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(71) Applicant: **CAMBRIDGE MECHATRONICS LIMITED** [GB/GB]; The Westbrook Centre, Building 6, Milton Road, Cambridge Cambridgeshire CB4 1YG (GB).

(72) Inventors: **FLOURIS, Andreas**; Cambridge Mechatronics Ltd, The Westbrook Centre, Building 6, Milton Road, Cambridge Cambridgeshire CB4 1YG (GB). **SCHOLZ, Marc-Sebastian**; Cambridge Mechatronics Ltd, The Westbrook Centre, Building 6, Milton Road, Cambridge Cambridgeshire CB4 1YG (GB). **BROWN, Andrew Benjamin Simpson**; Cambridge Mechatronics Ltd, The Westbrook Centre, Building 6, Milton Road, Cambridge Cambridgeshire CB4 1YG (GB).

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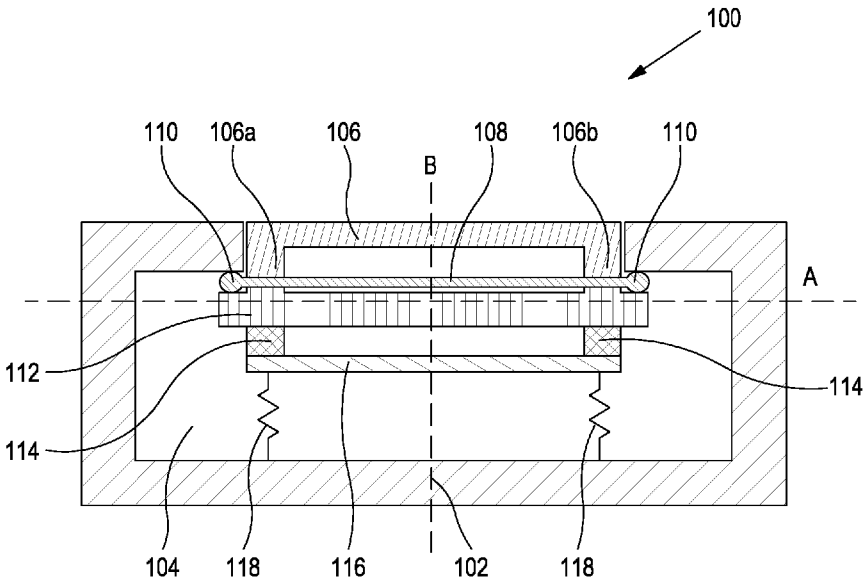


FIGURE 1

(57) Abstract: Broadly speaking, embodiments of the present techniques provide a haptic button assembly for providing haptic feedback in consumer electronic devices and comprising a compression seal. The compression seal both seals a cavity of the assembly against liquid and/or dust ingress, and exerts a preload force on a force sensing mechanism of the assembly (which also helps to maintain the sealing). Advantageously, because the compression seal is under compression within the haptic button assembly both when the button is not moving and when the button is moving, the compression seal may form a tight seal against liquid/dust ingress.

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A HAPTIC BUTTON ASSEMBLY

The present application generally relates to a haptic button assembly for providing haptic feedback in consumer electronic devices, and in particular to a haptic button assembly comprising a compression seal.

In a first approach of the present techniques, there is provided a haptic button assembly comprising: a housing comprising a cavity; a button provided within the cavity and moveable within the cavity, the button having a contact surface; a force sensing mechanism for detecting contact on the contact surface of the button; an actuator for moving the button to provide haptic feedback in response to detecting contact; and a sealing mechanism for sealing the cavity and arranged to exert a preload force on the force sensing mechanism.

In a second approach of the present techniques, there is provided an apparatus comprising: a haptic button assembly as described herein for delivering a haptic sensation to a user of the apparatus.

The apparatus may be any one of: a smartphone, a camera, binoculars, a foldable smartphone, a foldable image capture device, a foldable smartphone camera, an image capture device, a consumer electronic device, a mobile computing device, a laptop, a tablet computing device, a gaming system, an augmented reality system, a virtual reality system, a wearable device, and a vehicle. It will be understood that this is a non-exhaustive list of example apparatus.

In a third approach of the present techniques, there is provided a method for providing a haptic sensation to a user using the haptic button assembly described herein, the method comprising: receiving data from the force sensing mechanism indicating that contact has been made on the contact surface of the button; and sending a signal to drive the actuator.

In a related approach of the present techniques, there is provided a non-transitory data carrier carrying processor control code to implement any of the method described herein.

Preferred features are set out in the appended dependent claims.

Implementations of the present techniques will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a cross-sectional view of a haptic button assembly;

Figure 2 is a free-body force diagram showing forces acting on the haptic button assembly in an equilibrium state;

Figure 3 is a free-body force diagram showing forces acting on the haptic button assembly when the button is pressed/touched;

Figures 4A and 4B are free-body force diagrams showing forces acting on the haptic button assembly when the button is pressed/touched on a particular side; and

Figure 5 shows a flowchart of example steps for operating the haptic button assembly.

Broadly speaking, embodiments of the present techniques provide a haptic button assembly for providing haptic feedback in consumer electronic devices and comprising a compression seal. The compression seal both seals a cavity of the assembly against liquid and/or dust ingress, and exerts a preload force on a force sensing mechanism of the assembly (which also helps to maintain the sealing). Advantageously, because the compression seal is under compression within the haptic button assembly both when the button is not moving and when the button is moving, the compression seal may form a tight seal against liquid/dust ingress.

Figure 1 shows a cross-sectional view of a haptic button assembly 100 comprising a compression seal. The haptic button assembly described herein may be incorporated into any device in which it may be useful to provide a user of the device with haptic feedback. For example, the haptic button assembly 100 may be incorporated into an electronic device or a consumer electronics device, such

as a computer, laptop, portable computing device, smartphone, computer keyboard, gaming system, portable gaming device, gaming equipment/accessory (e.g. controllers, wearable controllers, etc.), medical device, user input device, etc. It will be understood that this is a non-limiting, non-exhaustive list of possible devices, which may incorporate the haptic button assembly described herein. The haptic button assembly described herein may be, for example, incorporated into or otherwise provided along an edge of a smartphone or on a surface of a smartphone. In embodiments, the haptic button assembly described herein may be provided as standalone modules that may be incorporated into an electronic device during manufacture, and may be adapted to suit the device specifications such that it fits into a casing or external surface of the electronic device. In alternative embodiments, some or all of the components of the haptic button assembly described herein may be integrally formed in an electronic device. For example, the housing and/or button of the haptic button assembly may be part of the electronic device itself. Each haptic button assembly may comprise electrical connections, which may couple the assembly to the device's processor(s), chip(s), motherboard, etc., such that the action of the button of the assembly being pressed may be processed by the device and so that the haptic feedback can be provided.

The haptic button assembly 100 comprises a button 106. The button 106 may be touched or pressed by a user to perform a particular operation, such as making a section, turning a device on/off, entering data (e.g. typing on a keyboard), scrolling, turning a function of the device in which the assembly 100 is located on or off or adjusting the function (e.g. adjusting volume of audio output from the device), etc. Pressing or depressing the button 106 may cause haptic feedback or a haptic sensation to be delivered to the user, so that the user is provided with some sensory feedback (particularly touch-based feedback) to indicate that the operation has been performed.

The haptic button assembly 100 comprises a housing 102 (also referred to herein as "support", "chassis", "casework", and "casing"). The housing 102 comprises a cavity or recess 104. The button 106 is provided within the cavity 104 of the housing 102. The button 106 comprises a contact surface, which may be level with/flush with an external surface of the housing 102, or may protrude

from or be recessed within the housing 102. It will be understood that the housing 102 surrounds and encases the button 106 such that only the contact surface of the button is visible/contactable by a user. The button 106 is moveable within the cavity 104.

The haptic button assembly 100 comprises a sealing mechanism and a force sensing mechanism. The sealing mechanism functions to seal the cavity 104 and is arranged within the cavity 104 to exert a constant preload force on a force sensing mechanism of the assembly 100. The force sensing mechanism functions to detect contact on the contact surface of the button 106 (e.g. a button press or a finger sliding along the button). The preload force may be, in certain embodiments, 3 Newtons. While the constant preload force may be provided by any mechanism, the present techniques advantageously make use of the presence of the sealing mechanism in the haptic assembly to perform both the sealing and the preloading. Thus, the haptic assembly may be simpler and/or cheaper to manufacture as it may comprise fewer components. The constant preload force may be necessary to pre-deform a deformable contact surface of the force sensing mechanism such that the force applied by the user on the button 106 is more likely to be sensed by the force sensing mechanism (or that a larger proportion of the force applied by the user is sensed). If the constant preload force is not present, some or all of the force may be transmitted through the deformable contact surface in a direction that means the force is not detected by the force sensor. Thus, by applying a preload force the force sensing mechanism may be better able to detect contact on the button 106, or may be more sensitive.

The force sensing mechanism comprises a compression mechanism. In embodiments, the compression mechanism may comprise a resilient element 118, and the preload force exerted by the sealing mechanism compresses the resilient element 118. As a result, the resilient element 118 exerts a force onto the sealing mechanism which pushes the sealing mechanism against the housing 102, thereby forming a seal against liquid and/or dust ingress even when the haptic button assembly 100 is not delivering haptic feedback. In this case, resilient element 118 may be located below a centre of the button 106 rather than being on one side (as illustrated). Alternatively, the compression mechanism may comprise at least two resilient elements 118 which are each coupled at one end to a coupling

element 116 and at another end to the housing 102. In this case, the preload force exerted by the sealing mechanism compresses the at least two resilient elements 118. The coupling element 116 functions to spread the spring bias force across a length of the button 106. The resilient elements 118 may be located below different sides of the button 106 (as shown). An array of resilient elements may be provided, in embodiments, where each resilient element is arranged below a different point of the button 106. The coupling element 116 may be a plate or have a plate-like form. The compression mechanism is contained within, and applies a force to, the housing 102 – the or each resilient element 118 pushes the sealing mechanism against the housing 102. The or each resilient element 118 may be a flexure, a coil spring or may be formed from a compliant material. Preferably, the spring constant of each resilient element 118 is the same.

The sealing mechanism comprises a thin membrane 108 provided between the button 106 and an actuator 112 (described below), such that the actuator 112 is able to transmit a force or a displacement through the thin membrane 108 to move the button 106. The sealing mechanism may comprise an O-ring seal 110 (or a hollow O-ring seal) which encloses the thin membrane 108. The O-ring seal 110 and thin membrane 108 may be integrally formed, or may be separate components which are fixedly attached to each other. The O-ring seal 110 may be formed from a compliant material. The sealing mechanism seals the cavity 104 against liquid and/or dust ingress, both when the assembly 100 is not being used to deliver haptic feedback, and when the button 106 is moving to deliver haptic feedback. The sealing mechanism is under compression within the cavity 104. The button 106 may comprise pillars or supports 106a, 106b. The supports 106a, b contact the thin membrane 108 and support the button 106 on the sealing mechanism. When the button 106 is touched, the force exerted by the user on the button 106 is therefore transferred through the supports 106a,b to the force sensing mechanism (via the thin membrane 108 and the actuator 112).

It will be understood that the compliance of the sealing mechanism and the compliance of the resilient element(s) 118 may be selected to apply a particular preload force.

In embodiments, the force sensing mechanism comprises a force sensor 114. The force sensor 114 may be arranged between the actuator 112 and a resilient element 118. In embodiments, where the assembly 100 comprises at least two resilient elements 118, the force sensing mechanism comprises at least two force sensors, where each force sensor is sandwiched between the actuator 112 and the coupling element 116. In embodiments, the assembly 100 may comprise at least one force sensor and at least one resilient element. Generally speaking, the assembly 100 may comprise N force sensors and M resilient elements, where N and M are integers and may be the same or different. If the assembly 100 comprises a single force sensor, the force sensing mechanism can only determine that the button 106 has been touched/pressed/swiped. However, if the assembly 100 comprises two or more force sensors, the force sensing mechanism may be able to determine where the button 106 is pressed or the type of contact that the user makes with the button 106 (e.g. a touch or a swipe), by analysing the magnitude of the force detected by each force sensor. Each force sensor may be coupled to (directly, or indirectly via the coupling element 116) a resilient element 118. The force sensors may be arranged to determine a location on the contact surface of the button 106 where contact is made – this is described in more detail with respect to Figure 3. The or each force sensor 114 measures the force transferred between resilient element 118 and the actuator 112.

In the embodiment shown in Figure 1, the force sensor(s) works under compression. However, the present techniques also work if the force sensor works under tension, though it will be understood that the arrangement of the force sensor and resilient element(s) relative to the actuator 112 may change to accommodate tension-based force sensors.

The haptic button assembly comprises an actuator 112 for moving the button 106 to provide haptic feedback in response to contact being detected on the contact surface of the button 106. The actuator 112 may comprise at least one shape memory alloy (SMA) actuator wire (not shown).

In embodiments, the button 106 may move laterally (side to side) within the housing 102. That is, the button 106 may be a 'horizontal button' that moves along an axis that is parallel to axis A. Example mechanisms for moving the button

106 laterally are described in pending International patent application WO2018/046937 and PCT/EP2018/064803, and pending United Kingdom patent application GB2551657, which are hereby incorporated by reference in their entirety.

In embodiments therefore, the actuator 112 may be arranged to deliver haptic feedback by moving the button 106 relative to the housing 102. The actuator 112 may be arranged to drive movement of the button 106 in a lateral direction with respect to the direction of travel of the button when pressed/touched.

In embodiments, the button 106 may move in and out of the housing 102/cavity 104. That is, the button 106 may be a 'vertical button' that moves along axis B. The actuator 112 may comprise an intermediate moveable element (not shown). The at least one SMA actuator wire may be coupled at one end to the intermediate moveable element and at another end to the housing 102. The intermediate moveable element may be arranged to move in one direction within the cavity, and the movement may cause the button 106 to move such that a haptic effect/sensation is delivered to a user touching the button 106. The intermediate moveable element and more generally, the mechanism for moving the button 106, may be any of the mechanisms described in pending United Kingdom patent applications GB1803084.1 and GB1813008.8, which are hereby incorporated by reference in their entirety.

In embodiments therefore, the button 106 may be moveable along a first axis B within the cavity 104 and the actuator 112 may comprise: at least one intermediate moveable element provided within the cavity 104 in contact with the button 106 and moveable in a plane defined by the first axis B and a second axis A, the second axis A being perpendicular to the first axis B, and arranged to drive movement of the button along the first axis B; wherein the at least one SMA actuator wire is coupled to the at least one intermediate moveable element and arranged to, on contraction, move the intermediate moveable element in the plane.

In alternative embodiments, the button 106 may be moveable along a first axis B within the cavity 104 and the actuator 112 may comprise: at least one intermediate moveable element provided within the cavity 104 in contact with the button 106 and rotatable about a second axis that is parallel to the first axis B, and arranged to drive movement of the button along the first axis B; wherein the at least one SMA actuator wire coupled to the at least one intermediate moveable element and arranged to, on contraction, rotate the intermediate moveable element about the second axis.

The intermediate moveable element of the actuator 112 may be coupled to the housing 102 by: the sealing mechanism, which is provided between the intermediate moveable element and the housing 102; and the force sensing mechanism, which is provided between the intermediate moveable element and the housing 102. A compliance of the coupling of the intermediate moveable element by the sealing mechanism may be greater than a compliance of the coupling of the intermediate moveable element by the force sensing mechanism. In this case, when the intermediate moveable element moves fractionally due to contact being made by a user on the contact surface of the button 106, then the change in force through the force sensing mechanism is greater than the change in force through the sealing mechanism (and in particular, through the O-ring 110). Thus, the force sensing mechanism may register more than half of the contact force applied by a user on the button 106.

Accordingly, the present techniques provided a haptic button assembly 100 comprising: a housing 102 comprising a cavity 104; a button 106 provided within the cavity 104 and moveable within the cavity 104, the button 106 having a contact surface; a force sensing mechanism for detecting contact on the contact surface of the button 106; an actuator 112 for moving the button 106 to provide haptic feedback in response to detecting contact; and a sealing mechanism for sealing the cavity 104 and arranged to exert a preload force on the force sensing mechanism.

In embodiments, the haptic button assembly 100 may comprise control circuitry (not shown) coupled to the force sensing mechanism and the actuator 112. The control circuitry may be arranged to/configured to: receive data from

the force sensing mechanism indicating that contact has been made on the contact surface of the button 106; and send a control signal to drive the actuator 112. If the assembly 100 comprises multiple force sensors 114, the control circuitry may be arranged to: determine, using the received data, a magnitude and position of the contact made on the contact surface. That is, the control circuitry may compare the force sensed by each force sensor 114 and determine where on the contact surface of the button 106 the contact force was applied.

Figure 2 is a free-body force diagram showing forces acting on the haptic button assembly 100 in an equilibrium state, i.e. when the button 106 is not moving. A sealing force F1 acts on the O-ring 110 of the sealing mechanism as the sealing mechanism is compressed within the housing 102. A bias force F3 acts on the force sensor(s) 114, which is applied by the resilient elements 118. (The gravitational force is small compared to all other forces and is omitted for clarity.) Here, when the haptic button assembly 100 is in the equilibrium state, the bias force F3 is equal to the sealing force F1, and therefore the system is static. In the illustrated example, there are two force sensors 114 and therefore, the preload force exerted on each of the force sensors 114 is equal to 0.5F3.

Figure 3 is a free-body force diagram showing forces acting on the haptic button assembly 100 when the button 106 is pressed/touched by a user. A sealing force acts on the O-ring 110 of the sealing mechanism as the sealing mechanism is compressed within the housing 102. A bias force acts on the force sensor(s) 114, which is applied by the resilient elements 118. A contact force F2 is exerted by a user on the contact surface of the button 106. In this case, the force F2 is applied to the middle of the contact surface of the button 106. Relative to the equilibrium state (Figure 2), the sealing force is now slightly smaller than F1 by "αF2", while the bias force is now slightly larger than F3 by "βF2". Sealing is still maintained and the preload force on the force sensors is still equal to 0.5F3. However, the force exerted on the force sensors 114 is now larger by 0.5βF2. The magnitude of the force in the sensors 114 above the constant preload force is the force measured by the force sensing mechanism.

Figures 4A and 4B are free-body force diagrams showing forces acting on the haptic button assembly when the button is pressed/touched on a particular

side. The contact force F2 may be applied at any position on the contact surface of the button 106 between the two extremes (i.e. two opposite edges of the button 106). The contact force F2 may be applied by a discrete touch/press of the button at a single position on the button 106, or may be applied when a finger slides across the contact surface between any positions. The positioning of the two force sensors 114, on two opposite sides of the button 106, may make it possible to determine the magnitude and position of the contact force F2 based on the force measured by each sensor 114. Thus, the measurements of the force sensors 114 may indicate where the button 106 has been pressed or if the user's finger slid across the button – this information may be used to provide different types of haptic feedback depending on the type of contact made with the button.

Figure 5 shows a flowchart of example steps for providing a haptic sensation to a user using the haptic button assembly 100. The method may comprise receiving data from the force sensing mechanism indicating that contact has been made on the contact surface of the button 106 (step S200). If contact is detected, the method may comprise sending a signal to drive the actuator 112 (step S204) to deliver the appropriate type of haptic feedback. Optionally, if the haptic button assembly 100 comprises multiple force sensors 114, the method may comprise determining, using the received data, a magnitude and position of the contact made on the contact surface (step S202), and then delivering (at step S204) the appropriate type of haptic feedback. Determining the magnitude and the position of the contact made on the contact surface may be useful for other purposes. For example, the button 106 may be operated by a user to perform a particular function, such as making a selection or scrolling – in these cases, the force sensors 114 enable the type of user input to be determined so that the desired function can be implemented.

Those skilled in the art will appreciate that while the foregoing has described what is considered to be the best mode and where appropriate other modes of performing present techniques, the present techniques should not be limited to the specific configurations and methods disclosed in this description of the preferred embodiment. Those skilled in the art will recognise that present techniques have a broad range of applications, and that the embodiments may

take a wide range of modifications without departing from any inventive concept as defined in the appended claims.

CLAIMS

1. A haptic button assembly comprising:

a housing comprising a cavity;

a button provided within the cavity and moveable within the cavity, the button having a contact surface;

a force sensing mechanism for detecting contact on the contact surface of the button;

an actuator for moving the button to provide haptic feedback in response to detecting contact; and

a sealing mechanism for sealing the cavity and arranged to exert a preload force on the force sensing mechanism.

2. The haptic button assembly as claimed in claim 1 wherein the force sensing mechanism comprises a compression mechanism.

3. The haptic button assembly as claimed in claim 2 wherein the compression mechanism comprises a resilient element, and the preload force compresses the resilient element.

4. The haptic button assembly as claimed in claim 2 wherein the compression mechanism comprises at least two resilient elements coupled to a coupling element, and the preload force compresses the at least two resilient elements.

5. The haptic button assembly as claimed in claim 3 or 4 wherein the or each resilient element is a flexure or coil spring or is formed from a compliant material.

6. The haptic button assembly as claimed in any preceding claim wherein the sealing mechanism comprises a thin membrane provided between the button and the actuator, and the actuator transmits a force through the thin membrane to move the button.

7. The haptic button assembly as claimed in claim 6 wherein the sealing mechanism comprises an O-ring seal which encloses the thin membrane.

8. The haptic button assembly as claimed in claim 7 wherein the O-ring seal and thin membrane are integrally formed.

9. The haptic button assembly as claimed in any preceding claim wherein the sealing mechanism seals the cavity against liquid and/or dust ingress.

10. The haptic button assembly as claimed in any one of claims 1 to 9 wherein the force sensing mechanism comprises a force sensor.

11. The haptic button assembly as claimed in any one of claims 1 to 9 wherein the force sensing mechanism comprises at least two force sensors arranged to determine a location on the contact surface of the button where contact is made.

12. The haptic button assembly as claimed in any preceding claim wherein the preload force is 3 Newtons.

13. The haptic button assembly as claimed in any preceding claim wherein the actuator comprises at least one shape memory alloy (SMA) actuator wire.

14. The haptic button assembly as claimed in claim 13 wherein the button is moveable along a first axis within the cavity and the actuator comprises:

at least one intermediate moveable element provided within the cavity contact with the button and moveable in a plane defined by the first axis and a second axis, the second axis being perpendicular to the first axis, and arranged to drive movement of the button along the first axis;

wherein the at least one SMA actuator wire is coupled to the at least one intermediate moveable element and arranged to, on contraction, move the intermediate moveable element in the plane.

15. The haptic button assembly as claimed in claim 13 wherein the button is moveable along a first axis within the cavity and the actuator comprises:

at least one intermediate moveable element provided within the cavity in contact with the button and rotatable about a second axis that is parallel to the first axis, and arranged to drive movement of the button along the first axis;

wherein the at least one SMA actuator wire coupled to the at least one intermediate moveable element and arranged to, on contraction, rotate the intermediate moveable element about the second axis.

16. The haptic button assembly as claimed in claim 14 or 15 wherein the intermediate moveable element is coupled to the housing by:

the sealing mechanism, which is provided between the intermediate moveable element and the housing; and

the force sensing mechanism, which is provided between the intermediate moveable element and the housing.

17. The haptic button assembly as claimed in claim 16 wherein a compliance of the coupling of the intermediate moveable element by the sealing mechanism is greater than a compliance of the coupling of the intermediate moveable element by the force sensing mechanism.

18. The haptic button assembly as claimed in claim 13 wherein the actuator is arranged to drive movement of the button in a lateral direction with respect to the direction of travel of the button when touched.

19. The haptic button assembly as claimed in any preceding claim further comprising control circuitry coupled to the force sensing mechanism and the actuator, and arranged to:

receive data from the force sensing mechanism indicating that contact has been made on the contact surface of the button; and

send a signal to drive the actuator.

20. The haptic button assembly as claimed in claim 19 wherein the control circuitry is arranged to:

determine, using the received data, a magnitude and position of the contact made on the contact surface.

21. An apparatus comprising:

a haptic button assembly according to any one of claims 1 to 20 for delivering a haptic sensation to a user of the apparatus.

22. The apparatus as claimed in claim 21 where the apparatus is any one of: a smartphone, a camera, binoculars, a foldable smartphone, a foldable image capture device, a foldable smartphone camera, an image capture device, a consumer electronic device, a mobile computing device, a laptop, a tablet computing device, a gaming system, an augmented reality system, a virtual reality system, a wearable device, and a vehicle.

23. A method for providing a haptic sensation to a user using the haptic button assembly according to any of claims 1 to 20, the method comprising:

receiving data from the force sensing mechanism indicating that contact has been made on the contact surface of the button; and

sending a signal to drive the actuator.

24. The method as claimed in claim 23 further comprising:

determining, using the received data, a magnitude and position of the contact made on the contact surface.

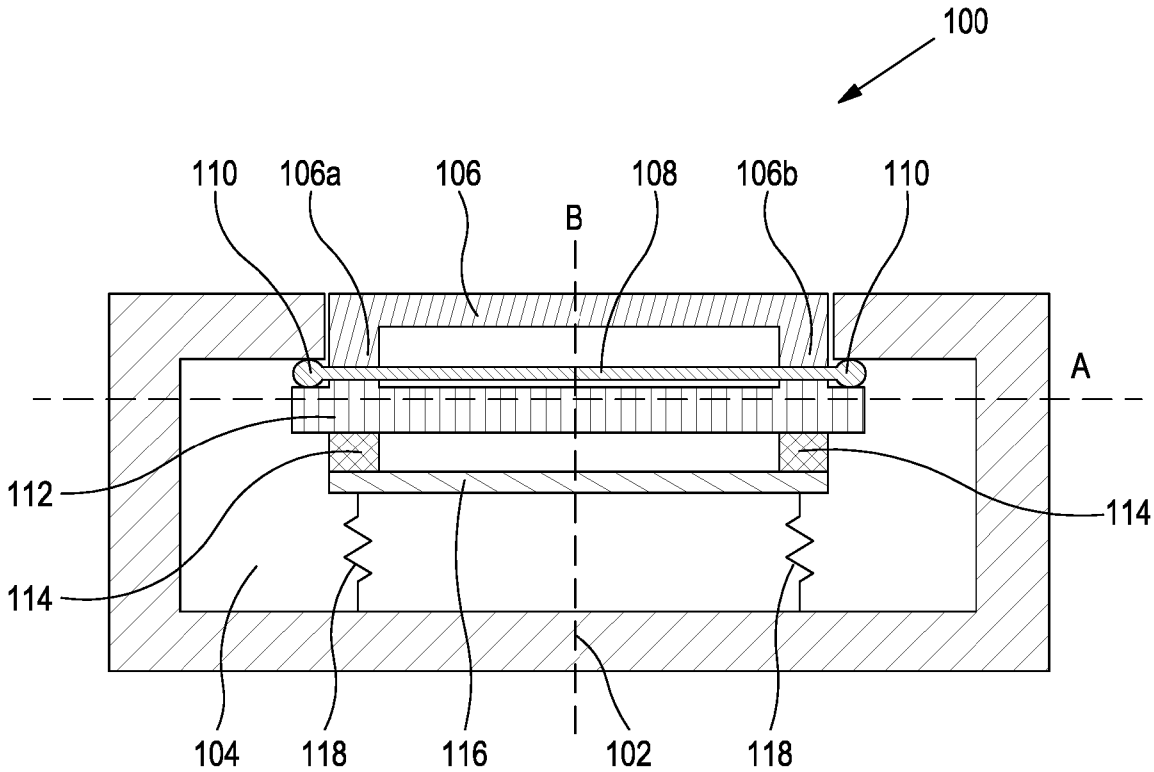


FIGURE 1

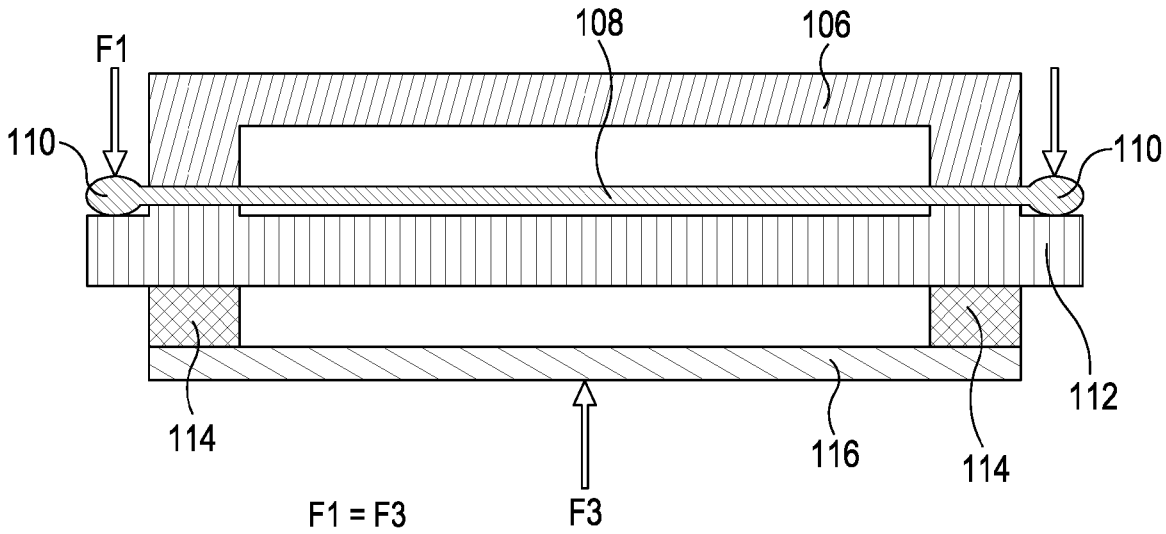


FIGURE 2

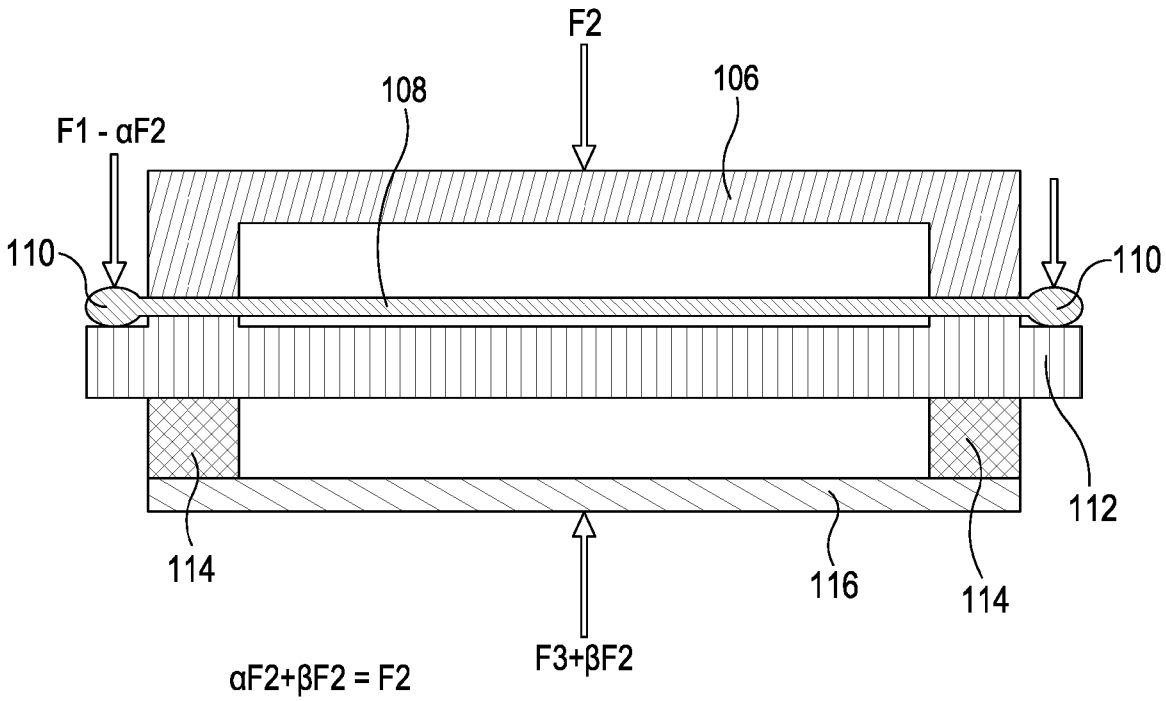


FIGURE 3

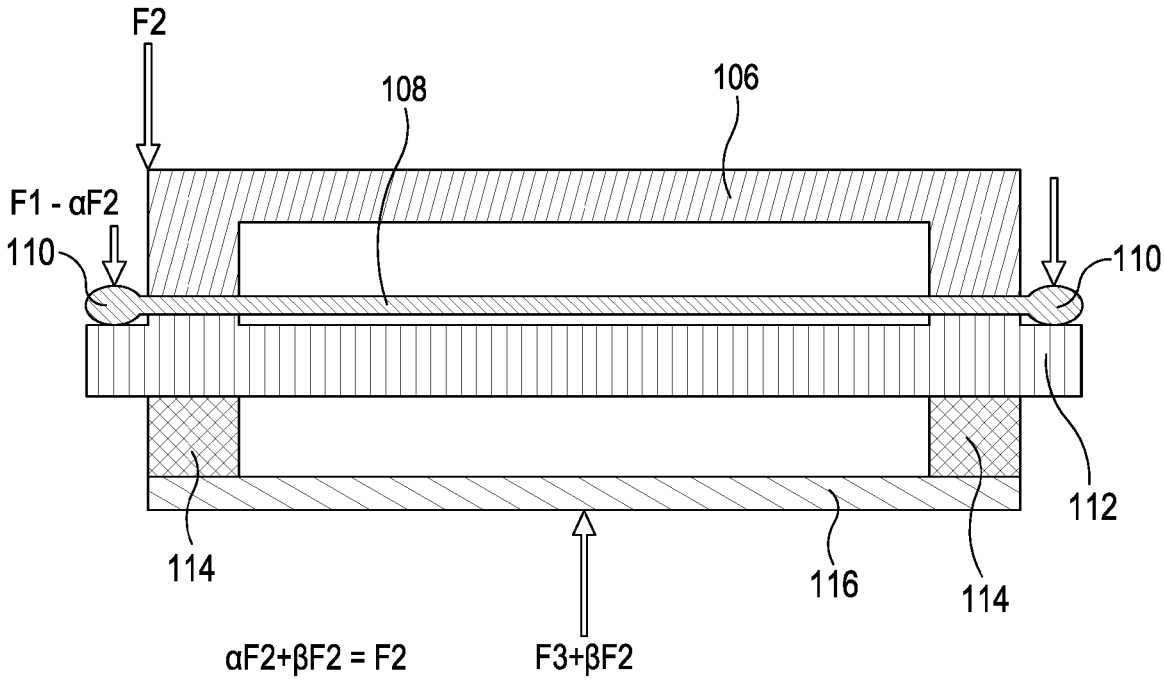


FIGURE 4A

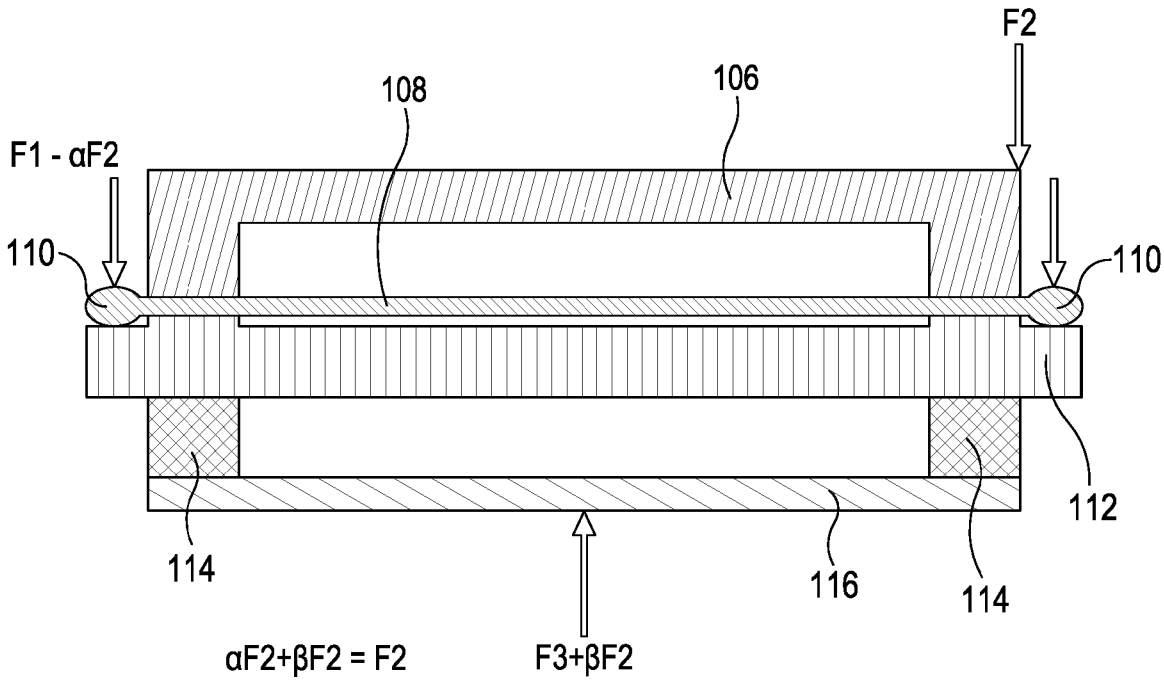


FIGURE 4B

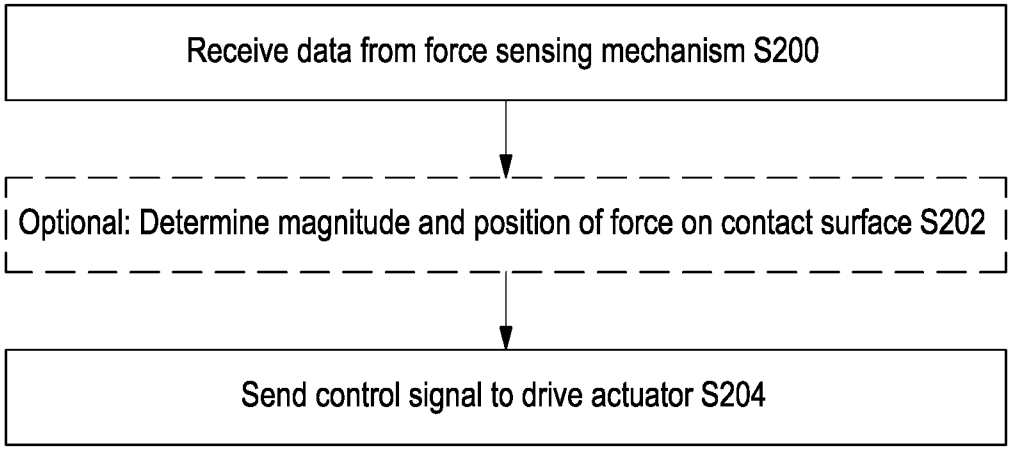

Receive data from force sensing mechanism S200
Optional: Determine magnitude and position of force on contact surface S202
Send control signal to drive actuator S204

FIGURE 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2019/052257

A. CLASSIFICATION OF SUBJECT MATTER
INV. H03K17/96 H03K17/965 G06F3/01 G06F3/041
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)
H03K G06F

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 202 619 A1 (RESEARCH IN MOTION LTD [CA]) 30 June 2010 (2010-06-30) figures 3A, 3B, 3C, 6 paragraph [0057] - paragraph [0061] -----	1-5, 10-12

☐ Further documents are listed in the continuation of Box C.

☒ 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

"E" earlier application or patent but published on or after the international filing date

"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
7 October 2019	09/12/2019

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	Simon, Volker

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2019/052257

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-5, 10-12

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5, 10-12

   Implementation of a force sensing mechanism

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2. claims: 6-9

   Implementation of a sealing mechanism

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3. claims: 13-24

   Implementation and driving of an actuator for providing haptic feedback

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2019/052257

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