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(54) Title: SYSTEM AND METHOD FOR DIAGNOSING SKIN AND HAIR CONDITIONS

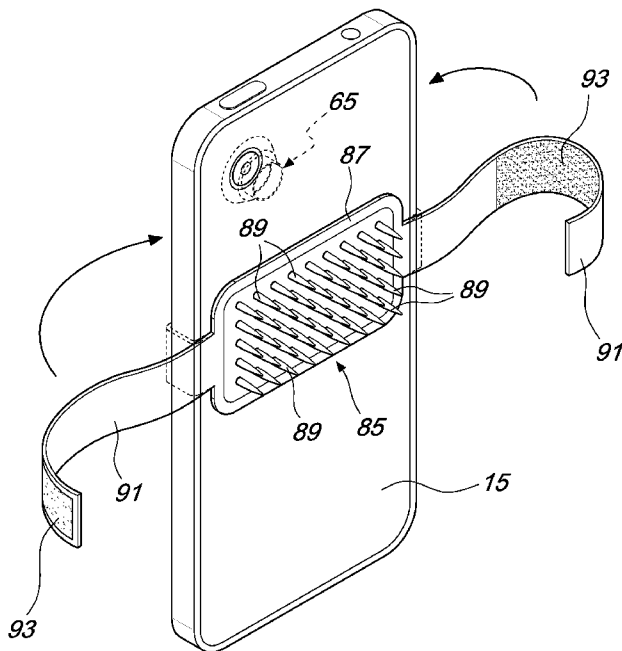


Fig. 6

(57) Abstract: A system and method for diagnosing skin and/or hair condition is disclosed. The system comprises: a mobile device connected to a camera to acquire an image of the skin and/ or hair condition; an extraction module to identify markers associated with the skin and/ or hair condition from the image; a plurality of databases comprising information on the diagnosis and treatment and management of the skin and/ or hair conditions; and an inference module to diagnose the skin and/ or hair condition and to propose a treatment and/ or management option for the diagnosed skin and/ or hair condition based on consultation of the plurality of databases.

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SYSTEM AND METHOD FOR DIAGNOSING SKIN AND HAIR CONDITIONS

Technical Field

This disclosure relates to the diagnostic systems and methods for skin and hair conditions, particularly to mobile devices for diagnosis of skin and hair conditions and more particularly to mobile devices for diagnosis of trichological conditions.

Background

Skin and/ or hair conditions may have a multitude of causes, for example genetics, environmental pollution, drugs or even excessive stress. Generally skin and/ or hair conditions may also have a multitude symptoms for example hair fall, hair breakage, hair thinning and diseases of the skin or scalp. Skin and/ or hair conditions is a problem faced by many men and women. These conditions may lead to visually conspicuous symptoms leading to psychological stress. Changes in confidence, body image may have an impact on individual economic competitiveness.

A specific example of a skin and/ or hair condition is alopecia, which includes androgenic alopecia (AGA). Alopecia generally refers to all conditions of baldness, including partial baldness, that are encountered by both genders. Although not completely understood alopecia may have many causes. The cause of alopecia in a specific individual must be diagnosed in order to identify a suitable treatment.

In order to manage and treat skin and/ or hair conditions, associated industries have emerged to cater to the needs of suffers afflicted with the condition. Products and services available to manage and treat a skin and/ or hair condition is dependent on an accurate diagnosis. Generally, diagnosis of a condition requires observation of the area affected by the condition. Conventionally, an enlargement of the skin and/ or hair may be required to assess the symptoms and to diagnose the state of the condition. Upon an accurate diagnosis, a suitable treatment or management regime may be provided that is commensurate with the condition.

In recent years, suffers of a skin and/ or hair condition are faced with an increasing number of options for management and treatment of a condition. Often these options include products available without the need for an initial diagnosis. Accordingly, there is a need for

the sufferer to access information relating to the specific condition in order to identify the appropriate treatment.

The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of the prior art system.

5 Brief Summary of the Invention

In a first aspect, the present disclosure describes a system for diagnosing skin and/ or hair condition. The system comprising a mobile device connected to a camera to acquire an image of the skin and/ or hair condition; an extraction module to identify markers associated with the skin and/ or hair condition from the image; a plurality of databases comprising
10 information on the diagnosis and treatment and/ or management of the skin and/ or hair conditions; and an inference module to diagnose the skin and/ or hair condition and to propose a treatment and/ or management option for the diagnosed skin and/ or hair condition based on consultation of the plurality of databases.

In a second aspect, the present disclosure describes a method for diagnosing skin and/
15 or hair condition. The method comprising the steps of acquiring an image of the skin and/ or hair condition; identifying markers of the skin and/ or hair condition from the acquired image; diagnosing the skin and/ or hair condition from a plurality of databases comprising information for the diagnosis of the skin and/ or hair condition; and proposing a treatment or management option for the diagnosed skin and/ or hair condition.

20 Brief Description of the Drawings

The foregoing and other features and advantages of the present disclosure will be more fully understood from the following description of various embodiments, when read together with the accompanying drawings, in which:

Figure 1 is a schematic illustration of a system for diagnosing skin and/ or hair
25 condition in accordance with the present disclosure;

Figure 2 is a flow chart illustrating the method for diagnosing skin and/ or hair condition according to the present disclosure;

Figure 3 is an overall view of a system for diagnosing skin and/ or hair condition, comprising an optical device, in accordance with the present disclosure;

30 Figures 4a and 4b are a top prospective view and a bottom prospective view,

respectively, of an optical device of a system for diagnosing skin and/ or hair condition according to the present disclosure;

Figures 5a and 5b are an exploded section view and an assembled section view, respectively, of an optical device of a system for diagnosing skin and/ or hair condition according to the present disclosure;

Figure 6 is an overall view of a system for diagnosing skin and/ or hair condition, comprising a comb attachment, in accordance with the present disclosure.

Detailed Description

This disclosure generally relates to a system and a method which enables diagnosis of a skin condition and/ or a hair condition. The system and method may be used to identify a condition related to the skin and/ or hair and to determine treatment options for the condition.

Fig. 1 is a schematic illustration of a system **10** for diagnosing skin and/ or hair condition. The system **10** comprises a mobile device **15**, an extraction module **35**, a plurality of databases **45**, **50**, **55** and an inference module **40**.

The mobile device **15** enables the skin and/ or a hair condition to be diagnosed. Mobile device **15** provides options for the management or the treatment of the condition upon diagnosis of the condition. Mobile device **15** serves as an interface for a user to access diagnostic tools and treatment and management options.

Mobile device **15** enables the user to provide personal information that may be used in the diagnosis of the condition. The treatment and management options may be targeted for the user on the basis of the personal information. The personal information may include one or more of the following: age, gender, residence, geographical location, diet, current season (or period of year) and related climatic conditions, activities that affect skin and/ or hair conditions, consumption of prescription drugs that affect skin and/ or hair conditions, medical treatments that affect skin and/ or hair conditions, and treatments or management options being undertaken by the user for the skin and/ or hair condition. The mobile device **15** may comprise a module for the input of the personal information. The module may prompt the user for the required information.

Mobile device **15** is a portable device that enables a diagnosis of a skin and/ or a hair condition to be performed in any suitable location. The diagnosis can be carried out at the

user's convenience without being restricted to a location or time. Mobile device **15** may be a portable device having computer processing capacity. Mobile device **15** may be a hand held device, such as a smart phone, a tablet or a notebook.

The system **10** comprises a camera. The camera serves to acquire an image of the skin and/ or hair condition. The image serves as a means for the diagnosis of the condition. The camera is connected to the mobile device **15**. In an embodiment, the mobile device **15** includes the camera. The camera is provided within the mobile device **15**. In an alternative embodiment, the camera is a separate device from the mobile device **15**. The camera is connectable to the mobile device **15** so as to transfer the acquired image to the mobile device **15**.

The system **10** comprises an extraction module **35**. Extraction module **35** serves to identify markers associated with the skin and/ or hair condition. Extraction module **35** is configured to isolate markers from the acquired image.

The extraction module **35** may identify one or more markers known in the field of diagnosis of skin and/ or hair conditions, namely, for example but not limited to, the general criteria for androgenic alopecia defined by Rakowska et al., that allow to arrive at the diagnosis of the androgenic alopecia condition in a simple manner. These known general criteria are grouped in major criteria and minor criteria, and the simultaneous presence of two major criteria, or a major criterion and two minor criteria, allows to diagnose androgenic alopecia condition with an accuracy of 98%.

The major criteria are: more than four yellow dots in four images of the frontal area; average hair thickness minor in the frontal area than in the occipital area; and more than 10% of thin hairs (thickness minor than 0.03 mm) in the frontal area.

The minor criteria are: percentage of pilosebaceous units with a single hair growing, going from the frontal area to the occipital area; presence of vellus hairs; and perifollicular discoloration.

In a preferred embodiment, the extraction module **35** identifies the hair thickness and the presence of vellus hairs: for example, if the hair thickness has a variability of 30%, there is a risk of androgenic alopecia condition in the medium term.

In an embodiment, extraction module **35** may be provided in the mobile device **15**. In

an alternative embodiment, extraction module **35** may be provided in a separate device connectable to the mobile device **15**. In a further embodiment, extraction module **35** may be a standalone programme. In yet a further embodiment, extraction module **35** may be a sub-routine within a programme.

5 The system **10** comprises a plurality of databases **45, 50, 55**. The plurality of databases **45, 50, 55** comprises information relating to the diagnosis of the skin and/ or hair condition. The plurality of databases **45, 50, 55** comprises information relating to the treatment of the skin and/ or hair condition. In an embodiment, the plurality of databases **45, 50, 55** may comprise information relating to the cosmetic treatment and/ or management of
10 the skin and/ or hair condition. In an alternative embodiment, the plurality of databases **45, 50, 55** may comprise information relating to the clinical treatment or management of the skin and/ or hair condition. Clinical treatments or management requires the presence or guidance of a specialist or a certified professional such as a doctor.

In a further embodiment, the plurality of databases **45, 50, 55** may be provided in the
15 mobile device **15**. In yet a further embodiment, the plurality of databases **45, 50, 55** may be provided in a separate device connectable to the mobile device **15**.

The plurality of databases **45, 50, 55** are selected from the group consisting of a user database **45**, a condition database **50** on skin and/ or hair conditions and a treatment database **55** for the treatment of skin and/ or hair conditions **55**. In an embodiment, the plurality of
20 databases **45, 50, 55** includes the user database **45**, the condition database **50** and the treatment database **55**.

The user database **45** comprises the personal information provided by the user. The personal information may be transferred from the mobile device **15** to the user database **45**.

The condition database **50** comprises information relating to skin and/ or hair
25 conditions. Condition database **50** comprises information relating to the markers for each skin and/ or hair conditions. The markers are associated to the respective skin and/ or hair condition in the condition database **50**. The information in the condition database **50** is pre-compiled and updated periodically or continuously.

Condition database **50** comprises correlative information of the skin and/ or hair
30 conditions. The correlative information enables diagnosis of the condition with improved

accuracy. The correlative information comprise metadata relating to specific skin and/ or hair conditions. The metadata includes the factors that are associated with respective skin and/ or hair conditions. The metadata may comprise the following: profiles of existing users having the condition, climatic conditions in the locality of the users that affected the condition, and
5 activities that impacted the respective skin and/ or hair conditions.

The treatment database **55** comprises treatment and management options available to the user. Management options are provided in the event no treatment for the skin and/ or hair conditions is available. Management options include clinical and non-clinical options. Management options comprise interventions based on medication, surgery and cosmetic
10 interventions.

Treatment database **55** comprises information relating to the treatment and/ or management for each skin and/ or hair conditions. The information comprises cosmetic or over the counter treatment and management options. Cosmetic or over the counter treatment and management options are non-clinical options. The information comprises alternative
15 treatment and management options. The information comprises clinical treatments and management options. The treatments and management options include respective products and services, with the indication of instructions for use for each product and service, and of molecules and active principles contained in each product. The information in the treatment database **55** is pre-compiled and updated periodically or continuously.

The system **10** comprises an inference module **40**. Inference module **40** is configured to diagnose the skin and/ or hair condition affecting the user. Inference module **40** is configured to use specific markers identified from the image for association with respective skin and/ or hair condition.

Inference module **40** is configured to consult of the plurality of databases **45**, **50**, **55** in
25 order to select the appropriate treatment or management options available to the user. Inference module **40** is configured to propose a treatment and/ or management option for the diagnosed skin and/ or hair condition. Inference module **40** is configured to propose non-clinical treatment and/ or management options. Inference module **40** is configured to advise seeking professional or specialist assistance in the event a clinical treatment and/ or
30 management options is required.

In an embodiment, inference module **40** is further configured to further consult an external information source **60**. The external information source **60** may provide information relating to prevailing factors that affect the skin and/ hair condition. The prevailing factors may comprise the following: climatic information, location of the user and sun exposure. The external information may be utilised to modify the treatment and/ or management options according to the user requirements.

Inference module **40** is further configured to quantitatively assess the course of the condition over a period of time with on-going input from the user. Over a period of time images of the condition are acquired and the course of the condition is assessed. Inference module **40** may provide feedback to the user relative to the effectiveness of the treatment and/ or management option being used by the user.

Inference module **40** is further configured to connect the user with a provider of a treatment and/ or management option. The user is able to interact with the provider in order to select appropriate product or services offered by the provider. The user is able to use the diagnosis provided by the inference module **40** to customise a product or service according to individual specification.

In an embodiment, inference module **40** may be a standalone programme. In an alternative embodiment, inference module **40** may be a sub-routine within a programme.

The system **10** further comprises a remote device **25**. Remote device **25** may be located in any suitable location. Remote device **25** may be a computer that is connectable to the mobile device **15**. Remote device **25** is able to interact and communicate with the mobile device **15** through the telecommunication network. Remote device **25** is able to interact and communicate with the mobile device **15** through the internet **20**. Remote device **25** may be a server.

The external information source **60** is connected to the remote device **25**. The inference module **40** is configured to further consult the external information source **60** through the remote device. In an embodiment, the extraction module **35**, the plurality of databases **45, 50, 55** and the inference module **40** may be provided in the remote device **25**.

The system **10** further comprises a processing module **30** to process the image acquired by the mobile device **15**. Processing module **30** processes the acquired image based

on predetermined parameters. The parameters may comprise luminosity, color, contrast, focus. The processed image may be used by the extraction module **35** to identify the markers. If an image is not suitable for providing information on the markers the processing module **30** may require that the user acquire a another image of the condition.

5 In an embodiment, the processing module **30** may be provided in the mobile device **15**. In an alternative embodiment, the processing module **30** may be provided in the remote device **25**. In a further embodiment, the processing module **30** may be a standalone programme. In yet a further embodiment, the processing module **30** may be a sub-routine within a programme.

10 The processing module **30** may implement one or more algorithms known in the field of computer vision, namely, for example but not limited to, low-pass filtering, high-pass filtering, band-pass filtering, Gaussian smoothing, Hough transform, or a combination thereof.

 The system **10** further comprises an optical device **65**. The optical device **65** is
15 mounted to the mobile device **15** in alignment with the camera. The optical device **65** is configured to assist in the acquisition of the image. Optical device **65** is configured to interact with the lens of the camera to acquire the image of the condition. Optical device **65** may be a magnification lens system.

 In an embodiment, the optical device **65** comprises a support body **67**, preferably
20 made of silicone, a spacing element **69**, and a magnification lens **71**. The spacing element **69** is configured to maintain a predetermined distance of the camera from the scalp of a user, for example during the acquisition of the image. The support body **67** may comprise a first seat **77** for the positioning or the interlocking of the magnification lens **71**, and a second seat **79** for the positioning or the interlocking of the spacing element **69**.

25 In an embodiment, the optical device **65** may be of circular shape: the support body **67** being hollow truncated cone shaped, for example with a diameter of 1.5 cm, the spacing element **69** being hollow cylinder or tubular shaped, for example with a diameter of 0.9 cm, and the lens **71** being circular shaped, for example with a diameter of 0.8 cm.

 In an embodiment, the optical device **65** may comprise an illumination element to
30 illuminate the area of the skin and/ or hair condition. The afflicted area is sufficiently

illuminated so that an acquired image includes the sufficient information to enable the identification of the markers. In an embodiment, the optical device **65** is provided with a series of slots to enable entry of ambient light. The series of slots into the afflicted area.

The optical device **65** is configured to provide a magnification of 3x to 80x.
5 Magnification of the afflicted area enables the acquired image to include sufficient information for identification of the markers.

In an embodiment, the optical device **65** may be mechanically connected to the mobile device **15**. In an alternative embodiment, the optical device **65** may be connected to the mobile device **15** through adhesives **73**, preferably covered with a removable film **75**
10 before the connection. The optical device **65** may be of the 'use and discard' type.

The system **10** further comprises a comb attachment **85**. The comb attachment **85** is mounted to the mobile device **15**. The comb attachment **85** is configured to position hair for acquisition of the image. The comb attachment **85** is configured to position hair in an afflicted area. The comb attachment **85** is configured to position hair in a manner selected
15 from the group consisting of: standardising the concentration of the hair in an area, placing the hair in parallel, exposing the afflicted skin or flattening the hair. Correct positioning of the hair enables the acquired image to include sufficient information for identification of the markers. The comb attachment **85** is configured to maintain a predetermined distance of the camera from the scalp of a user, for example during the acquisition of the image.

In an embodiment, the comb attachment **85** may be mechanically connected to the mobile device **15**. In an alternative embodiment, the comb attachment **85** may be connected to the mobile device **15** through adhesives.
20

In an embodiment, the comb attachment **85** comprises a plate **87** and a strap **91**, the plate **87** being provided with soft and/ or spaced teeth **89** that are placed to its exposed
25 surface, preferably at a perpendicular angle. Both the plate **87** and the teeth **89** are preferably made of silicone. The strap **91** is configured to mechanically connect the comb attachment **85** to the mobile device **15**.

In an embodiment, the plate **87** may be of rectangular shape, or substantially of rectangular shape that is of rectangular shape with rounded corners. In a preferred
30 embodiment, the strap **91** comprises a Velcro closure **93**.

The optical device **65** and the comb attachment **85** may be separately connectable for mounting to the mobile device **15**. In an embodiment, the optical device **65** and the comb attachment **85** may be mutually interlocking. The optical device **65** may be connected to the comb attachment **85** mounted to the mobile device **15**. Alternatively, the comb attachment **85** may be connected to the optical device **65** mounted to the mobile device **15**. In a further embodiment, the optical device **65** and the comb attachment **85** may be integrally formed.

A method for diagnosing skin and/ or hair condition is described with reference to Fig. 2. In an embodiment, the method comprises a step **100** of acquiring an image of the skin and/ or hair condition; a step **110** of identifying markers of the skin and/ or hair condition from the acquired image; a step **115** of diagnosing the skin and/ or hair condition from a plurality of databases **45, 50, 55** comprising information for the diagnosis of the skin and/ or hair condition; and a step **120** of proposing a treatment or management option for the diagnosed skin and/ or hair condition.

The method further comprises a step **105** of processing the acquired image based on predetermined parameters prior to step **110**. If the acquired image does not conform to the required predetermined parameters the method returns to step **100** in order to re-acquire an image of the skin and/ or hair condition. If the acquired image conforms to the required predetermined parameters the method moves to step **110**.

In an alternative embodiment, the method comprises a step **110** of identifying markers of the skin and/ or hair condition from an image acquired from a user afflicted with the skin and/ or hair condition; a step **115** of diagnosing the skin and/ or hair condition from a plurality of databases **45, 50, 55** comprising information for the diagnosis of the skin and/ or hair condition; and a step **120** of proposing a treatment or management option for the diagnosed skin and/ or hair condition.

The alternative method further comprises a step **105** of processing the acquired image based on predetermined parameters prior to step **110**. If the acquired image does not conform to the required predetermined parameters the method requests for a further image of the skin and/ or hair condition. If the acquired image conforms to the required predetermined parameters the method moves to step **110**.

The method further comprises the step of consulting an external information source

60. The step of consulting an external information source **60** is performed simultaneously with consultation of the plurality of databases **45, 50, 55** at step **115**.

The skilled person would appreciate that foregoing embodiments may be modified or combined to obtain the system **10** and method of the present disclosure.

5 Industrial Applicability

This disclosure describes a diagnostic system **10** and a diagnostic method of skin and/or hair pathologies. The system **10** and method provides for early diagnosis of diseases relating to the skin, scalp and hair. The system **10** and method enables the automatic proposition of cosmetic treatments and / or clinical treatments. The system **10** and method
10 may be used to diagnose conditions relating to the skin and hair on all parts of the body. In an embodiment, the system **10** and method may be used to diagnose trichological conditions.

The course of the disease may be monitored using the system **10** and the method subsequent to an adopted treatment. The system **10** and method provides for feedback on the course of the disease over the period of the treatment. The system **10** and method serves as a
15 support and a guide for improving the effectiveness of the treatment. The system **10** and method may enable a direct relationship to be built between supplier and end user of the treatment for both therapeutic and commercial applications.

Accordingly, this disclosure includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any
20 combination of the above-described elements in all possible variations thereof is encompassed by the disclosure unless otherwise indicated herein.

Where technical features mentioned in any claim are followed by reference signs, the reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, neither the reference signs nor their absence have any limiting effect
25 on the technical features as described above or on the scope of any claim elements.

One skilled in the art will realise the disclosure may be embodied in other specific forms without departing from the disclosure or essential characteristics thereof. The foregoing embodiments are therefore to be considered in all respects illustrative rather than limiting of the disclosure described herein. Scope of the invention is thus indicated by the
30 appended claims, rather than the foregoing description, and all changes that come within the

meaning and range of equivalence of the claims are therefore intended to be embraced therein.

Claims

1. A system (10) for diagnosing skin and/ or hair condition, the system (10) comprising:
 - a mobile device (15) connected to a camera to acquire an image of the skin and/ or hair condition;
 - 5 an extraction module (35) to identify of markers associated with the skin and/ or hair condition from the image;
 - a plurality of databases (45, 50, 55) comprising information on the diagnosis and treatment and/ or management of the skin and/ or hair conditions; and
 - 10 an inference module (40) to diagnose the skin and/ or hair condition and to propose a treatment and/ or management option for the diagnosed skin and/ or hair condition based on consultation of the plurality of databases (45, 50, 55).
2. The system (10) of claim 1 further comprising a remote device (25) including the extraction module (35), the plurality of databases (45, 50, 55) and the inference module
15 (40).
3. The system (10) of claim 1 or 2 wherein the databases are selected from the group consisting of a user database (45), a condition database (50) on skin and/ or hair conditions and a treatment database (55) of skin and/ or hair conditions.
20
4. The system (10) of claim 1, 2 or 3 further comprising a processing module (30) to process the acquired image based on predetermined parameters.
5. The system (10) of any one of preceding claims further comprising an optical device (65)
25 mounted to the mobile device (15) in alignment with the camera, the optical device (65) being configured to assist in the acquisition of the image.
6. The system (10) of claim 5 wherein the optical device (65) comprises a support body (67), a spacing element (69), and a magnification lens (71), the spacing element (69)
30 being configured to maintain a predetermined distance of the camera from the scalp of a

user.

7. The system (10) of claim 6 wherein the support body (67) comprises a first seat (77) for the positioning or the interlocking of the magnification lens (71), and a second seat (79)
5 for the positioning or the interlocking of the spacing element (69).
8. The system (10) of claim 5, 6 or 7 wherein the optical device (65) comprises an illumination element to illuminate the area of the skin and/ or hair condition.
- 10 9. The system (10) of any one of claims 5 - 8 wherein the optical device (65) is provided with a series of slots to enable entry of ambient light.
10. The system (10) of any one of claims 5 - 9 wherein the optical device (65) is configured to provide a magnification of 3x to 80x.
15
11. The system (10) of any one of preceding claims further comprising a comb attachment (85) mounted to the mobile device (15), the comb attachment (85) being configured to position hair for acquisition of the image.
- 20 12. The system (10) of claim 11 wherein the comb attachment (85) is configured to position hair in a manner selected from the group comprising: standardising the concentration of the hair in an area, placing the hair in parallel, exposing the afflicted skin and flattening the hair.
- 25 13. The system (10) of claim 11 or 12 wherein the comb attachment (85) is configured to maintain a predetermined distance of the camera from the scalp of a user.
14. The system (10) of claim 11, 12 or 13 wherein the comb attachment (85) comprises a plate (87) and a strap (91), the plate (87) being provided with teeth (89) that are placed to
30 its exposed surface, and the strap (91) being configured to mechanically connect the comb

attachment (85) to the mobile device (15).

15. The system (10) of claim any one of claims 11 - 14 wherein the strap (91) comprises a Velcro closure (93).

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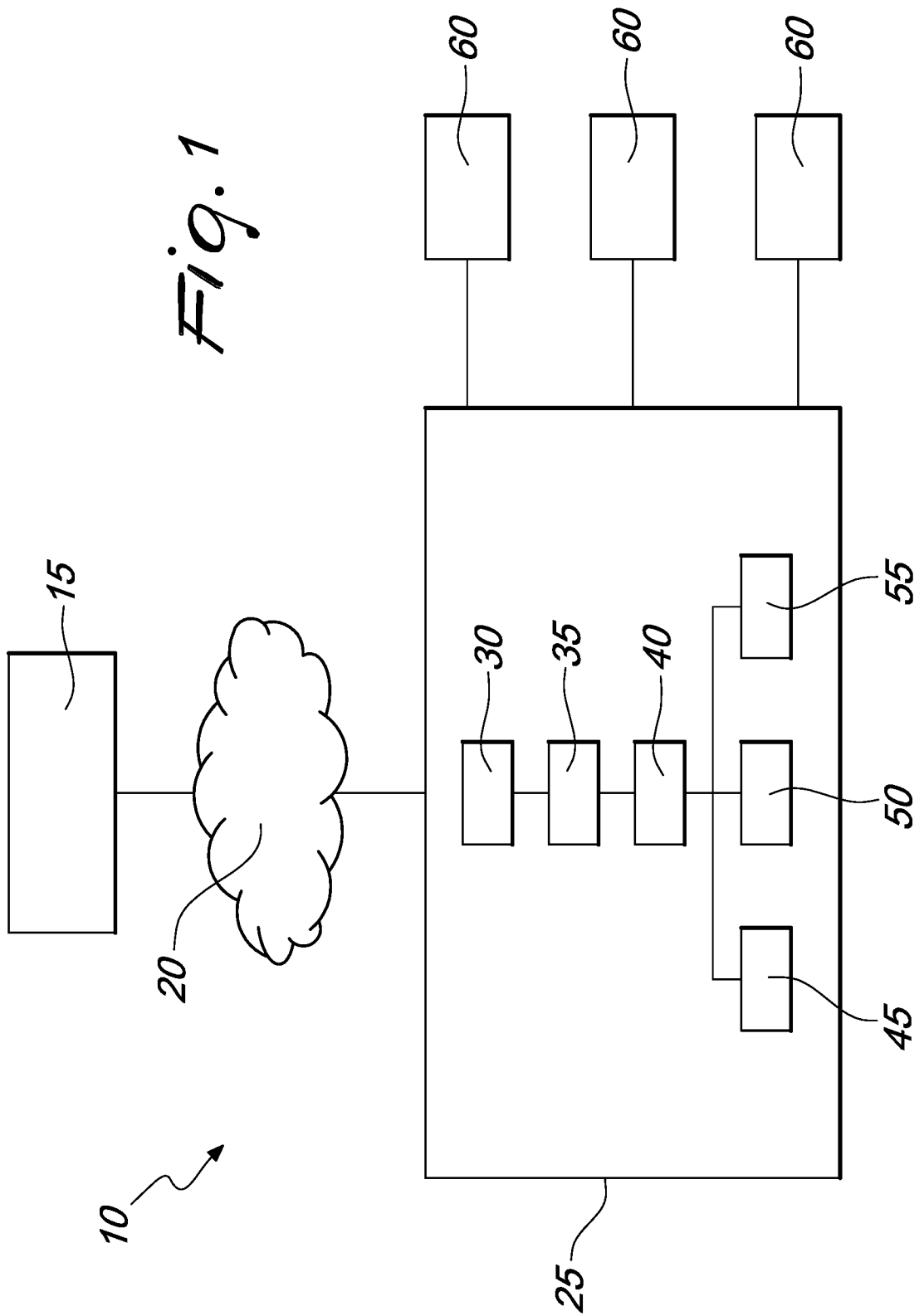
16. A method for diagnosing skin and/ or hair condition, the method comprising the steps of:
acquiring (100) an image of the skin and/ or hair condition;
diagnosing (115) the skin and/ or hair condition from a plurality of databases (45, 50, 55) comprising information for the diagnosis of the skin and/ or hair condition;
10 proposing (120) a treatment or management option for the diagnosed skin and/ or hair condition.

17. The method of claim 16 further comprising the step of processing (105) the acquired image based on predetermined parameters.

15

18. The method of claim 16 or 17 further comprising the step of consulting external information source (60).

Fig. 1



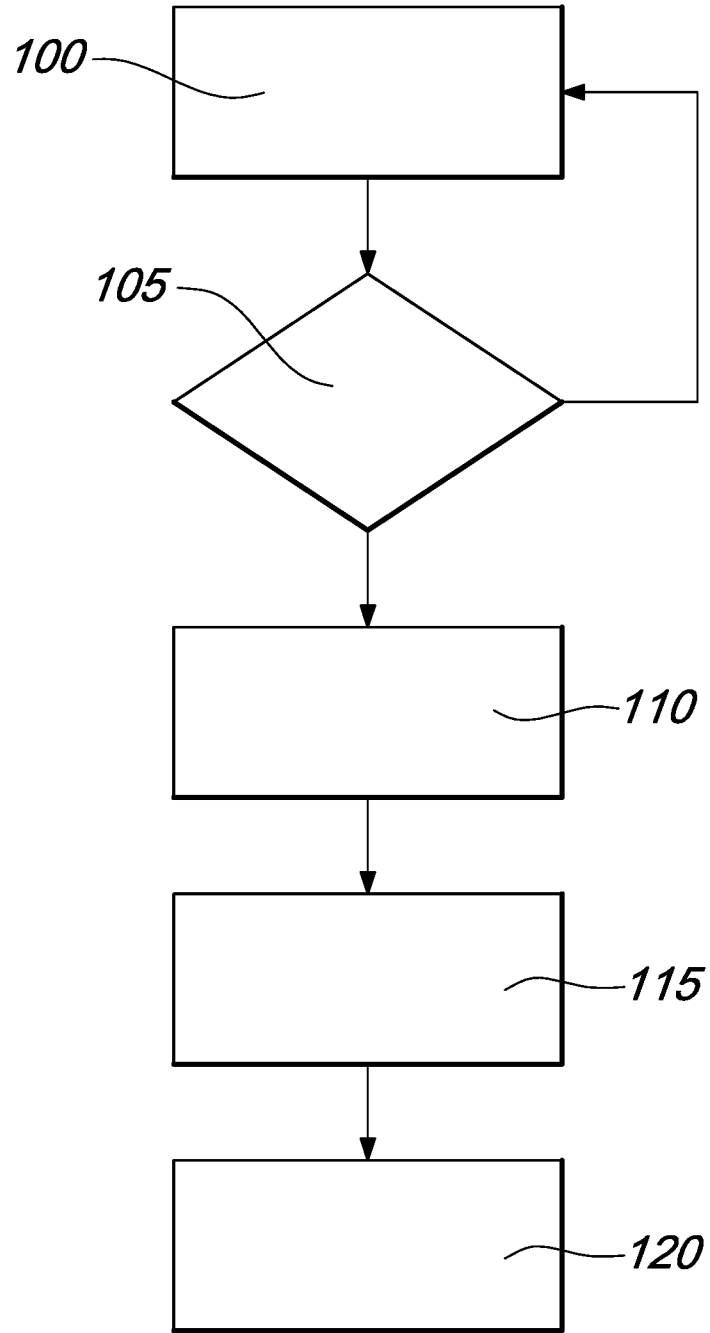


Fig. 2

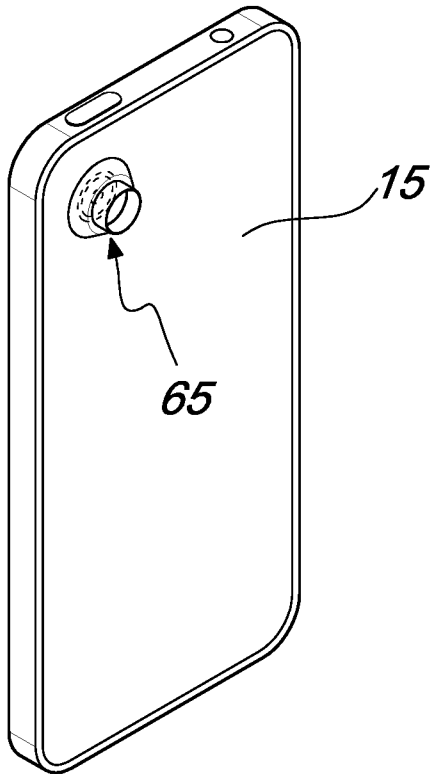


Fig. 3

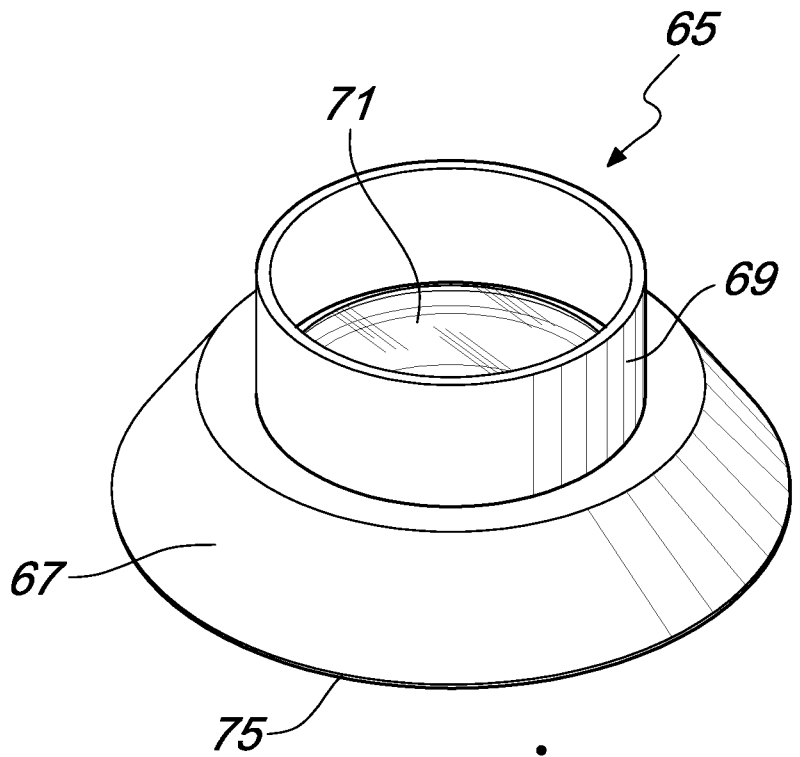


Fig. 4a

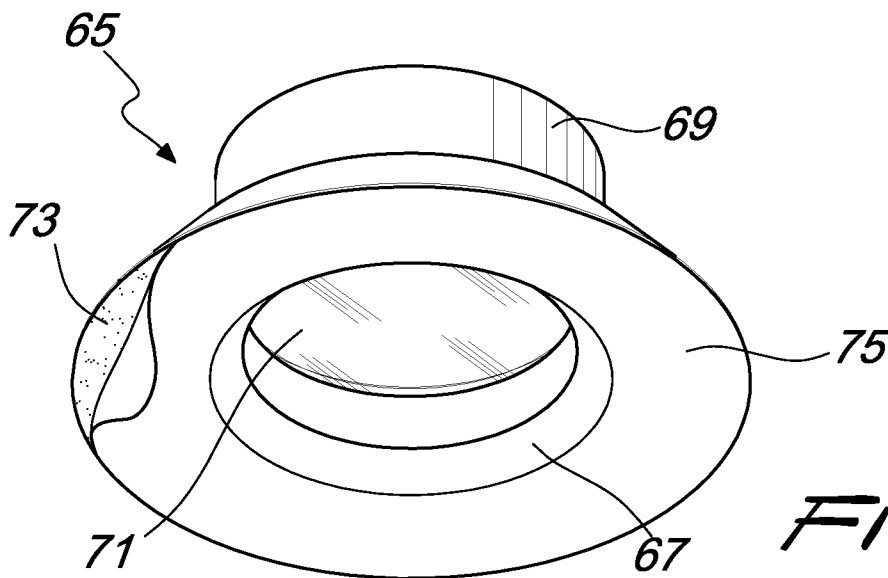
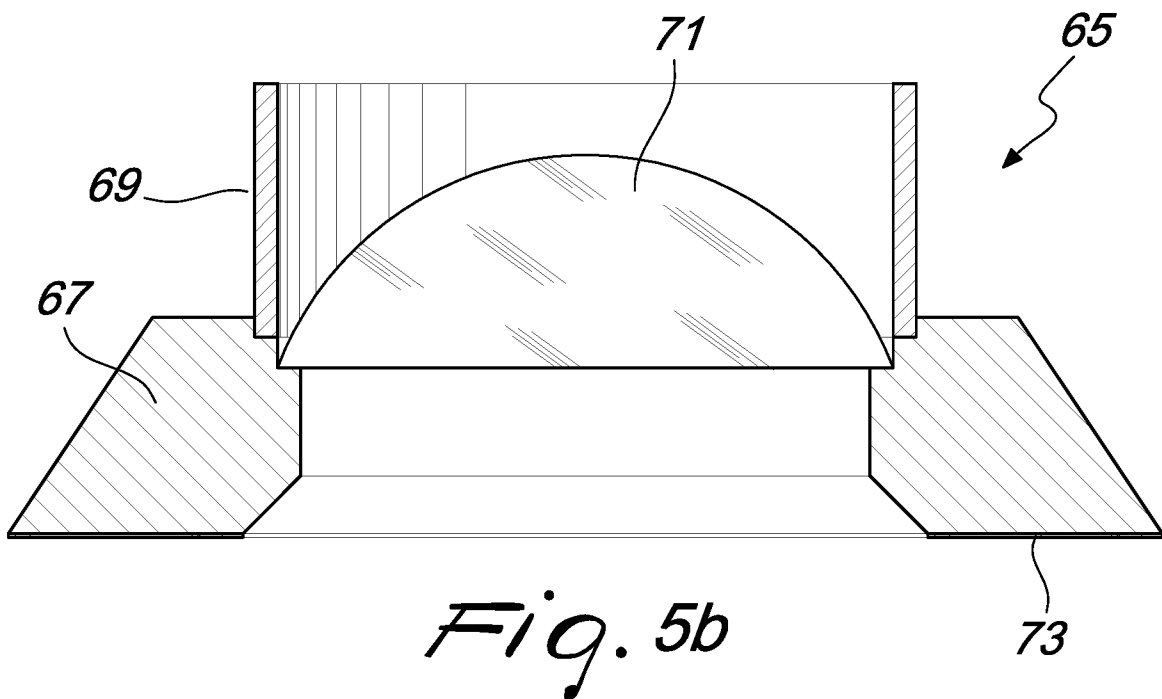
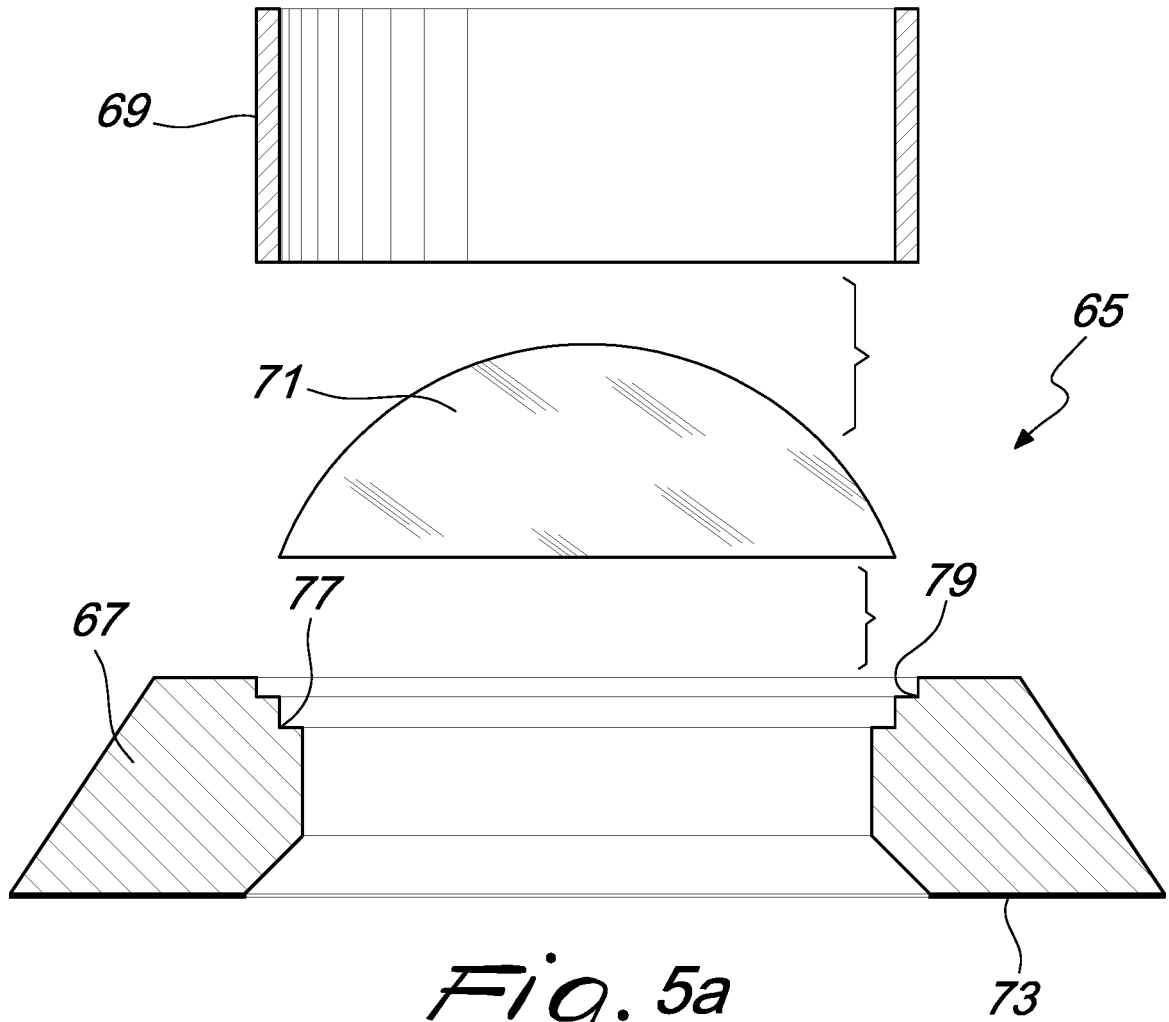


Fig. 4b

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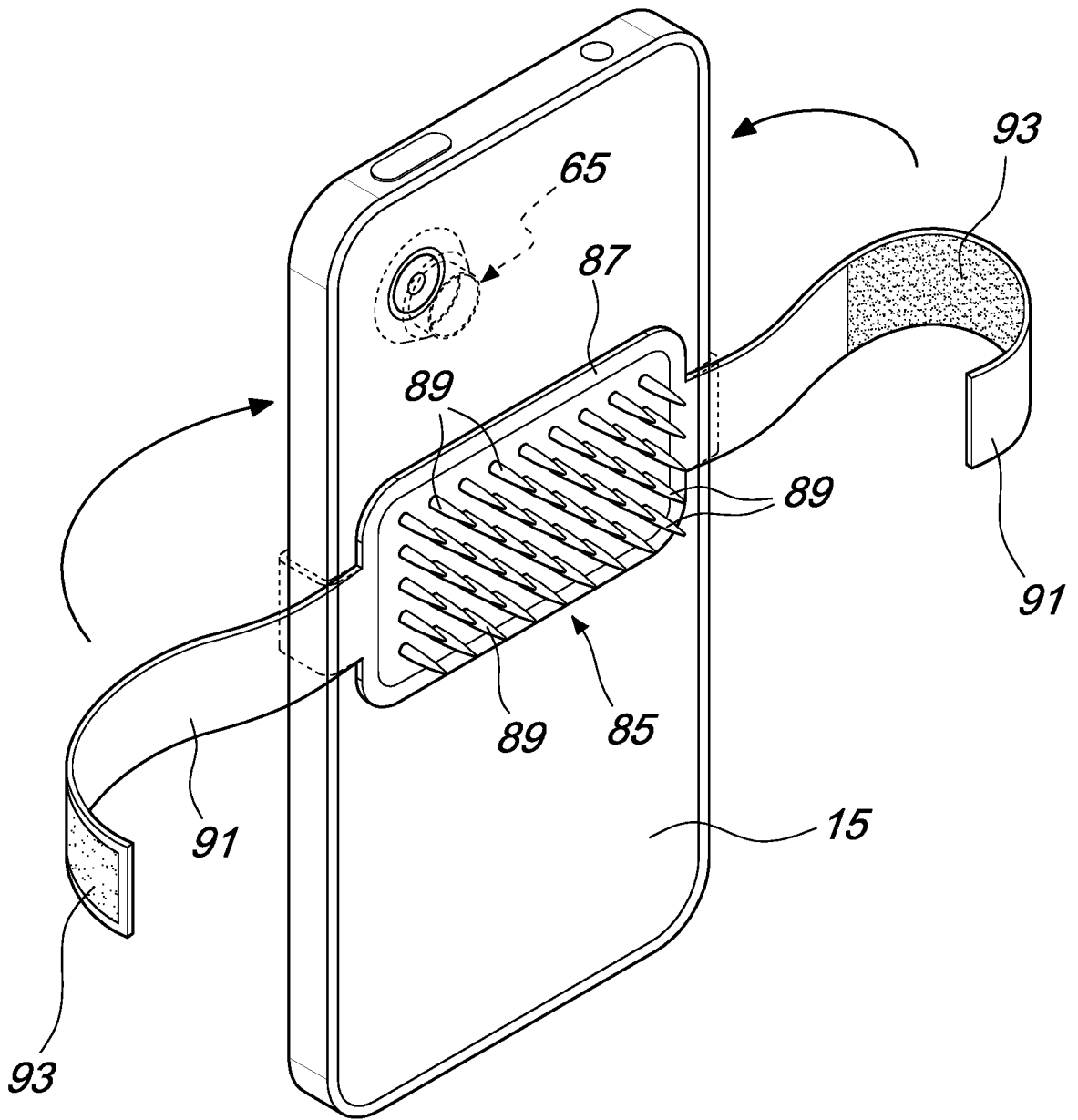


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/052691

A. CLASSIFICATION OF SUBJECT MATTER
 INV. G06F19/00
 ADD. A61B5/00 G03B17/56

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 G06F A61B G03B

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	WO 2012/058641 A2 (UNIV CALIFORNIA [US]; FLETCHER DANIEL [US]; DOUGLAS ERIK [US]; SHENG A) 3 May 2012 (2012-05-03) abstract; figures 1-17 paragraph [0057] - paragraph [0059] paragraph [0066] paragraph [0069] paragraph [0072] - paragraph [0074] paragraph [0078] - paragraph [0080]	1-18
X	WO 2015/060376 A1 (HITACHI MAXELL [JP]) 30 April 2015 (2015-04-30) abstract ----- -/--	1-18

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search 30 September 2016	Date of mailing of the international search report 18/10/2016
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Filloy García, E
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/052691

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2015/342515 A1 (HUTCHINGS CEDRIC [FR] ET AL) 3 December 2015 (2015-12-03) abstract; figures 1-4 paragraph [0016] paragraph [0020] - paragraph [0021] paragraph [0053] - paragraph [0058] paragraph [0061] - paragraph [0065] paragraph [0072] - paragraph [0077] -----	1-18
A	US 2009/147081 A1 (HANSON THOMAS [US]) 11 June 2009 (2009-06-11) abstract; figures 1-11 paragraph [0026] - paragraph [0028] paragraph [0031] -----	11-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/052691

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		WO 2009076162 A2	18-06-2009
