Title: A DEVICE, A KEYPAD, AND A STEERING WHEEL

Abstract: A device (10) comprises a plurality of keys (101) assembled onto a flexible support sheet (103); and profiling means (105) that are adapted to give a predefined profile for the flexible support sheet (103). Surfaces of the keys (101) are together adapted to form a surface of the device (10).
A DEVICE, A KEYPAD, AND A STEERING WHEEL

Field of the invention
The invention relates to surface shape of a device comprising keys.

Background of the invention
Very small portable electronic devices usually have a relatively large number of keys in a relatively small area, thus having a high key density. This is due to the fact that the physical size of such devices is quite small as compared to the number of keys. Typically, the number of keys is 9 or 12, possibly further including one or more keys for control functions.

The high key density makes it more difficult for the user to give input for the portable electronic device. Using the keypad becomes frustrating and cumbersome. In some cases the functionality degrades so that when a user is willing to give one input only, he unintentionally presses two keys simultaneously. As a result, the input thus obtained from the keypad may be erroneous. In the present market situation, where the number of different manufacturers of portable electronic devices, especially mobile terminals, is constantly increasing, no manufacturer can afford losing customers because of having a keypad of poor quality.

The hard competition in the market has led to a close collaboration between a designer and a keypad engineer. Even though the latter would prefer having a traditional and easy-to-assemble-and-use keypad, the former might require more sophisticated looks for the complete portable electronic
device. As a consequence, not only the device but also the keypad has become a target of even increasing research and design work.

In US patent 5,929,401 a keypad having a curved structure was presented. A problem related to '401 solution is that such a keypad is still not aesthetically satisfying and it sets too tight requirements for the variability of the housing, because the keypad comprises a rigid supporting or insertion plate which takes the form of the device and has a certain profile. The insertion plate has holes for the keys to pass through. By using such a rigid supporting plate some part of flexibility is already lost. Especially dynamically changing the shape of the housing of the device is not possible.

So it remains a problem how to construct a device comprising a plurality of keys assembled onto a flexible support sheet, further comprising and profiling means, in such a manner that the device has an easily changeable profile.

Summary of the invention

The problem can be solved with a device as defined in the first independent patent claim. If the profiling means are adapted to give a predefined profile for the flexible support sheet, and surfaces of the keys are together adapted to form a surface of the device, there is then no need for a separate supporting plate with holes for the keys. Such a supporting plate would drastically limit the design. A further advantage is that because now surfaces of the keys are together adapted to form a surface of the device, in the case of a shape change of the device, there is no need to redesign the supporting plate, but it suffices to redesign the profiling means.
Especially, the device according to the invention is a keypad of an electronic device, or a steering wheel of a vehicle. If the device is a keypad, then, preferably, the profiling means are not visible. As a consequence, the quality of the molding does not need to be that perfect than otherwise would be the case, thereby reducing significantly the manufacturing cost for the manufacture of the device comprising such a keypad, because the reusability of the keypad can be increased.

According to a further aspect of the present invention, changing the shape or profile of a device by simply changing the profile of the profiling means. Especially, if this is performed in response to a control signal responsive to a state of an external entity, new possibilities for using the device are opened. In the past, because the rigid support plate has fixed the shape of the device, rendering these possibilities unavailable. In this manner, giving tactile feedback to the user becomes much more feasible than before.

The first particular embodiment of the present invention includes a keypad. The keypad, if used in a portable electronic device, can be adapted to change its profile in response to a control signal responsive to a charge state of the electronic device. Or, if the electronic device is a mobile terminal, then it can be adapted to change its profile in response to a control signal responsive paging the mobile terminal, for example.

The second particular embodiment of the present invention includes a steering wheel. Some steering wheels include a portion with some keys. Following the logics above, the steering wheel can now be made to soften or smallen in
response to a control signal. Such a control signal may be responsive to a speed meter or fuel gauge reading of a vehicle, or to a tyre pressure.

5 Short description of the drawings

In the following, the invention will be described in more detail with reference to the accompanying drawings in Figures 1 to 5B, of which:

10 Figure 1 shows a device comprising a plurality of keys assembled onto a flexible support sheet, and profiling means adapted to give a predefined profile for the flexible support sheet, and wherein surfaces of the keys are together adapted to form a surface of the device according to a first aspect of the present invention;

15 Figure 2 shows a device according to a second aspect of the present invention, wherein the profiling means further comprise means for changing the profile of the flexible support sheet.

20 Figure 3A is top view (from direction E) of a keypad according to one aspect of the present invention;

25 Figure 3B is side view (from direction C) of the keypad shown in Figure 3A;

Figure 3C is side view (from direction A) of the keypad shown in Figures 3A and 3B;
Figure 4 shows a device according to a third aspect of the present invention, wherein the profiling means further comprising means for changing the profile are adapted to change the profile of the flexible support sheet in response to a control signal responsive to a state of an external entity;

Figure 5A shows a top view of a steering wheel according to one aspect of the present invention; and

Figure 5B shows section in direction II-II of the steering wheel of Figure 5A.

Same reference numbers refer to similar structural elements throughout figures 1 to 5B.

**Detailed description of the invention**

Figure 1 shows a device 10 comprising a plurality of keys 101 assembled onto a flexible support sheet 103. Further, the device 10 comprises profiling means 105 adapted to give a predefined profile for the flexible support sheet 103. Surfaces of the keys 101 are together adapted to form a surface of the device 10 according to a first aspect of the present invention.

Figure 2 shows a device 10 according to a second aspect of the present invention. In the device 10 of Figure 2, the profiling means 105 further comprise means 107, 109, and 111 for changing the profile of the flexible support sheet 103. In this example, the flexible support sheet 103 forms a substantially closed surface. The device 10 includes now a processing unit 107, which can activate the pump 111 to pump air or any other fluid through a pipe 113. The processing
unit 107 and the pump 111 are both energized by a rechargeable battery 109. Instead of pipe 113 a flexible pipe or hose can be used as well. The pipe 113 is connected via a ventile 115 to the cavity formed by the substantially closed surface of the flexible support sheet 103.

If the cavity 103 is to be filled with air, then the pump 111 can have an inlet through the housing of the device 10. At least some air molecules from the flexible support sheet 103 can be pumped out from the cavity as well. Then the pump 111 pumps them outside the device 10. Also a ventile controlled by the processing unit 107 could be applied.

If the cavity 103 were to be filled with some other fluid, such as with a geleous substance, then the device 10 would preferable comprise a container for the fluid as well. Then instead of pumping the fluid outside the device 10 the pump 111 could be activated to pump an amount of the fluid out from the cavity back to the container.

As an alternative, the electrical state of the material can be changed. Materials under continuinig research include Electro-Rheological Fluids ERF, of which more information can be found in document "Modelling and Design of an Electro-Rheological Fluid Based Haptic System for Teleoperation of Space Robots", at the time of writing (September 18, 2003) downloadable in the Internet at http://cronos.rutgers.edu/~mavro/papers/robotics2000.pdf. The main advantage gaied from ERF materials which as the main rule are electroactive polymers that change their viscosity in response to an electrical field is that in this manner the feeling of the stiffness of the keyboard can be changed.
An advantage of the arrangement as shown in Figure 2 is that now the profile of the flexible support sheet 103 can be changed by the profiling means 105 thus increasing the versatility of the device 10.

The flexible support sheet 103 itself does not need to form the whole cavity, but preferably a part of it. At least some of the keys 101 can act as a part of cavity wall. Further, if the profiling means 105 as shown in Figure 1 are used in connection with profiling means 105 as shown in Figure 2, the profiling means 105 of Figure 1 can act as a part of cavity wall. The flexible support sheet 103 provides elastic properties necessary for the expansion or contraction of the cavity.

Instead of pumping the cavity, it can be changed in some other manner. For example, some materials have a large thermal expansion coefficient. Then the profiling means 105 can be adapted to heat or cool the flexible support sheet 103 to give the predefined profile. Some materials have magnetostrictive properties, they can be used in the flexible support sheet 103; then if the profiling means 105 change the magnetization of the flexible support sheet 103, the shape changes. In both of these particular cases, the flexible support sheet 103 does not need to be flexible in the conventional manner but with flexibility is meant in this context that the profile of the flexible support sheet 103 can be changed with the profiling means 105 as if the flexible support sheet were flexible.

Figure 3A is top view (from direction E) of a keypad 30 according to one aspect of the present invention. The keypad 30 comprises keys 101 arranged in rows and columns. The keys
101 are placed at different levels with the help of a flexible support sheet 103 and profiling means 105, for example in the manner as shown in Figures 1 or 2. The rows of keys can be placed at different levels. The keys 101 follow the shape of the flexible support sheet 103 which in turn follows the shape of the profiling means 105. In this manner, the keypad 103 can we wrapped around a desired volume defined by the profiling means 105. Surfaces of the keys 103 are together adapted to form a surface of the keypad 30.

In the case of the profiling means 105 following the principle laid down in Figure 1, the profiling means 105 act then as a guiding surface. By selecting the shape of the profiling means 105 suitably, the keys 101 in keypad 30 can even be wrapped around a sphere or semisphere.

A benefit of such a keypad is that now the user does not need to move his or her finger a long way in order to press different keys while reducing the probability of a pressing a false key. This is a consequence of enhanced key packing. On one hand, the key density is at minimum possible for a fixed device 30 size and for an allowed keypad size. On the other hand, because the keys follow the volumetric form, the keys are as big as possible and the distance between key edges is at maximum.

In the case of the profiling means 105 following the principle laid down in Figure 2, the profiling means 105 act then as means for shaping the profile of the flexible support sheet 103.
Figure 3B is side view (from direction C) of the keypad 30 shown in Figure 3A. Figure 3C is side view (from direction A) of the keypad 30 shown in Figures 3A and 3B.

Figure 4 shows a device 10 according to a third aspect of the present invention, wherein the profiling means 105 further comprise means 107, 111 for changing the profile of the flexible support sheet 103 in response to a control signal responsive to a state of an external entity 500. The control signal is preferably generated by the processing unit 107 in response to a signal from the external entity 500. The external entity 500 can be any device, depending on the device 10. Some aspects of the feature "external" can be understood to mean an entity internal to the device but external to the keypad. Following this way of thought, the changing of the profile can be used as an indicator or to optimize user input in a particular task. Game applications are a good example of possible uses of such a design.

For example, if the device 10 is a keypad 30 as in Figures 3A to 3C, then the device 500 wherefrom the signal comes from can be a rechargeable battery, or a terminal unit.

In the case of a rechargeable battery, the signal can correspond to the reading of the battery fuel gauge or battery voltage. The shape of the keypad 30 depends then on the battery charge state or voltage. For example, the by suitably emptying the cavity at least partially formed by the flexible support sheet 103, the keypad 30 can be softened when the charge state of the battery or voltage drops in order to notify the user in a tactile manner that he or she needs to recharge the battery.
In the case of a terminal unit, the signal can correspond to the receiving of a paging signal. Normally, a user is then paged by playing a ringing tone, or by using a vibratory motor usually in the back cover. Some vibratory motors shake the rechargeable battery to alert the user. By using this aspect of the present invention, such a "vibrating alarm", i.e. the repeatedly softening and hardening of the keypad 30, or the keypad 30 repeatedly enlarging and contracting, replaces the vibrator in the battery pack, thus simplifying the mechanical design. And because the keypad 30 according to the present invention may be used for other purposes as principally defined in the other embodiments and aspects of the present invention, the keypad 30 becomes really multifunctional.

The device 10 can be a steering wheel as well. If the device 10 would then be used in a vehicle, especially in a passenger car, then the external entity 500 could correspond to fuel gauge, central diagnostics system, speed meter, or accelerometer. Some of these embodiments are described in more detail below with reference to Figures 5A and 5B.

Figure 5A shows a top view of a steering wheel 50 according to one aspect of the present invention. The steering wheel comprises a plurality of keys 101, wherein surfaces of the keys 101 are together adapted to form a surface of the steering wheel 50. The steering wheel 50 does not need to be wholly covered by the keys 101 but it suffices that there is at least one key. The controls for constant speed ("Tempomat") device will do as well.

As can be seen in Figure 5B showing a section in direction II-II of the steering wheel of Figure 5A, a key 101 is
embedded or assembled onto a flexible support sheet 103. The flexible support sheet 103 now preferably has a tube-like form. A closed band shape or a substantially closed surface will do as well.

The profiling means 105 are located within the wheel 50. They may include a pump and ventile 511 to the steering wheel 50. The profiling means, in the manner shown in Figure 4, receive a signal from an external unit 500 and change the flexible support sheet 103 to have a predetermined profile.

If the external unit 500 is a speed meter, then the steering wheel 50 can become soft if the driver is driving too fast. The question of driving too fast may be driver-dependent, i.e. for young drivers in possession of a driver's licence for under a predefined period, there is a speed limit of 80 km/h. Alternatively, it may depend on environment parameters, such as the current speed limit on the road, or on road conditions, such as icing or excessive amount of water or snow on the road.

If the external unit 500 is a fuel gauge, then the steering wheel 50 can become soft or begin to shrink if the vehicle is running out of gas.

If the external unit 500 is an accelerometer, then the steering wheel 50 can act as an airbag-like device. If the accelerometer detects a sudden acceleration, i.e. an acceleration exceeding a predefined limit, then the probability of a collision is high. In this case the profiling means 105 can explode a load 513 of explosive normally used in current airbags. All rims of the steering wheel 50 in Figure 5A can include a load 513 of explosive,
then in the example of Figure 5A the number of loads would be 4. However, the number of rims can conveniently be changed to be anything between 2 and 8.

The device 10 can include any characteristics of the keypad 30 and the steering wheel 50.

A specific embodiment is that a mobile terminal, such as a mobile phone, is equipped with an accelerometer. Then the external unit 500 would correspond to this accelerometer. If the mobile terminal is dropped, the accelerometer detects an acceleration of close to 1 G. Then the profiling means 105 can give a predefined profile for the flexible support sheet 103. Two possibilities are proposed as specific embodiments: i) the flexible support sheet 103 shrinks, or ii) it expands.

If the flexible support sheet 103 shrinks, the keypad 30 comprised within the mobile terminal shrinks as well. This approach may be useful if the keypad 30 is one of the most vulnerable parts of the mobile terminal, because shrinking protects the keypad 30 then from hitting the ground.

If the flexible support sheet 103 expands, then the keypad 30 may be an airbag for a mobile terminal, protecting the display and other vulnerable parts from damages. In other words, by enlarging a keypad 30 in order to use it excessively as an element receiving collision forces, the mechanical shock to other components can be reduced.

After a predefined time interval, the keypad 30 can be returned to its normal state. If the keypad 30 comprises explosives, because of a small pump might be too slow in some occasions, then the keypad 30 is preferably replaced with a new, unexploded one.
Claims:

1. A device (10) comprising: a plurality of keys (101) assembled onto a flexible support sheet (103); and profiling means (105) adapted to give a predefined profile for the flexible support sheet (103); and wherein surfaces of the keys (101) are together adapted to form a surface of the device (10).

2. A device (10) according to claim 1, further characterized in that: the flexible support sheet (103) forms a closed band.

3. A device (10) according to claim 1, further characterized in that: the flexible support sheet (103) forms a substantially closed surface.

4. A device (10) according to claim 1, 2, or 3, further characterized in that: said profiling means (105) comprise means (107, 109, 111) for changing the profile of the flexible support sheet (103).

5. A device (10) according to claim 4, wherein: said means (107, 109, 111) for changing the profile of the flexible support sheet (103) are adapted to change the profile of the flexible support sheet (103) in response to a control signal responsive to a state of an external entity (500).

6. A device (10) according to claim 5, wherein: said means (107, 109, 111) for changing the profile of the flexible support sheet (103) are adapted to apply a different pressure on or into the flexible support sheet (103).
7. A device (10) according to claim 5, wherein: said means (105) for changing the profile of the flexible support sheet (103) are adapted to change an elastic property of said flexible support sheet (103).

8. A keypad (30) comprising at least one device according to any one of the preceding claims.

9. A keypad (30) comprising at least one device according to claim 5, 6, or 7, wherein: said means (105) for changing the profile of the flexible support sheet (103) are adapted to change the profile of the flexible support sheet (103) in response to a control signal responsive to a charge state of a battery (500).

10. A keypad (30) comprising at least one device according to claim 5, 6, or 7, wherein: said means (105) for changing the profile of the flexible support sheet (103) are adapted to change the profile of the flexible support sheet (103) in response to a control signal responsive to a mobile terminal receiving an incoming call.

11. A steering wheel (50) comprising at least one device according to any one of the preceding claims 1 to 7.

12. A steering wheel (50) comprising at least one device according to claim 5, 6, or 7, wherein: said means (105) for changing the profile of the flexible support sheet (103) are adapted to change the profile of the flexible support sheet (103) in response to a control signal responsive to a fuel gauge (500) of a vehicle.
13. A steering wheel (50) comprising at least one device according to claim 5, 6, or 7, \textit{wherein}: said means (105) for changing the profile of the flexible support sheet (103) are adapted to change the profile of the flexible support sheet (103) in response to a control signal responsive to a speed meter (500) reading of a vehicle.

14. A steering wheel (50) comprising at least one device according to claim 5, 6, or 7, \textit{wherein}: said means (105) for changing the profile of the flexible support sheet (103) are adapted to change the profile of the flexible support sheet (103) in response to a control signal responsive to an accelerometer (500) reading of a vehicle.
### INTERNATIONAL SEARCH REPORT

**International Application No:** PCT/EP 03/16541

### A. CLASSIFICATION OF SUBJECT MATTER

- IPC 7: H01H13/70, G06F3/02, H04M1/23, B60R16/02

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): IPC 7: H01H, G06F, H04M, B60R, G05G

- Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:
  - Electronic data base consulted during the international search (name of data base and, where practical, search terms used): PAJ, EPO-Internal, WPI Data, INSPEC

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

- "A" document defining the general state of the art which is not considered to be of particular relevance.
- "E" earlier document but published on or after the international filing date.
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