conductive assembly **30**. The coil spring **31** is an example of a lower body which is provided between the substrate **10** and the conductive member **32**, which is the upper body. The conductive assembly **30** is formed of a conductive material, such as a metal. Alternatively, the conductive assembly **30** may be formed by providing a conductive coating on a non-conductive material such as a resin, or by providing a non-conductive material on a conductive material.

[0075] The coil spring **31** is arranged so that the axis thereof is positioned on the axis X of the key assembly **1**. The coil spring **31** is also positioned on the electrode **13** and in contact with the electrode **13**. In particular, the coil spring **31** is constantly in contact with the electrode **13** due to the clastic force of the coil spring **31**. Thus, the coil spring **31** is electrically connected to the electrode **13**. When the conductive member **32** is positioned lower than in the natural state thereof, the coil spring **31** is arranged between the substrate **10** and the conductive member **32** and biases the conductive member **32** upward with respect to the substrate **10**. Thus, the coil spring **31** biases the upper end of the conductive assembly **30** upward.

[0076] In the present embodiment, the coil spring **31** is formed so that when the conductive member **32** and the moving part **21** move downward from the natural states thereof, the force with which the coil spring **31** biases the conductive member **32** upward is less than the force with which the biasing part **22** biases the moving part **21** upward. When the biasing force of the coil spring **31** is greater than the biasing force of the biasing part **22**, the conductive member **32** biased by the coil spring **31** will be moved upward faster than the moving part **21** biased by the biasing part **22**. As a result, the conductive member **32** and the moving part **21** may separate in the upward-downward directions. Conversely, since the biasing force of the coil spring **31** is less than the biasing force of the biasing part **22** in the present embodiment, the conductive member **32** and the moving part **21** are prevented from separating in the upward-downward directions.

[0077] The coil spring **31** may be affixed to the electrode **13** by, for example, solder or the like. Furthermore, another elastic member may be used as the lower body in place of the coil spring **31**. As such another member, for example, a conductive elastic member which can be electrically

connected to the electrode **13** and biases the conductive member **32** upward can be used.
[0078] The conductive member **32** has a higher rigidity than the other components, and in particular, than the elastic member **20**. In particular, the conductive member **32** has a rigidity such that it will not deform even if the key assembly **1** is pressed by a finger of a user or the like. The conductive member **32** is arranged so that the axis thereof is positioned on the axis X of the key assembly **1**. The conductive member **32** has a disk-shaped plate-like part **33**, an intermediate part **34** having a smaller outer diameter than the plate-like part **33**, and a protruding part **35** having a smaller outer diameter than the intermediate part **34**. The intermediate part **34** is provided above the protruding part **35**, and the plate-like part **33** is provided above the intermediate part **34**. The plate-like part **33**, the intermediate part **34**, and the protruding part **35** are formed as an integral member.
[0079] The plate-like part **33** is arranged on the moving part upper surface **23**. In the present embodiment, the plate-like part **33** has a shape which is substantially the same as the shape (circular shape) of the moving part upper surface **23**. Thus, the plate-like part **33** is formed so as to cover the entire moving part upper surface **23**. By covering the entire moving part upper surface **23** with the plate-like part **33** of the conductive assembly **30** in this manner, the corner between the lower surface and the outer circumferential surface of the plate-like part **33** is prevented from being positioned on the moving part upper surface **23**, whereby the application of a large load on a part of the moving part upper surface **23** by such a corner is suppressed. The plate-like part **33** may be formed so as to cover the entire moving part upper surface **23** and to protrude radially outward from the moving part upper surface **23**. Alternatively, the plate-like part **33** may be formed so as to be smaller than the moving part upper surface **23** while covering the moving part upper surface **23**.
[0080] Furthermore, the plate-like part **33** is arranged above the conductor **25** so as to overlap the entire conductor **25** when viewed in the upward-downward directions. In particular, the plate-like part **33** is arranged above the conductor **25** with the moving part **21** interposed therebetween. Thus, the plate-like part **33** is arranged from the conductor **25** at a distance corresponding to the thickness of the moving part **21** in the upward-downward directions. Note that the plate-like part **33** may be arranged so as to partially overlap or so as not to overlap the conductor **25** when viewed in the upward-downward directions.
[0081] Furthermore, the plate-like part **33** is arranged above the ground contact **15** so as to overlap the entire ground contact **15** when viewed in the upward-downward directions. Thus, the plate-like part **33** is arranged above the ground contact **15** with the moving part **21** and the conductor **25** interposed therebetween. Note that the plate-like part **33** may be arranged so as to partially overlap or so as not to overlap the ground contact **15** when viewed in the upward-downward directions.
[0082] The intermediate part **34** and the protruding part **35** are positioned in the through hole **26** of the moving part **21**. Thus, the conductive member **32** is partially positioned in the through hole **26**. By positioning the rigid conductive member **32** in the moving part **21** in this manner, misalignment and shape change of the moving part **21** and the elastic member **20** including the moving part **21** can be suppressed. In the present embodiment, the intermediate part **34** has a cylindrical shape, and is formed so that the outer periphery thereof contacts the inner surface **29** of the moving part **21** that defines the through hole **26** over the entire circumference in the radial direction. In particular, the intermediate part **34** may be formed so that the outer diameter thereof is slightly larger than the inner diameter of the inner surface **29** of the moving part **21**. In this case, the intermediate part **34** is fitted into the through hole **26**. This allows the moving part **21** and the conductive member **32** to be positioned relative to each other.
[0083] The protruding part **35** has a cylindrical shape, and the coil spring **31** is arranged so as to surround the outer periphery of the protruding part **35**. Thus, the coil spring **31** is positioned with respect to the conductive member **32** by the protruding part **35**.
[0084] Furthermore, the conductive member **32** is arranged so that the axis thereof is positioned on the axis X of the key assembly **1**. Therefore, the conductive member **32** is positioned above the coil spring **31**, and thus comes into contact with the coil spring **31**. In particular, the upper end of the

coil spring **31** comes into contact with the lower surface of the intermediate part **34** around the protruding part **35**. In the present embodiment, the conductive member **32** is constantly in contact with the coil spring **31** due to the elastic force of the coil spring **31**. Therefore, the conductive member **32** is electrically connected to the coil spring **31**. That is, the entire conductive assembly **30** including the coil spring **31** and the conductive member **32** is electrically connected to the electrode **13**. The coil spring **31** may be affixed to the conductive member **32** by, for example, soldering or the like.

[0085] As a result of being constructed as described above, the conductive assembly **30** is electrically connected to the electrode **13** and extends to the moving part upper surface **23** through the through hole **26**.

Adhesive

[0086] The adhesive **40** adheres the key top **50** to the conductive member **32** of the conductive assembly **30**. In particular, the adhesive **40** adheres the lower surface of the key top **50** to the upper surface of the plate-like part **33** of the conductive member **32**. Thus, the key top **50** is adhered to the upper surface of the conductive member **32** via the adhesive **40**. As a result, the key top **50** moves integrally with the conductive member **32**. Since the conductive member **32** is affixed to the moving part **21** by engagement and the conductor **25** is affixed to the moving part **21** by the adhesive, the key top **50**, the conductive member **32**, the moving part **21**, and the conductor **25** move integrally.

[0087] Any material having adhesive strength can be used as the adhesive **40**. The adhesive **40** is also formed of a non-conductive material.

Key Top

[0088] The key top **50** is the part of the key assembly **1** that is directly operated by the user. The key top **50** is formed of a non-conductive material, for example, a resin such as polyacetal. The key top **50** is provided above the elastic member **20** including the moving part **21** and the conductive assembly **30**. The key top **50** is arranged so that the axis thereof is positioned on the axis X of the key assembly **1**.

[0089] The key top **50** includes a circular upper wall **51**, a cylindrical side wall **52**, and a flange **53**. The upper end of the cylindrical side wall **52** is connected to the outer periphery of the upper wall **51**. The flange **53** extends outward from the lower end of the side wall **52**.

[0090] The key top **50** is arranged so that the side wall **52** is positioned within an opening **62** formed in the cover **60**. The outer diameter of the side wall **52** is smaller than the outer diameter of the opening **62**. Thus, the key top **50** can move up and down within the opening **62**. The flange **53** is formed so that the outer diameter thereof is larger than the outer diameter of the opening **62**. As a result, the flange **53** cannot move upward beyond the opening **62**. Thus, even if the moving part **21** and the conductive member **32** are biased upward and the key top **50** is biased upward accordingly, the key top **50** cannot move upward beyond the state where the flange **53** contacts the lower surface of the cover **60**. In the present embodiment, the state where the key top **50** is biased upward and the flange **53** contacts the lower surface of the cover **60** is the natural state.

Cover

[0091] The cover **60** constitutes a part of the housing which accommodates the components of the key assembly **1**. The cover **60** is formed of a material such as resin. The cover **60** includes a guide member **61** for guiding the key top **50** so as to move in the upward-downward directions, an opening **62** through which the key top **50** moves, and an affixation part **63** which extends to the substrate **10**.

[0092] The guide member **61** is formed in an annular shape so as to at least partially surround the flange **53** and extends in the upward-downward directions. The guide member **61** is formed so that the inner surface thereof is positioned outwardly of the outer periphery of the flange **53**. The guide member **61** is formed so as to guide the outer peripheral surface of the flange **53** in the upward-downward directions.

[0093] The affixation part **63** is used to affix the cover **60** to the substrate **10**. Thus, when the key assembly **1** is assembled, the lower end of the affixation part **63** comes into contact with the substrate upper surface **11**, thereby affixing the cover **60** to the substrate **10**. Note that any fastener such as a bolt may be used to affix the cover **60** to the substrate **10**.

Operation

[0094] Next, the operation of the key assembly **1** and the signals output from the key assembly **1** will be described with reference to FIGS. **5** to **11**. FIG. **5** is a view schematically detailing the substantial circuit configuration of the controller including the key assembly **1**.

[0095] As shown in FIG. **5**, the controller includes a detection circuit **101** for detecting capacitance between the ground and the conductive member **32** and detecting continuity between the contacts **14**, **15**. The detection circuit **101** is connected to the conductive member **32** via the electrode **13** of the substrate **10** to detect capacitance. Furthermore, the detection circuit **101** is connected to the wiring between the high potential contact **14** and the electrical resistance **16** to detect the voltage at the high potential contact **14**. The voltage at the high potential contact **14** is used to determine the continuity between the contacts **14**, **15**. The detection circuit **101** is further connected to the ground contact **15**.

[0096] As shown in FIG. **5**, in a state in which the key assembly **1** is in the natural state and an object such as a finger is not approaching the conductive member **32**, the plate-like part **33** of the conductive member **32** is arranged above the ground contact **15** so as to face the ground contact **15** with the conductor **25** interposed therebetween. Thus, a capacitance Cx is generated between the conductive member **32** and the ground contact **15**. Therefore, the capacitance Ct generated between the ground and the conductive member **32** is equal to the capacitance Cx generated between the conductive member **32** and the ground contact **15**.

[0097] In this state, the high potential contact **14** is not electrically connected to the ground contact **15**, and thus, the electric potential of the high potential contact **14** is maintained at a high level. Therefore, at this time, the voltage at the high potential contact **14** detected by the detection circuit **101** is higher than a predetermined reference voltage.

[0098] FIG. **6** is a cross-sectional view of the key assembly **1** similar to FIG. **1**, when a finger approaches the key top **50**. Furthermore, FIG. **7** is a view similar to FIG. **5**, schematically showing the substantial circuit configuration when a finger approaches the key top **50** as shown in FIG. **6**.

[0099] As shown in FIG. **7**, when a finger approaches the key top **50**, a capacitance Cf is generated between the finger and the conductive member **32** due to the finger. Furthermore, a capacitance Ch is generated between the human body including the finger and the earth. Thus, the capacitance Ct generated between the ground and the conductive member **32** can be expressed by the following formula (**1**):

$$Ct=Cx+1/Cf+1/Ch+1/Cg \qquad (1)$$

[0100] FIG. **8** is a cross-sectional view of the key assembly **1** similar to FIG. **1**, when a finger presses the key top **50** downward and the conductor **25** comes into contact with the contacts **14**, **15**. FIG. **9** is a view similar to FIG. **5**, schematically showing the substantial circuit configuration when the conductor **25** comes into contact with the contacts **14**, **15** as shown in FIG. **8**.

[0101] As shown in FIG. **9**, when the conductor **25** comes into contact with the ground contact **15**, the conductor **25** is connected to the ground. In particular, the plate-like part **33** of the conductive member **32** is arranged above the conductor **25** connected to the ground contact **15** so as to face the conductor **25**, and thus, a capacitance C′x is generated between the conductive member **32** and the conductor **25**. Therefore, the capacitance Ct generated between the ground and the conductive member **32** can be expressed by the following formula (2):

$$Ct=C'x+1/Cf+1/Ch+1/Cg \qquad (2)$$

[0102] Furthermore, when the conductor **25** comes into contact with the ground contact **15**, it also comes into contact with the high potential contact **14** at substantially the same time. Thus, the high potential contact **14** is conductive with the ground contact **15**, and as a result, the electric potential of the high potential contact **14** becomes low. Thus, at this time, the voltage at the high potential contact **14** detected by the detection circuit **101** is lower than a predetermined reference voltage. In this manner, the voltage at the high potential contact **14** is a parameter which changes in accordance with the presence or absence of conductivity between the contacts **14**, **15**, and thus, it can be said that the detection circuit **101** detects the value of a parameter which changes in accordance with the presence or absence of conductivity between the contacts **14**, **15**.

[0103] Thereafter, when the finger presses the key top **50** further downward, and specifically, when the conductive member **32** is pressed downward, the moving part **21** is deformed so as to be compressed in the upward-downward directions. Specifically, the moving part **21** is formed so that when the conductive member **32** is pressed downward after the conductor **25** comes into contact with both contacts **14**, **15**, the greater the pressing force, the smaller the distance between the moving part upper surface **23** and the moving part lower surface **24** becomes. As a result, as the key top **50** moves downward, the distance between the plate-like part **33** of the conductive member **32** and the conductor **25** in contact with the ground contact becomes shorter. Finally, as shown in FIG. **10**, the key top **50** is pressed down until the flange **53** of the key top **50** comes into contact with the base part **27** of the elastic member **20**.

[0104] FIG. **11** is a view showing the relationship between the position of the finger of a user, which is the object that operates the key assembly **1**, and the capacitance between the conductive member **32** and ground detected by the detection circuit **101**, and the voltage at the high potential contact **14**. The finger position is represented as zero when the finger touches the key top **50**, and the value of the finger position increases as the finger moves downward. Thus, when the finger is not in contact with the key top **50** and is spaced from the key top **50**, the value of the finger position is negative, and when the finger is in contact with the key top **50** and pressing it down, the value of the finger position is positive.

[0105] When the key assembly **1** is in the natural state and the finger is positioned away from the kcy top **50**, the capacitance Ct generated between the ground and the conductive member **32** is equal to the capacitance Cx generated between the conductive member **32** and the ground contact **15**. In this case, the capacitance Cf generated by the finger is low and the ground contact **15** and the conductive member **32** are separated. Thus, in this case, as shown in FIG. **11**, the capacitance Ct generated between the ground and the conductive member **32** is relatively low. At this time, since the high potential contact **14** is not electrically connected to the ground contact **15**, the voltage at the high potential contact **14** is higher than a predetermined reference voltage Vref.

[0106] In a state in which the key assembly **1** is in the natural state, as a finger approaches the key top **50** (i.e., as the finger position moves to the right toward zero in FIG. **11**), the capacitance Cf by the finger increases. The capacitance Ct generated between the ground and the conductive member **32** at this time is calculated by formula (1) above. Thus, as shown in FIG. **11**, as the finger approaches the key top **50**, the capacitance Ct generated between the ground and the conductive member **32** also increases.

[0107] Thereafter, as the finger contacts the key top **50** and the key top **50** is pressed down (and thus, as the finger position moves from zero to the right in FIG. **11**), the distance between the ground contact **15** and the conductive member **32** gradually decreases. As a result, the capacitance Cx between the ground contact **15** and the conductive member **32** gradually increases. In particular, since the plate-like part **33** of the conductive member **32** is arranged so as to at least partially overlap the ground contact **15** when viewed in the upward-downward directions in the present embodiment, the capacitance Cx is likely to change with respect to the change in the distance between the ground contact **15** and the conductive member **32**. Furthermore, as the key top **50** is pressed down, since the force with which the finger presses the key top **50** increases, the finger is compressed and the contact area of the finger with the key top **50** gradually increases, albeit slightly. As a result, as the key top **50** is pressed down, the capacitance Cf by the finger increases. The capacitance Ct generated between the ground and the conductive member **32** at this time is calculated by formula (1) above. Thus, as shown in FIG. **11**, as the finger moves downward after contacting the key top **50**, the capacitance Ct generated between the ground and the conductive member **32** also increases. However, the rate at which the capacitance Ct generated between the ground and the conductive member **32** increases in response to the movement of the finger at this time is slower than the rate at which the capacitance Ct increases in response to the movement of the finger when the finger approaches the key top **50**.

[0108] Thereafter, when the key top **50** is pressed further and the conductor **25**, which moves integrally with the key top **50**, moves downward until it comes into contact with both contacts **14**, **15** (i.e., when the finger position moves to de in FIG. **11**), the conductor **25** comes into contact with both contacts **14**, **15**, and both contacts **14**, **15** become conductive. Thus, at this time, the voltage at the high potential contact **14** becomes lower than the predetermined reference voltage Vref.

[0109] Furthermore, when the conductor **25** comes into contact with both contacts **14**, **15** (and in particular, the ground contact **15**), the capacitance C′x is generated between the conductor **25** and the conductive member **32**. Since the surface area of the conductor **25** facing the conductive member **32** is larger than the surface area of the ground contact **15** facing the conductive member **32**, and the distance to the conductive member **32** is reduced by the thickness of the conductor **25**, when the conductor **25** comes into contact with the ground contact **15** (when the finger position reaches dc), the capacitance Ct generated between the ground and the conductive member **32** suddenly increases.

[0110] Thereafter, as the key top **50** is pressed downward after the conductor **25** comes into contact with the ground contact **15** (i.e., as the finger position moves from de to the right in FIG. **11**), since the moving part **21** is compressed in the upward-downward directions, and the conductor **25** and the conductive member **32** approach each other, the capacitance C′x between the conductor **25** and the conductive member **32** gradually increases. In particular, since the plate-like part **33** of the conductive member **32** is arranged so as to at least partially overlap the conductor **25** when viewed in the upward-downward directions in the present embodiment, the capacitance C′x changes relatively greatly when the distance between the conductor **25** and the conductive member **32** changes. Further, since the surface area of the conductor **25** is larger than that of the ground contact **15** as described above, the rate of increase of the capacitance Ct generated between the ground and the conductive member **32** in response to movement of the finger at this time is greater than the rate of increase before the conductor **25** comes into contact with the ground contact **15**.

Information Processing System

[0111] Next, a controller **100** including the key assembly **1** and an information processing system **200** including the controller **100** and a body device **110** will be described with reference to FIG. **12**. FIG. **12** is a view schematically showing the system configuration of the information processing system **200** including the controller **100**.

[0112] The controller **100** is used to perform various operations associated with information processing. The controller **100** is, for example, a game controller used to operate a game. However, the controller **100** may also be an information processing controller used to perform operations such as moving a cursor and selecting a menu. As shown in FIG. **12**, the controller **100** includes the key assembly **1**, the detection circuit **101**, a sensor **102**, a storage unit **103**, and a communication control unit **104**. The detection circuit **101**, the sensor **102**, and the storage unit **103** are all connected to the communication control unit **104**.

[0113] The detection circuit **101** detects the capacitance between the ground and the conductive member **32** of the key assembly **1**, and detects the voltage at the high potential contact **14** in the key assembly **1**. For example, the detection circuit **101** periodically charges between the ground and the conductive member **32**, and detects the capacitance between the ground and the conductive member **32** based on the time until full charge at this time or the current flowing during charging.

Thus, the capacitance detected by the detection circuit **101** changes in accordance with the distance between the ground contact **15** and the conductive member **32** until the conductor **25** contacts the ground contact **15**. Furthermore, after the conductor **25** contacts the ground contact **15**, the capacitance detected by the detection circuit **101** changes in accordance with the distance between the conductor **25** in contact with the ground contact **15** and the conductive member **32**. The detection circuit **101** detects the voltage at the high potential contact **14** to be used for determining the continuity between the contacts **14**, **15**. The detection circuit **101** outputs a signal which changes in accordance with the capacitance between the ground and the conductive member **32** and a signal which changes in accordance with the voltage at the high potential contact **14**, and the output signals are input to the communication control unit **104**.

[0114] As described above, the capacitance between the ground and the conductive member **32** indicates the degree to which the finger of a user or the like approaches the key assembly **1** or the degree to which the key assembly **1** is pressed. Thus, the detection circuit **101** can detect the capacitance indicating the degree to which the finger of a user or the like approaches the key assembly **1** or the degree to which the key assembly **1** is pressed. Furthermore, the voltage at the high potential contact **14** indicates whether or not the user has pressed the key assembly **1**. Thus, the detection circuit **101** of the present embodiment can detect the value of a parameter which changes in accordance with whether or not the key assembly **1** is pressed. Note that in the present embodiment, the voltage at the high potential contact **14** is used as the parameter which changes in accordance with whether or not the key assembly **1** is pressed, but other parameters, such as the current flowing through the high potential contact **14**, may be used as long as they change in accordance with whether or not the key assembly **1** is pressed.

[0115] The sensor **102** detects the state of the controller **100**. The sensor **102** includes, for example, an acceleration sensor and an angular velocity sensor. Output signals of the sensor **102** are input to the communication control unit **104**.

[0116] The communication control unit **104** communicates with the body device **110** by wireless communication. The communication control unit **104** acquires information (for example, information regarding the operation of the key assembly **1**, or the result of detection by the sensor **102**) from each input unit (such as the detection circuit **101** connected to the key assembly **1**, the sensor **102**, etc.). Furthermore, the communication control unit **104** transmits data including the acquired information (or information obtained by performing a predetermined process on the acquired information) to the body device **110**. The communication control unit **104** is constituted by, for example, a microprocessor. The communication control unit **104** executes various processes by executing firmware stored in the storage unit **103**. Note that the communication control unit **104** may communicate with the body device **110** by wired communication instead of or in addition to wireless communication.

[0117] As shown in FIG. **12**, the body device **110** includes a display **111**, a speaker **112**, a communication unit **113**, a storage unit **114**, and a processor **115**. The display **111**, the speaker **112**, the communication unit **113**, and the storage unit **114** are electrically connected to the processor **115**.

[0118] The display **111** and the speaker **112** are examples of output devices for outputting information to a user. The display **111** displays images based on commands from the processor **115**. The speaker **112** generates sound based on commands from the processor **115**.

[0119] The communication unit **113** is a device for communicating with other devices (for example, the controller **100**) via wireless communication. Note that the communication unit **113** may be configured so as to be capable of communicating with other devices via wired communication instead of or in addition to wireless communication.

[0120] The storage unit **114** includes, for example, volatile semiconductor memory, non-volatile semiconductor memory, etc. The storage unit **114** may further include a storage medium such as a hard disk drive (HDD), a solid-state drive (SSD), etc. The storage unit **114** stores computer

programs which are executed by the processor **115**, and various data which is used when various processes are executed by the processor **115**.
[0121] The processor **115** includes one or more central processing units (CPUs) and peripheral circuits therefor. The processor **115** executes various information processing by executing information processing programs stored in the storage unit **114**. The information processing programs include, for example, an OS program and an application program (for example, a game program).
[0122] In particular, in the present embodiment, the processor **115** performs processing in accordance with an information processing program based on the signal output from the detection circuit **101**. For example, the processor **115** may perform processing based on the signal which changes in accordance with the capacitance output from the detection circuit **101**. The signal which changes in accordance with the capacitance output from the detection circuit **101** represents the degree to which the finger of a user or the like, approaches the key assembly **1**, the degree to which the key assembly **1** is pressed, etc. Thus, the processor **115** performs processing based on the degree to which the finger of a user or the like approaches the key assembly **1**, and the degree to which the key assembly **1** is pressed.
[0123] Further, the processor **115** calculates a change in the capacitance which changes in accordance with the distance between the ground contact **15** and the conductive member **32** or the distance between the conductor **25** in contact with the ground contact **15** and the conductive member **32**, based on the signal which changes in accordance with the capacitance output from the detection circuit **101**. The processor **115** may perform processing based on the change in the capacitance calculated in this manner. Such a change in capacitance represents the degree to which the finger of a user or the like approaches the key assembly **1**, the degree to which the key assembly **1** is pressed and moved, etc. Thus, the processor **115** performs processing based on the degree to which the finger of a user or the like approaches the key assembly **1**, and the degree to which the key assembly **1** is pressed and moved. In particular, the change in capacitance which changes in accordance with the distance between the conductor **25** in contact with the ground contact **15** and the conductive member **32** represents a change in the amount of pressing of the key assembly I by the user after the pressing of the key assembly **1** by the user is detected. Thus, the processor **115** performs processing based on the change in the amount of depression of the key assembly **1** by the user after the depression of the key assembly **1** by the user is detected.
[0124] The processor **115** determines whether or not the user has pressed the key assembly **1** based on the signal which changes in accordance with the voltage output from the detection circuit **101**. The processor may then perform processing based on the result of the determination of whether or not the key assembly **1** has been pressed.
[0125] The processor **115** then outputs the results of the processing to output devices such as the display **111** and the speaker **112**. Thus, the display **111** and the speaker **112** output the results of the processing performed by the processor **115** based on the signal which changes in accordance with the capacitance and the signal which changes in accordance with the voltage, output from the detection circuit **101** of the key assembly **1**.
[0126] In this manner, the processor **115** can perform processing based not only on whether or not the user has pressed key assembly **1**, but also on the degree to which the finger of a user or the like approaches the key assembly **1** and the degree to which the key assembly **1** is pressed, allowing for a wider variety of processing than the case in which processing is based only on whether or not key assembly **1** is pressed.
[0127] In the present embodiment, the controller **100** is provided with a detection circuit **101**, which outputs a signal which changes in accordance with the capacitance between the ground and the conductive member **32** and a signal which changes in accordance with the voltage at the high potential contact **14**. However, such a detection circuit **101** may be provided in the body device **110** instead of the controller **100**. In this case, the controller **100** communicates with the body device

110 via, for example, a wire, and the detection circuit of the body device **110** is directly electrically connected to the key assembly **1**. Alternatively, a processor may be provided in the controller **100**. In this case, the processor provided in the controller **100** may calculate the change in capacitance based on the signal which changes in accordance with the capacitance, and may also determine whether or not the key assembly **1** has been pressed by a user.

[0128] In the present embodiment, the body device **110** includes output devices such as a display and a speaker, and the processing results by the processor **115** of the body device **110** are output from these output devices. However, the body device **110** may output the processing results to an external output device (such as an external display, speaker, or controller). Furthermore, the body device **110** may be a server which communicates with the controller **100**.

Effects

[0129] In the key assembly **1** according to the present embodiment, when a user operates the key assembly **1** to move the key top **50** and the moving part **21** of the elastic member **20** downward, the conductor **25** comes into contact with the contacts **14**, **15**, and the contacts **14**, **15** become conductive. Thus, by determining whether the contacts **14**, **15** are conductive, it is possible to detect whether the user has pressed the key assembly **1**.

[0130] Furthermore, the conductive assembly **30** electrically connected to the electrodes of the substrate **10** extends to the moving part upper surface **23**. Thus, when a finger of a user approaches the key top **50** to operate the key assembly **1**, and specifically, when the finger of the user approaches the moving part upper surface **23**, the distance between the finger of the user and the conductive assembly **30** changes, and the capacitance generated therebetween changes. As a result, the approach or contact of the finger of a user to the key assembly I can be detected based on the capacitance or based on the change in capacitance.

[0131] In the present embodiment, the conductive assembly **30** extends through the through hole **26** provided in the moving part **21**, and the conductor **25** is arranged around the through hole **26**. Thus, the structure of the key assembly I can be simplified as compared to the case in which the conductive assembly **30** is arranged around the outer periphery of the moving part **21** or the conductor **25**. Thus, according to the present embodiment, a key assembly **1** having a simple structure which can detect not only whether the key assembly **1** is pressed but also whether an object such as a finger of a user approaches or comes into contact with the key assembly I can be provided.

[0132] In the key assembly **1** according to the present embodiment, the conductive member **32**, i.e., the upper end of the conductive assembly **30**, is biased upward by the coil spring **31**. By providing an elastic member such as the coil spring **31** in this manner, the coil spring **31** can maintain contact with the conductive member **32** even if the conductive member **32** moves in conjunction with the movement of the moving part **21**. Thus, by providing such an elastic member, disconnection of the connection between the conductive member **32** and the electrode **13**, i.e., the connection between the conductive assembly **30** and the electrode **13**, can be prevented.

[0133] In the present embodiment, since the electrode **13** and the conductive member **32** are connected by a coil spring, which is an elastic member, the shape change which occurs when the moving part **21** and the conductive member **32** move can be predicted. Thus, by appropriately arranging the elastic member and other surrounding components, the occurrence of connection failures and the like caused by interference, such as the elastic member becoming entangled with other components, due to the movement of the moving part **21**, can be prevented.

[0134] In the key assembly **1** according to the present embodiment, the plate-like part **33** of the conductive member **32** is formed so as to at least partially cover the moving part upper surface **23**. By positioning the conductive member **32** not only in the through hole **26** of the moving part **21** but also on the moving part upper surface **23** in this manner, even if an object such as a finger of a user is positioned laterally deviated from the through hole **26**, the capacitance is likely to change in accordance with the distance between the conductive member **32** and the object, and thus, the approach or contact of the object to the key top **50** can easily be detected. Since the conductive member **32** including the plate-like part **33** is formed of a rigid material, even if the key top **50** is pushed down by a finger or the like off the axis X, the entire moving part **21** can be moved downward relatively uniformly.

[0135] Furthermore, in the key assembly **1** according to the present embodiment, the conductor **25** extends around the entirety of the circumference so as to surround the through hole **26**. Thus, the area of overlap between the conductor **25** and the plate-like part **33** of the conductive member **32** when viewed in the upward-downward directions can be made larger than the case in which the conductor **25** is formed so as to extend partially in the circumferential direction. As a result, the amount of change in the capacitance C′x relative to the change in the distance between the conductor **25** and the conductive member **32** can be made larger, making it easier to detect the change in the distance between the conductor **25** and the conductive member **32**. In addition, since the conductor **25** is formed so as to extend around the entirety of the circumference so as to surround the through hole **26**, and the contacts **14**, **15** of the substrate **10** are both positioned radially inward and radially outward in an annular manner, the contacts **14**, **15** can be made conductive even if the conductor **25** is slightly inclined in any direction when it moves downward and only a part thereof comes into contact with the contacts **14**, **15**.

[0136] In the present embodiment, at least one of the adhesive **40** and the key top **50** is formed of a non-conductive material. Thus, even if an object such as a human finger touches the key top **50**, there is no direct electrical connection between the conductive member **32** and the object. If there is direct electrical connection between the conductive member **32** and the object, the capacitance between the ground and the conductive member **32** changes significantly, and thus, a detection circuit **101** with a large dynamic range is required. In contrast, in the present embodiment, since there is no direct electrical connection between the conductive member **32** and the object, the capacitance can be detected even by the detection circuit **101** with a relatively small dynamic range.

Modification Examples

[0137] In the embodiment described above, the conductive member **32** includes the plate-like part **33**, which covers the moving part upper surface **23**. However, as long as the conductive assembly **30** extends through the through hole **26** of the moving part **21** to the moving part upper surface **23**, the conductive member **32** need not include the plate-like part **33**. Alternatively, the conductive member **32** may include a non-plate-like member which covers the moving part upper surface **23**, such as a mesh-like member.

[0138] In the embodiment described above, the intermediate part **34** of the conductive member **32** is formed so as to fit into the through hole **26**. However, as long as the conductive assembly **30** extends within the through hole **26** to the moving part upper surface **23** even if the moving part **21** moves in the upward-downward directions, the intermediate part **34** need not fit into the through hole **26**.

[0139] Furthermore, in the present embodiment, the conductive assembly **30** includes the coil spring **31** and the conductive member **32**, but the conductive assembly **30** may not include the coil spring **31** and the conductive member **32** as long as the conductive assembly **30** is connected to the electrode **13** and extends to the moving part upper surface **23** through the through hole **26** regardless of the clearance between the key top **50** and the substrate **10**. FIG. **13** is a cross-sectional view similar to FIG. **1**, of a key assembly **1** according to one modification. As shown in FIG. **13**, the conductive assembly **30** may be a conductor wire **36** or an FPC connected to the electrode **13** and bonded to the lower surface of the upper wall **51** of the key top **50**. Alternatively, the conductive assembly **30** may include a coil spring which extends to the moving part upper surface **23** without the conductive member **32**.

[0140] Furthermore, in the embodiment described above, the moving part **21** is formed so as to solid except for the through hole **26**. However, the part of the moving part **21** except for the through hole **26** may be formed so as to be hollow or porous. Specifically, for example, the moving part **21** may be formed of urethane foam. By forming the moving part **21** hollow or porous in this manner, it becomes easier for the user to compress the moving part **21** in the upward-downward directions. Furthermore, in the embodiment described above, the moving part **21** is formed of an elastic material. However, the moving part **21** may be formed of a rigid material.

[0141] In the embodiment described above, the elastic member **20** includes the moving part **21** and the biasing part **22**. However, the elastic member **20** may not include the biasing part **22**. FIG. **14** is a cross-sectional view of a key assembly **1** according to a modification similar to FIG. **1**. In the example shown in FIG. **14**, the elastic member **20** includes only the moving part **21** without the biasing part **22**. However, even in this case, the moving part **21** is biased upward together with the conductive member **32** by the coil spring **31**. In the example shown in FIG. **14**, the moving part **21** may be a member which is not elastic. In this case, since the moving part **21** does not clastically deform when the conductor **25** contacts the contacts **14**, **15**, the key top **50** and the conductive member **32** cannot be pressed further. Thus, in this case, the change in capacitance or the like, which represents the change in the amount of pressing of the key assembly **1** by the user after the pressing of the key assembly **1** is detected, need not be calculated.

[0142] In the embodiment described above, both the adhesive **40** and the key top **50** are formed of a non-conductive material. However, either one of the adhesive **40** and the key top **50** may be formed of a conductive material, and the other may be formed of a non-conductive material. Thus, the adhesive **40** may be formed of a non-conductive material, and the key top **50** may be formed of a conductive material. In this case, when an object such as a finger contacts the key top **50**, since the distance between the conductive key top **50** contacting the object and the conductive member **32** is short, the capacitance generated between the object and the conductive member **32** at this time can be high. Alternatively, both the adhesive **40** and the key top **50** may be formed of a conductive material. In this case, when an object such as a finger contacts the key top **50**, the capacitance Cf caused by the finger in FIG. **7** disappears, and the capacitance Ct generated between the ground and the conductive member **32** increases rapidly.

[0143] In the embodiment described above, the key assembly **1** is generally circular and includes a set of the electrode **13** and the contacts **14**, **15**. However, the key assembly **1** may be generally rectangular or have a shape other than a circle. The key assembly **1** may also be used in a cross key or the like. In this case, for example, an assembly which includes the electrode **13**, the contacts **14**, **15**, the elastic member **20**, the conductive assembly **30**, and the adhesive **40** is provided at each of the four ends of the cross key.

[0144] Though the preferred embodiments of the present invention have been described above, the present invention is not limited to these embodiments, and various modifications and changes can be made within the scope described in the claims.

Claims

1. A key assembly, comprising: a substrate comprising an electrode and at least two contacts on an upper surface, which is a surface on a first direction side, thereof; a moving part which is arranged on the first direction side of the substrate and which is non-conductive; and a first conductor which is electrically connected to the electrode, wherein the moving part comprises a first surface which is spaced from and faces the upper surface of the substrate in a natural state, a second surface which is provided on a side opposite of the first surface, and a through hole which penetrates the moving part in the first direction between the first surface and the second surface, a second conductor is provided on the first surface of the moving part at a position which contacts the at least two contacts simultaneously in response to a movement of the moving part from the natural state in a second direction opposite to the first direction, and the first conductor extends to the second surface through the through hole.

2. The key assembly according to claim 1, wherein the first conductor comprises an elastic member which biases an end of the first conductor on the second direction side in the first direction.
3. The key assembly according to claim 1, wherein the first conductor covers the second surface of the moving part.
4. The key assembly according to claim 3, wherein the first conductor covers an entirety of the second surface of the moving part.
5. The key assembly according to claim 3, wherein the first conductor comprises an upper body which covers the second surface and which is rigid.
6. The key assembly according to claim 5, wherein the first conductor comprises a lower body which is provided between the substrate and the upper body and which biases the upper body in the first direction.
7. The key assembly according to claim 6, wherein the upper body is partially positioned in the through hole of the moving part.
8. The key assembly according to claim 7, wherein a portion of the upper body which is positioned in the through hole is in radial contact with an inner surface of the moving part, which defines the through hole.
9. The key assembly according to claim 8, wherein the lower body is a coil spring and is arranged so as to surround a periphery of a portion of the upper body on the second direction side more than a portion of the upper body in contact with the inner surface of the moving part.
10. The key assembly according to claim 6, further comprising an elastic member which comprises the moving part and a biasing part which biases the moving part in the first direction toward a position in the natural state when the moving part moves from the natural state in the second direction, wherein when the moving part moves from the natural state in the second direction, a force by which the biasing part biases the moving part in the first direction is greater than a force by which the lower body biases the upper body in the first direction.
11. The key assembly according to claim 3, wherein at least one of the at least contacts is connected to a ground, and the moving part is formed such that a distance between the first surface and the second surface decreases as a pressing force increases when the first conductor is pressed in the second direction after the second conductor has come into contact with the at least two contacts.
12. The key assembly according to claim 11, wherein at least one of the at least two contacts is connected to a ground, and the first conductor is arranged on the first direction side of the second conductor so as to at least partially overlap the second conductor when viewed in the first direction.
13. The key assembly according to claim 1, wherein the second conductor extends so as to surround the through hole.
14. The key assembly according to claim 12, wherein two of the contacts are provided on the substrate, and two of the contacts are arranged so as to be co-annular and positioned radially inward and radially outward relative to each other.
15. The key assembly according to claim 1, further comprising a key top which is provided further on the first direction side than the moving part and the first conductor, wherein the key top is adhered to a surface of the first conductor on the first direction side via an adhesive, and at least one of the key top and the adhesive is non-conductive.
16. The key assembly according to claim 1, wherein one of the two contacts is connected to a ground, and the first conductor is arranged on a first direction side of the contact which is connected to the ground so as to at least partially overlap the contact which is connected to the ground when viewed in the first direction.
17. A controller, comprising the key assembly according to claim 1, and a detection circuit, wherein the detection circuit is configured so as to be capable of detecting a value of a parameter which changes in accordance with a presence or absence of current between the contacts and a capacitance of a circuit including the electrode.
18. A controller, comprising the key assembly according to claim 11 and a detection circuit,

wherein the detection circuit is configured so as to be capable of detecting a capacitance which changes in accordance with a distance between the second conductor, which is in contact with the contact which is connected to the ground, and the first conductor.

19. An information processing system, comprising the key assembly according to claim 1, and one or a plurality of processors, wherein the processors perform processing based on a value of a parameter which changes in accordance with a presence or absence of current between the contacts and a capacitance of a circuit including the electrode.