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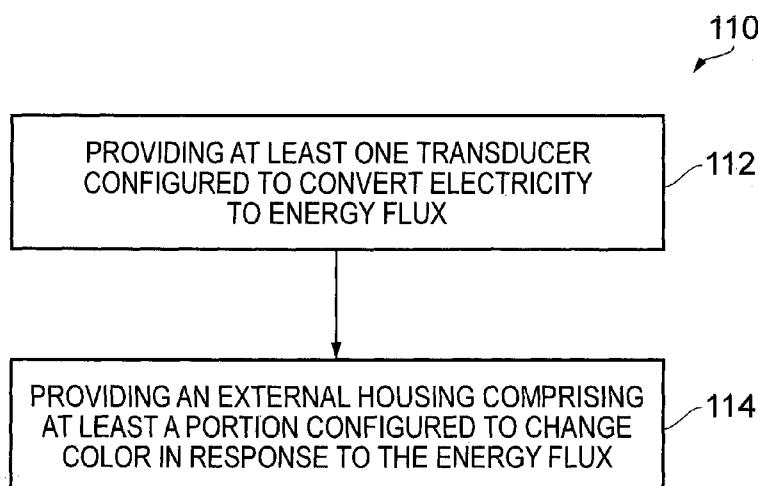


FIG. 9

(57) Abstract: An apparatus comprising: at least one transducer configured to convert electricity to an alternative energy flux; and an external housing comprising at least a portion configured to change color in response to receiving the alternative energy flux.

TITLE

An apparatus, an external housing portion and a method.

TECHNOLOGICAL FIELD

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Embodiments of the present invention relate to an apparatus, an external housing portion and a method. In particular, they relate to changing an appearance of an apparatus and/or an external housing portion of an apparatus.

10 BACKGROUND

It is known, for example in the Nokia® 5110, to use user replaceable covers to make mobile cellular telephones more personal.

15 It is known, for example in Windows Phone 8, to enable a user to reconfigure a home screen to make mobile cellular telephones more personal.

BRIEF SUMMARY

20 According to various, but not necessarily all, embodiments of the invention there is provided an apparatus comprising: at least one transducer configured to convert electricity to an alternative energy flux; and an external housing comprising at least a portion configured to change color in response to receiving the alternative energy flux.

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According to various, but not necessarily all, embodiments of the invention there is provided an external housing portion comprising: a body having an interior surface and an exterior surface, wherein the exterior surface is configured to change color in response to incidence of a flux of energy on the interior surface.

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According to various, but not necessarily all, embodiments of the invention there is provided a method comprising: providing at least one transducer configured to convert electricity to an alternative energy flux; and providing an external housing

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comprising at least a portion configured to change color in response to the alternative energy flux.

BRIEF DESCRIPTION

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For a better understanding of various examples that are useful for understanding the brief description, reference will now be made by way of example only to the accompanying drawings in which:

Fig 1 illustrates an example of an apparatus that changes color;

10 Fig 2 illustrates an example of the apparatus in which the or each transducer comprises one or more light emitting devices configured to convert the electrical control signal to electro-magnetic (EM) radiation;

Fig 3 illustrates an example of the apparatus in which the or each transducer comprises one or more heat generating devices configured to convert the
15 electrical control signal to heat;

Fig 4 illustrates, in plan view, an exterior face of an example of an apparatus which comprises multiple transducers;

Fig 5 illustrates an example of an apparatus which is capable of controlling one or more transducers;

20 Figs 6A and 6B illustrates an example of a color change as a consequence of the color-changing portion receiving an energy flux;

Figs 7A and 7B illustrate an example in which the apparatus is a hand-portable electronic apparatus;

Fig 8 illustrates a housing cover portion that attaches to a housing body portion
25 and comprises one or more color changing portions; and

Fig 9 illustrates a method.

DETAILED DESCRIPTION

30 The Figures illustrate an apparatus 10 comprising: at least one transducer 20 configured to convert electricity 22 to an alternative energy flux 24; and an external housing 30 comprising at least a portion 32 configured to change color in response to receiving the alternative energy flux 24.

Fig 1 illustrates an example of an apparatus 10 that changes color.

5 The apparatus 10 comprises an external housing 30 comprising a portion 32 that is configured to change color. The color change occurs in response to receiving an energy flux 24 from one or more transducers 20. The or each transducer 20 is configured to convert an electrical control signal 22 to energy flux 24 (different to the electrical energy of the electrical control signal 22). This (alternative) energy flux 24 may, for example, be radiated electro-magnetic radiation such as ultra-
10 violet light or may be, for example, thermal energy flux (heat).

In this illustrated example, the or each transducer 20 is housed within the housing 30. The color-changing portion 32 of the housing 30 has an exterior face 34 and an interior face 36. The or each transducer 20 provides an alternative energy flux
15 34 to the interior face 36. The incident alternative energy flux 34 produces a color change at the color-changing portion 32 of the housing 30, which is visible to a human user viewing the exterior face 34 of the color-changing portion 32.

Fig 2 illustrates an example of the apparatus 10 in which the or each transducer
20 20 comprises one or more light emitting devices 40 configured to convert the electrical control signal 22 to electro-magnetic (EM) radiation, as the alternative energy flux 24. The EM radiation 24 is provided to the interior face 36 of the color-changing portion 32. The color changing portion 32 of the external housing 30 comprises plastic with photochromatic pigment and the incident EM radiation
25 produces a color change in the photochromatic pigment at the color-changing portion 32. This color change is visible to a human user viewing the exterior face 34 of the color-changing portion 32.

In this example, the EM radiation 24 is ultra-violet radiation and the one or more
30 light emitting devices 40 may be light emitting diodes (LEDs).

The color-changing portion 32 of the external housing 30 may comprise, supported on the exterior face 34, an external ultra-violet filter 42. If present, this prevents or

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reduces color change dependent upon the ambient external lighting conditions. The external ultra-violet filter 42 may be transparent. It may be a layer of suitable material attached to the exterior face 34.

- 5 The apparatus 10 may comprise one or more light-guides 44 configured to transfer the EM radiation from the one or more light emitting devices 40 to the color-changing portion or portions 32 of the external housing 30. This enables the light emitting devices 40 to be positioned remotely from the color-changing portion or portions 32. The light-guides 44 may be positioned on and attached to the interior
10 face 36 of the color-changing portion 32. The light-guide(s) 44 may be planar.

In the illustrated example, but not necessarily all examples, the apparatus 10 comprises as part of the housing 30 a housing cover portion 70 that attaches to a housing body portion 72. In this example, the housing cover portion 70 comprises
15 one or more color changing portions 32. It may also comprise an external ultra-violet filter 42 and an internal light-guide 44. The housing body portion 72 comprises a controller 60 that is used to provide electrical control signals 22 to one or more transducers 20 also comprised within the housing body portion 72.

- 20 In some embodiments, the housing cover portion 70 and the housing body portion 72 may be attached and detached by a user. A set of different housing cover portions 70 may be provided each of which has different color-changing portions 32. A user, by interchanging the housing cover portions 70 can adapt the color change effected by the controller 60.

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The apparatus 10 may be an electronic device such as, for example, a mobile cellular telephone, a headset, a speaker, a monitor, accessories. The housing body portion 72 may comprise the engine for the electronic device which enables its key functions.

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The apparatus 10 may be a hand-portable electronic device such as a mobile cellular telephone, for example. The housing body portion 72 may be sized so that it first within a palm of a human hand.

Fig 3 illustrates an example of the apparatus 10 in which the or each transducer 20 comprises one or more heat generating devices 50 configured to convert the electrical control signal 22 to heat, as the alternative energy flux 24. The heat 24 is provided to the interior face 36 of the color-changing portion 32. The color changing portion 32 of the external housing 30 comprises plastic with thermochromatic pigment and the incident heat 24 produces a color change in the thermochromatic pigment at the color-changing portion 32. The color change is visible to a human user viewing the exterior face 34 of the color-changing portion 32.

In this example, the one or more heat generating devices 50 may be Peltier elements.

The color-changing portion 32 of the external housing 30 may comprise, on the exterior face 34, an external thermal insulating layer. If present, this prevents or reduces color change dependent upon the ambient temperature. The external thermal insulating layer may be transparent. It may be an applied layer of suitable material.

The apparatus 10 may comprise one or more thermal conductors configured to transfer the heat from the one or more heat generating devices 50 to the color-changing portion or portions 32 of the external housing 30. This enables the heat generating devices 50 to be positioned remotely from the color-changing portion or portions 32. The thermal conductors may be positioned on the interior face 36 of the color-changing portion 32.

In the illustrated example, but not necessarily all examples the apparatus 10 comprises as part of the housing 30 a housing cover portion 70 that attaches to a housing body portion 72. In this example, the housing cover portion 70 comprises one or more color changing portions 32 and one of more heat generating devices 50 positioned on the interior face 36 of the color-changing portion 32. The housing

body portion 72 comprises a controller 60 that is used to provide electrical control signals 22 to one or more transducers 20 (heat generating devices 50).

5 In some embodiments (not shown) the housing cover portion 70 may also comprise an external insulating layer (not shown) and internal thermal conductors (not shown).

10 In some embodiments, the housing cover portion 70 and the housing body portion 72 may be attached and detached by a user. A set of different housing cover portions 70 may be provided each of which has different color-changing portions 32. A user, by interchanging the housing cover portions 70 can adapt the color change effected by the controller 60.

15 The apparatus 10 may be a hand-portable electronic device such as a mobile cellular telephone, for example. The housing body portion 72 may comprise the engine for the electronic device which enables its key functions.

20 In the examples illustrated in Figs 1, 2 and 3, only a single transducer 20 is illustrated. In some implementations, the apparatus 10 may comprise a single transducer 20. In other implementations, the apparatus 10 may comprise more than one transducer 20.

25 Fig 4 illustrates, in plan view, an exterior face 34 of an example of an apparatus 10 which comprises multiple transducers 20_n . An index n is used as a sub-script to reference numbers in this figure to differentiate features associated with different transducers.

30 Each transducer 20_n is associated with a particular color-changing portion 32_n which is configured to change color. The color change occurs in response to receiving an energy flux 24 from the associated transducer 20_n . Each transducer 20_n is configured to convert an electrical control signal 22_n to an alternative energy flux 24_n (see Fig 5). The alternative energy flux 24 may, for example, be radiated

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electro-magnetic radiation such as ultra-violet light or may be, for example, thermal energy flux (heat).

5 Each distinct color-changing portion 32_n may be controlled independently of the others.

The color-changing portions 32_n may have the same or different color attributes. For example, the colors C_n of the color-changing portions 32_n , when activated by the alternative energy flux 24_n , may be different. The color-changing portions 32_n
10 may be activated by the same or different types/levels of alternative energy flux 24_n .

As the color-changing portions 32_n may be controlled independently to be visually distinct, they may be used to selectively convey information to a user.

15

Fig 5 illustrates an example of an apparatus 10 which is capable of controlling one or more transducers 20_n . An index n is used as a sub-script to reference numbers in this figure to differentiate features associated with different transducers.

20 Each transducer 20_n is associated with a particular color-changing portion 32_n which is configured to change color to color C_n . The color change occurs in response to receiving an energy flux 24_n from the associated transducer 20_n . Each transducer 20_n is configured to convert an electrical control signal 22_n to energy flux 24_n that is an alternative to the electrical energy of the electrical control signal
25 22_n . The alternative energy flux 24_n may, for example, be radiated electro-magnetic radiation such as ultra-violet light or may be, for example, thermal energy flux (heat).

Each distinct color-changing portion 32_n may be controlled independently of the
30 others using controller 60 to produce independent electrical control signals 22_n . The amplitude V_n and/or duration t_n of electrical control signals 22_n may be controlled.

The color-changing portions 32_n are located at different locations L_n and may have the same or different color attributes. For example, the colors C_n of the color-changing portions 32_n , when activated by the alternative energy flux 24_n , may be different. The color-changing portions 32_n may be activated by the same or
5 different types/levels of alternative energy flux 24_n .

As the color-changing portions 32_n may be controlled independently to be visually distinct, they may be used to selectively convey information to a user.

10 The location L_n and/or amplitude V_n and/or duration t_n of the alternative energy flux 24 defines a color state C_n of the color-changing portion 32_n of the external housing 32 (L_n , V_n , t_n). The controller 60 is configured to control the color state or states of the color-changing portion(s) 32_n .

15 In the illustrated example, the apparatus 10 comprises an input interface 80 that provide triggers 81 to the controller 60.

In the illustrated example, the input interface 80 comprises an input user interface 82 configured to enable user manual control of the color state or states.

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In the illustrated example, the input interface 80 comprises an input alert interface 84 configured to enable automated control of the color state or states. The input alert interface 84 informs the controller 60 when alert conditions are satisfied. An alert condition may, for example, be satisfied by an alarm clock setting; a reminder
25 setting; a received message; a battery charge state etc.

In the illustrated example, the input interface 80 comprises an environment interface 86 configured to enable automated control of the color state or states. The environment interface 86 informs the controller 60 when environment
30 conditions are satisfied. An environment condition may be satisfied when an event external to the apparatus 10 occurs such as, for example, a particular ambient temperature is sensed; a particular level or color of ambient light is sensed; another apparatus 10 is detected.

In the illustrated example, the input interface 80 comprises a context interface 88 configured to enable automated control of the color state or states. The context interface 88 informs the controller 60 when context conditions are satisfied. A context condition may be satisfied when a combination of events occur e.g. receive a message during the particular time period.

The controller 60 may comprise at least one processor 62; and at least one memory 64 including computer program code 66, the at least one memory 64 and the computer program code 66 configured to, with the at least one processor 62, cause the apparatus 10 at least to control the color state.

Figs 6A and 6B illustrates a notional example of a color change as a consequence of a color-changing portion 32 receiving an energy flux 24.

The energy flux 24 is activated by the controller 60 for excitation time E. As a consequence, the color-changing portion 32 changes color. Its hue saturation at the color of interest increases from S1 to S2.

The energy flux 24 is then de-activated by the controller 60 for relaxation time R. As a consequence, the color-changing portion 32 changes color. Its hue saturation at the color of interest decreases from S2 to S1. The color state relaxes from its excitation state towards its default state S0 after a cessation of the alternative energy flux 24.

The cycle of activation and de-activation is repeated so that the color of the color-changing portion 32 has a color saturation above the level S1.

As illustrated in Fig 6B, the electrical control signal 22 used by the controller 60 to control the alternative energy flux 24 has a duty cycle 90 of $E: (E+R)$. The electrical control signal 22 has a voltage level V2 for the excitation time E. This activates the energy flux 24 for excitation time E and causes an increase in the hue saturation at the color of interest to S2. The electrical control signal 22 then

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has a lower voltage level V1 (e.g. 0V) for the relaxation time R. This de-activates the energy flux 24 for relaxation time R and causes a decrease in the hue saturation at the color of interest to S1. It is therefore possible to maintain a desired color saturation (above S1) with reduce power consumption.

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Figs 7A and 7B illustrate an example in which the apparatus 10 is a hand-portable electronic apparatus 100 such as a mobile personal device or a mobile cellular telephone.

10 The color-changing portion 32 of the housing 30 part of an exchangeable housing element 100 defining at least a portion an exterior surface 102 of the apparatus 100.

15 A color-changing portion 32 may be a part of a front face 102A of a housing cover portion 101 (Fig 7A).

A color-changing portion 32 may be a part of a rear face 102B of a housing body portion 103 (Fig 7B).

20 In Fig 8, the apparatus 10 comprises as part of the exterior housing 30 a housing cover portion 70 that attaches to a housing body portion 72. In this example, the housing cover portion 70 comprises one or more color changing portions 32. The housing body portion 72 may comprise the engine for the electronic device which enables its key functions.

25

In some embodiments, the housing cover portion 70 and the housing body portion 72 may be attached and detached by a user. A set of different housing cover portions 70 may be provided each of which has different color-changing portions 32. A user, by interchanging 104 the housing cover portions 70 can adapt the color
30 change effected by the controller 60.

In Fig 8, the external housing cover portion 70 comprises: a body 106 having an interior surface 36 and an exterior surface 34, wherein the exterior surface 36 is

configured to change color in response to incidence of a flux of energy 24 on the interior surface 36.

5 The body 106 may, for example, comprise photochromatic pigment that changes color in response to ultra-violet light. The exterior face 34 may support an ultra-violet filter and/or the interior face 36 may support one or more light-guides.

10 The body 106 may, for example, comprise thermochromatic pigment that changes color in response to heat. The interior face 36 may support one or more heat generating devices such as, for example, Peltier elements.

Fig 9 illustrates a method 110. The method 110 comprises: at block 112, providing at least one transducer 20 configured to convert electricity to an alternative energy flux 24; and at block 114, providing an external housing 30 comprising at least a
15 portion 32 configured to change color in response to the alternative energy flux 24. The method 110 enables personalization of an apparatus 10 by exchanging color-changing portions 32 of the external housing 30.

20 Implementation of controller 60 can be in hardware alone (a circuit, a processor...), have certain aspects in software including firmware alone or can be a combination of hardware and software (including firmware).

25 The controller 60 may be implemented using instructions that enable hardware functionality, for example, by using executable computer program instructions 66 in a general-purpose or special-purpose processor 62 that may be stored on a computer readable storage medium (disk, memory etc) 64 to be executed by such a processor 62.

30 The processor 62 is configured to read from and write to the memory 64. The processor 62 may also comprise an output interface via which data and/or commands are output by the processor 62 and an input interface via which data and/or commands are input to the processor 62.

The memory 64 stores a computer program 66 comprising computer program instructions (computer program code) that controls the operation of the apparatus 10 when loaded into the processor 62. The computer program instructions, of the computer program 66, provide the logic and routines that enables the apparatus to perform the methods illustrated in Fig 9. The processor 62 by reading the memory 64 is able to load and execute the computer program 66.

The computer program 66 may arrive at the apparatus 10 via any suitable delivery mechanism. The delivery mechanism may be, for example, a non-transitory computer-readable storage medium, a computer program product, a memory device, a record medium such as a compact disc read-only memory (CD-ROM) or digital versatile disc (DVD), an article of manufacture that tangibly embodies the computer program 66. The delivery mechanism may be a signal configured to reliably transfer the computer program 66. The apparatus 10 may propagate or transmit the computer program 66 as a computer data signal.

Although the memory 64 is illustrated as a single component it may be implemented as one or more separate components some or all of which may be integrated/removable and/or may provide permanent/semi-permanent/dynamic/cached storage.

Although the processor 62 is illustrated as a single component it may be implemented as one or more separate components some or all of which may be integrated/removable.

As used here 'module' refers to a unit or apparatus that excludes certain parts/components that would be added by an end manufacturer or a user. The external housing cover portion 70 may be a module. Alternatively or additionally, the apparatus 10 may, in some examples, be a module.

The term 'comprise' is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use 'comprise'

with an exclusive meaning then it will be made clear in the context by referring to “comprising only one.” or by using “consisting”.

5 In this brief description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term ‘example’ or ‘for example’ or ‘may’ in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some of or all other examples. Thus ‘example’, ‘for example’ or ‘may’ refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class.

15 Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

20 Features described in the preceding description may be used in combinations other than the combinations explicitly described.

Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

25 Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

30 Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable

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feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

I/we claim:

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CLAIMS

1. An apparatus comprising:
at least one transducer configured to convert electricity to an alternative energy
5 flux; and
an external housing comprising at least a portion configured to change color in
response to receiving the alternative energy flux.
2. An apparatus as claimed in claim 1, wherein the transducer is housed within the
10 housing.
3. An apparatus as claimed in claim 1 or 2, wherein the alternative energy flux is
electro-magnetic radiation.
- 15 4. An apparatus as claimed in claim 3, wherein the at least one transducer is one
or more light emitting devices configured to convert electricity to electro-magnetic
radiation.
- 20 5. An apparatus as claimed in claim 4, further comprising one or more light-guides
configured to transfer the electro-magnetic radiation from the one or more light
emitting devices to the portion of the external housing.
- 25 6. An apparatus as claimed in claim 5, wherein the portion of the external housing
comprises an interior face and comprising on the interior face the
one or more light-guides.
7. An apparatus as claimed in any of claims 3 to 6, wherein the portion of the
external housing comprises photochromatic pigment.
- 30 8. An apparatus as claimed in any of claims 3 to 7, wherein the alternative energy
flux is ultra-violet light.

9. An apparatus as claimed in claim 8, wherein the portion of the external housing comprises an exterior face and comprises on the exterior face an external ultra-violet filter.

5 10. An apparatus as claimed in claim 1 or 2, wherein the alternative energy flux is heat flux.

11. An apparatus as claimed in claim 10, wherein the at least one transducer is one or more heat generating devices configured to convert electricity to heat.

10

12. An apparatus as claimed in claim 11, wherein the portion of the external housing comprises an interior face and comprises on the interior face the one or more heat generating devices.

15 13. An apparatus as claimed in claim 11 or 12, wherein the one or more heat generating devices are Peltier elements.

14. An apparatus as claimed in any of claims 10 to 13, wherein the portion of the external housing comprises thermochromatic pigment.

20

15. An apparatus as claimed in any preceding claim, wherein a location and/or quantity and/or duration of the alternative energy flux defines a color state of each portion of the external housing portion configured to change color in response to receiving an alternative energy flux, the apparatus further comprising a controller
25 configured to control the color state or states.

16. An apparatus as claimed in claim 15, comprising an input user interface wherein the input user interface is configured to enable user control of the color state or states.

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17. An apparatus as claimed in claim 15 or 16, comprising an input interface wherein the input interface is configured to enable automatic control of the color

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state or states in response to one or more of: an alert state of the apparatus; an environment of the apparatus; and/or a context of the apparatus.

18. An apparatus as claimed in any of claims 15 to 17, wherein a color state
5 relaxes after a cessation of the alternative energy flux and a color state is repeatedly activated with a duty cycle of alternative energy flux.

19. An apparatus as claimed in any preceding claim, comprising multiple
distributed transducers each configured to convert electricity to an alternative
10 energy flux and each individually controllable.

20. An apparatus as claimed in any preceding claim, wherein the apparatus is a hand-portable apparatus

15 21. An apparatus as claimed in any preceding claim, wherein the portion of the housing is an exchangeable housing element defining at least a portion of an exterior surface of the apparatus.

22. An apparatus as claimed in claim 21, wherein the housing element is user
20 interchangeable with a different housing element that is associated with one of more different colors.

23. An external housing portion comprising:
a body having an interior surface and an exterior surface, wherein the exterior
25 surface is configured to change color in response to incidence of a flux of energy on the interior surface.

24. An external housing portion as claimed in claim 23, comprising photochromatic pigment.

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25. An external housing portion as claimed in claim 24, wherein the photochromatic pigment changes color in response to ultra-violet light.

26. An external housing portion as claimed in claim 25 comprising an exterior face supporting an ultra-violet filter.
27. An external housing portion as claimed in claim 23, comprising an interior face supporting one or more light-guides.
28. An external housing portion as claimed in claim 23, comprising thermochromatic pigment.
29. An external housing portion as claimed in claim 28, wherein the thermochromatic pigment changes color in response to heat.
30. An external housing portion as claimed in claim 29, comprising an interior face supporting one or more heat generating devices.
31. An external housing portion as claimed in claim 30, wherein the one or more heat generating devices are Peltier elements.
32. A method comprising:
providing at least one transducer configured to convert electricity to an alternative energy flux; and
providing an external housing comprising at least a portion configured to change color in response to the alternative energy flux.
33. A method as claimed in claim 32, further comprising enabling personalization by exchanging the portion of the external housing.

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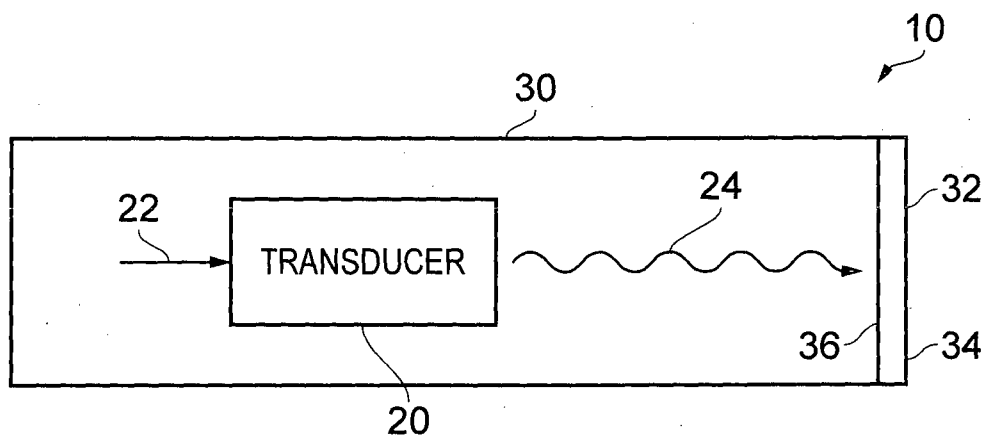


FIG. 1

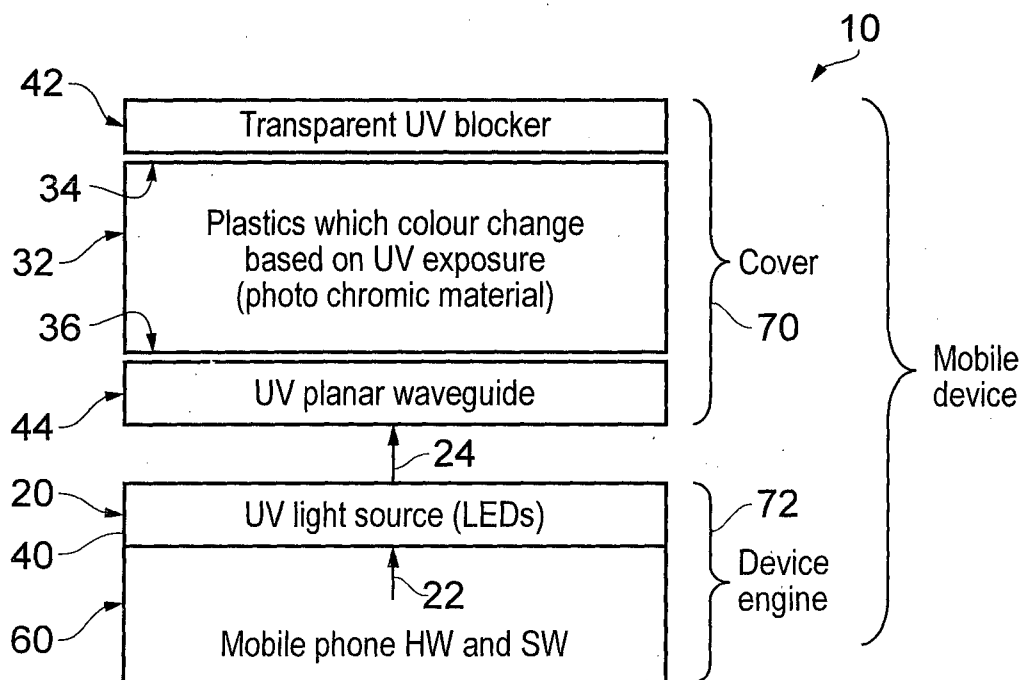


FIG. 2

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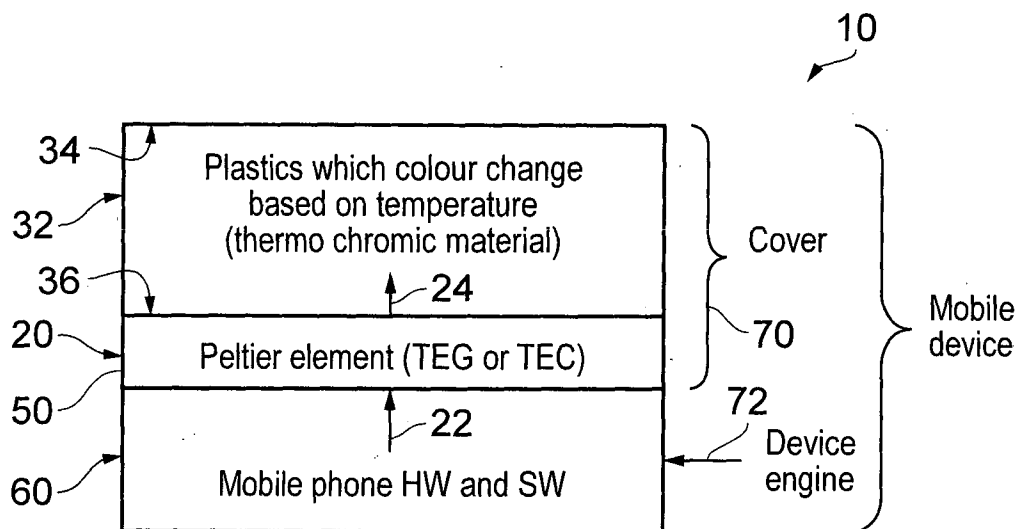


FIG. 3

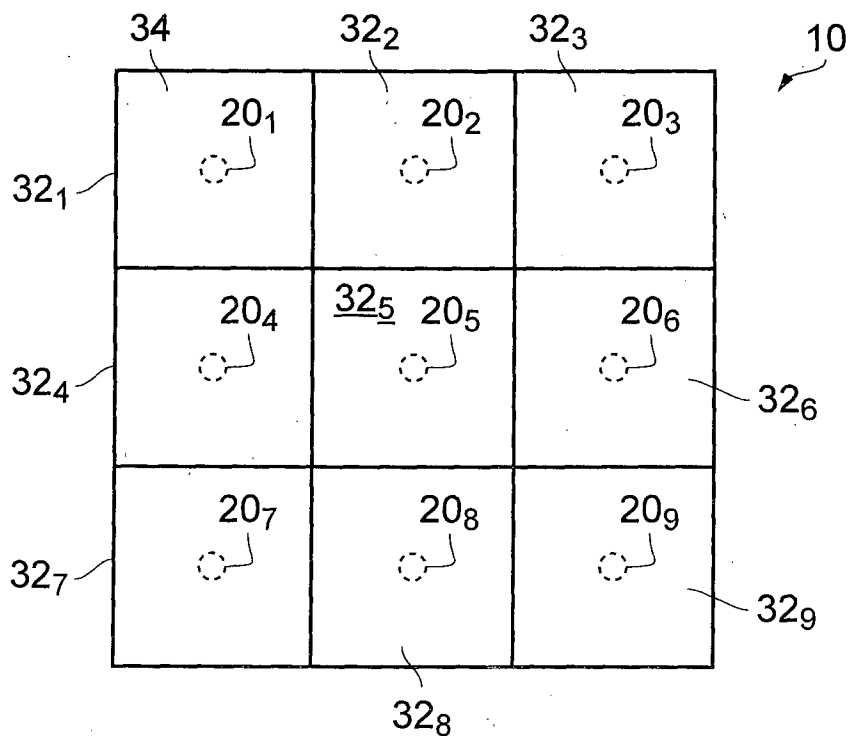


FIG. 4

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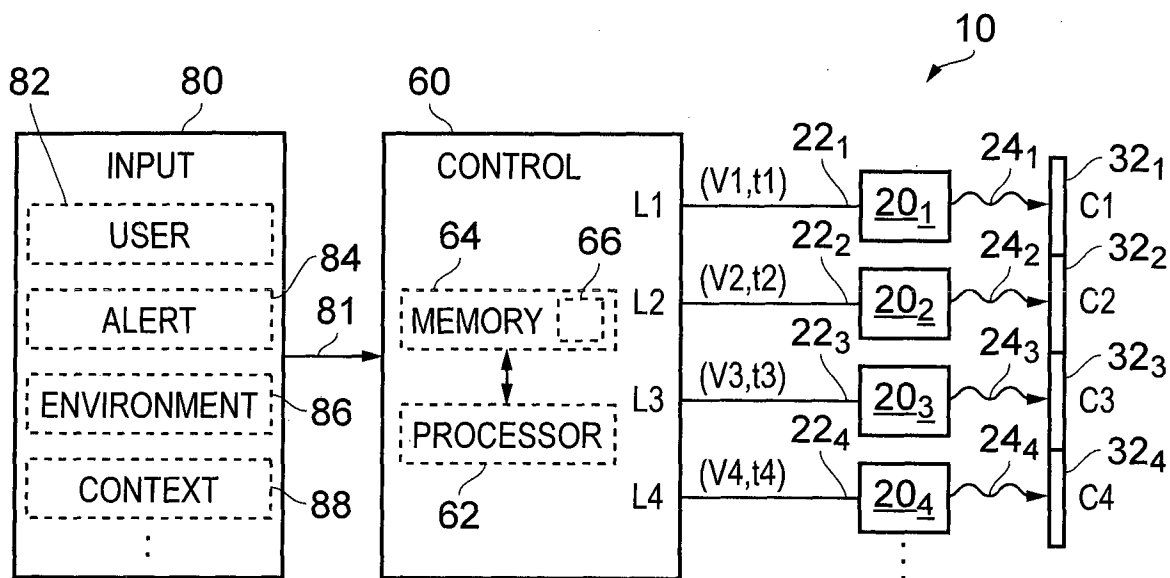


FIG. 5

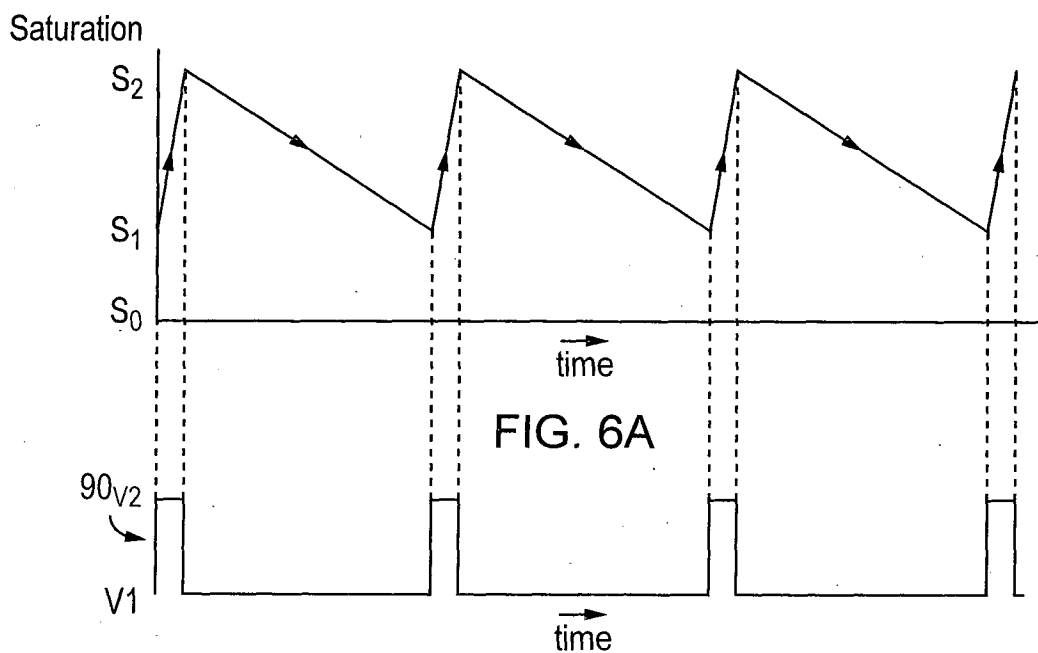
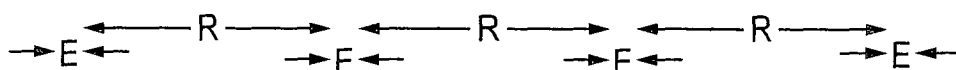


FIG. 6A

FIG. 6B



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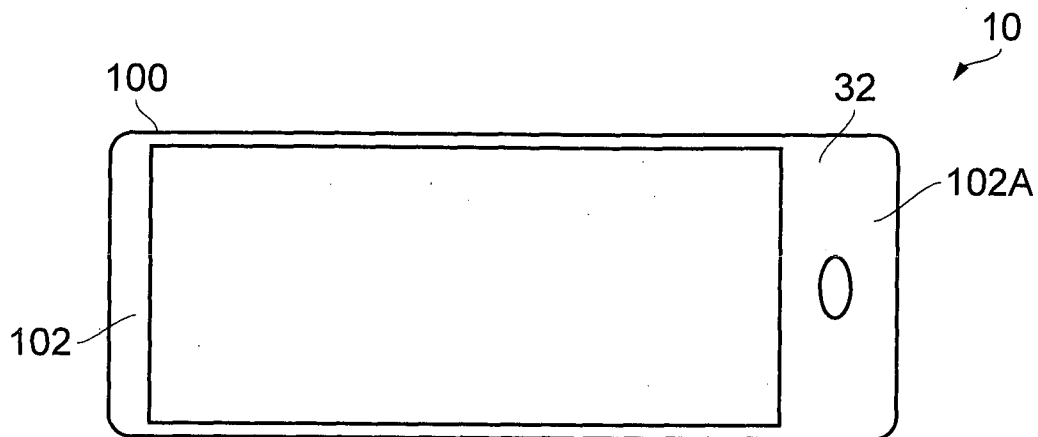


FIG. 7A

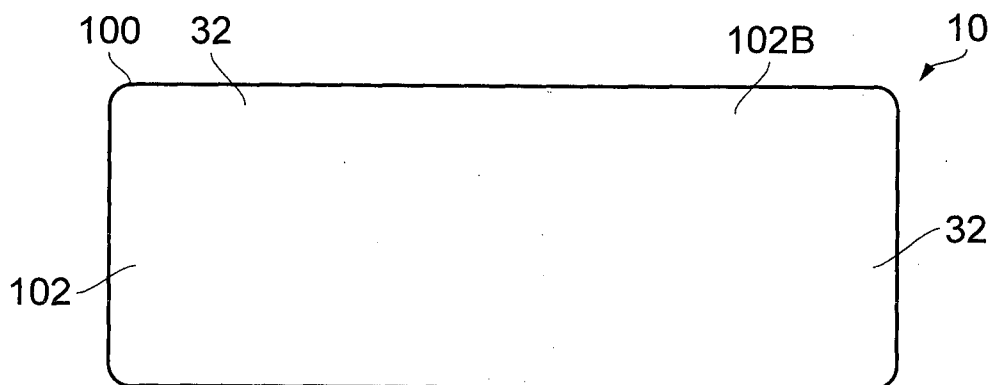


FIG. 7B

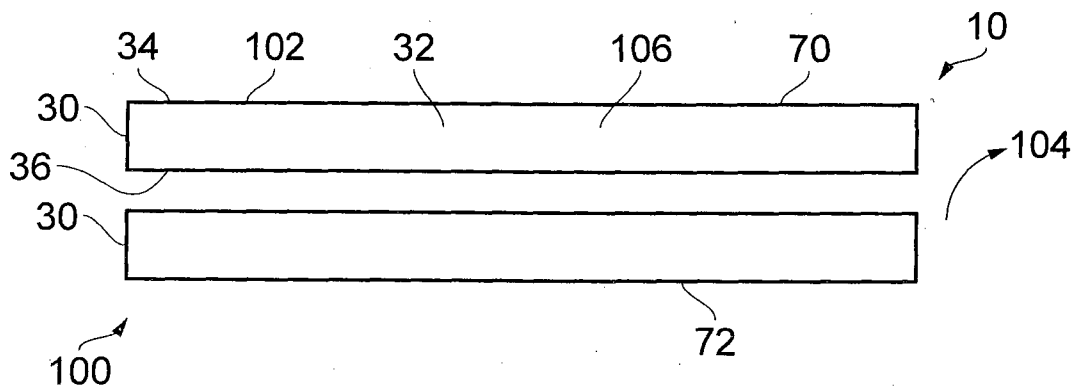


FIG. 8

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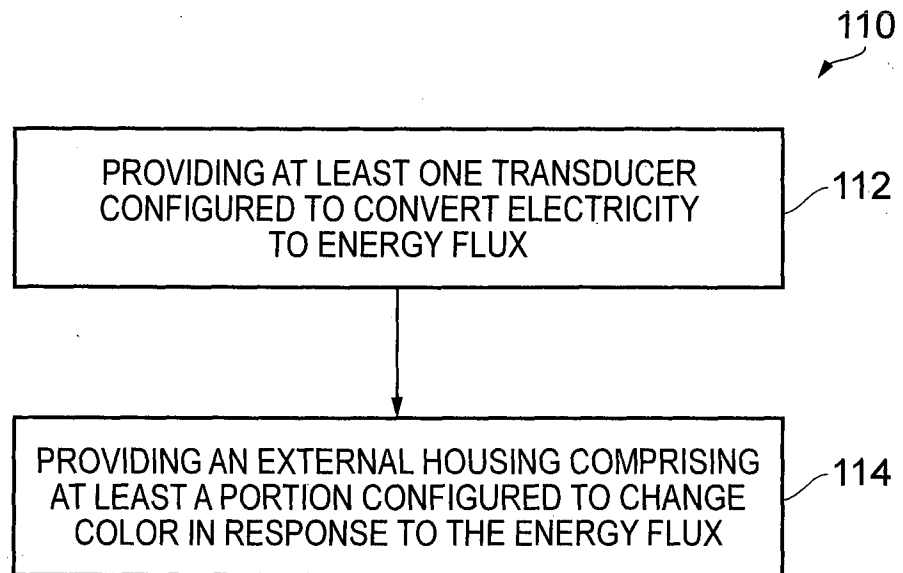


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2013/050478

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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: H04M, H05K, G02B, H01L, F21K

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

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI, XP3GPP, XPAIP, XPESP, XPESP2, XPETSI, XPI3E, XPIEE, XPIETF, XPIOP, XPIPCOM, XPJPEG, XPOAC, XPRD, XPTK, COMPDX, INSPEC, TDB, NPL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010163542 A1 (KWON KI HWAN [KR] et al.) 01 July 2010 (01.07.2010) paragraphs [0005], [0013], [0023]-[0025], [0030]-[0031], [0034], [0038]; Figs. 1-2	1, 2, 10-16, 18, 20-21, 23, 28-32
X	JP 2012054746 A (NEC CORP) 15 March 2012 (15.03.2012) & machine translation into English by Thomson Reuters [online] EPOQUENET TXTJPS paragraphs [0019], [0028], [0030]	1, 15, 17, 32
X	US 2003210780 A1 (PRATT STEVEN DUANE [US] et al.) 13 November 2003 (13.11.2003) paragraphs [0011], [0015], [0017]-[0020]	1, 3-9, 15, 17, 22-27, 32-33
X	EP 2429152 A1 (ZTE CORP [CN]) 14 March 2012 (14.03.2012) paragraph [0007]	1, 19, 32



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

17 April 2014 (17.04.2014)

Date of mailing of the international search report

22 April 2014 (22.04.2014)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2013/050478

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
US 2010163542 A1	01/07/2010	US 8314365 B2 KR 20100078219 A	20/11/2012 08/07/2010
JP 2012054746 A	15/03/2012	None	
US 2003210780 A1	13/11/2003	AU 2003225149 A1 BR 0310103 A CN 1653786 A EP 1525735 A2 KR 20040108797 A WO 03096079 A2	11/11/2003 05/04/2005 10/08/2005 27/04/2005 24/12/2004 20/11/2003
EP 2429152 A1	14/03/2012	WO 2010127516 A1 CN 101577747 A CN 101577747 B US 2012044045 A1 US 8648691 B2	11/11/2010 11/11/2009 09/05/2012 23/02/2012 11/02/2014

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CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

H04M 1/02 (2006.01)

H05K 5/02 (2006.01)

G02B 6/00 (2006.01)

H01L 35/28 (2006.01)

F21K 99/00 (2010.01)