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(54) Title: DEVICE FOR GENERATING COLD PLASMA WITH A POROUS OZONE FILTER

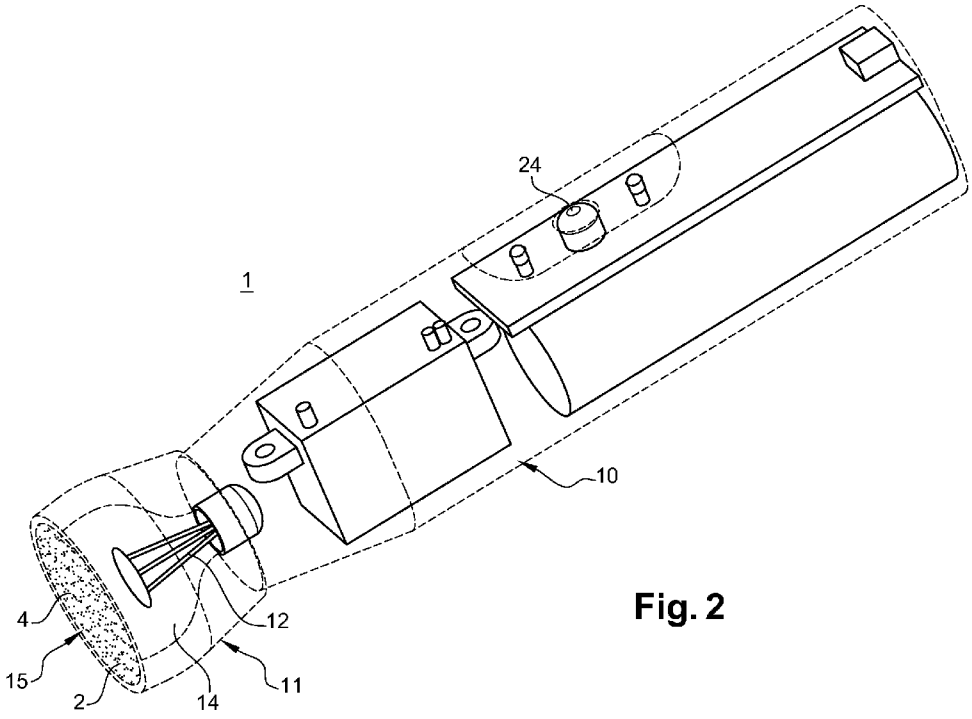

Fig. 2

(57) Abstract: The present invention relates to a plasma treatment device (1) for a body surface to be treated, comprising a high-voltage generator connected to a headpiece (11) including a plasma treatment electrode (12), and it further comprises a porous ozone filter (2).

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Device for generating cold plasma with a porous ozone filter

FIELD OF THE INVENTION

The invention relates to a treatment device for a body surface to be treated using a dielectric barrier plasma, the device comprising a headpiece with a porous ozone filter.

The invention also relates to a process comprising moving the treatment device on the skin as well as to the use of the treatment device for preventing and/or treating aesthetic disorders of the healthy scalp or of the healthy skin.

By "cosmetic product" is meant any product as defined in Regulation (EC) No. 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products.

BACKGROUND OF THE INVENTION

Plasma, sometimes referred to as the “fourth state of matter”, typically includes partially and/or fully ionized gas molecules and can be produced and directed in a variety of ways and geometries. More specifically, a plasma can be thought of as a gas having molecules that can be partially or fully ionized and electrons that have kinetic energy sufficient to strip at least one electron from at least one of the gas molecules through collisions, such that the resulting plasma includes a mixture of positively charged ions in a sea of free electrons that may or may not also include neutral species mixed therewith.

The plasma produces reactive chemical species such as hydroxyl radicals (OH), nitrous oxide (NO_2), nitric oxide (NO), ozone (O_3), superoxide (O_2^-) that kill the pathogens responsible for skin conditions such as acne. The plasma also emits light of a variety of wavelengths, generates heat, ions, and electrons. The combination of these species and energy emissions can react with or cause reactions within the skin that can affect the local cellular arrangement, inflammation or other cellular processes.

Among the reactive species present in the plasma, ozone is a species with a long lifetime in the air. If inhaled in large amounts, it may be toxic. At low doses, ozone is the source of a smell that can be unpleasant. It is therefore appropriate to limit exposure to the respiratory tract.

Plasma devices comprising ozone filters are known in the art.

DE102011001416 discloses a plasma treatment device with two flexible surface electrodes insulated and arranged adjacent to one another on a surface to be treated, where suitable alternating voltage and alternating potential difference are producible between the electrodes. Each electrode includes electrically insulated conductors. A wound contact layer is detachably secured on an outer side of the electrodes facing the surface. An active oxygen reducing layer is detachably secured on another outer side of the electrodes, the latter outer side is turned away from the surface to be treated.

US2015137677 discloses a dielectric barrier discharge-type plasma generating electrode structure comprising an upper conductive electrode and a lower conductive electrode, at least one conductive electrode protrusion formed on at least one inner surface of the upper conductive electrode and the lower conductive electrode facing each other; a dielectric layer formed with a substantially uniform thickness on at least one inner surface of the upper conductive electrode and the lower conductive electrode facing each other; and a predetermined gap formed between the upper and lower conductive electrodes and the dielectric layer. Optionally, the electrode structure further comprises an ozone removal functional layer formed on a surface of the upper conductive electrode, a surface of the lower conductive electrode, or a surface of the dielectric layer.

US2013345620 discloses a system for applying a plasma discharge, comprising an electrode adapted to be placed proximate an anatomical region of interest and a power supply in electrical communication with the electrode. A spacer made from a non-conductive material can be used to set the distance between the plasma treatment electrode and the skin. The spacer/spacing means can be provided around the periphery of the treatment electrode, in which case it can also surround or encapsulate the local gas. By surrounding the local gas, the structure can facilitate concentration of the heat and reactive species in the desired treatment area. Such a border can also incorporate an ozone-absorbing material, such as carbon black, to absorb the ozone that is commonly generated by the dielectric barrier discharge.

The problem addressed by the present invention is to provide a treatment device capable of ensuring the most controlled plasma generation possible on the skin, to improve tolerance by avoiding tingling due to electric charges, while reducing the lifetime of the ozone produced by the generator of plasma.

SUMMARY OF THE INVENTION

In order to solve this problem, the invention proposes a treatment device for a body surface to be treated, comprising a high-voltage generator connected to a headpiece including a plasma treatment electrode, characterized by the fact that it further comprises a porous ozone filter.

According to the invention, the porous ozone filter porous network to increase the exchange surfaces with ozone and without interfering between the plasma and the biological target to be treated. The efficiency of the ozone filter is increased.

The plasma formation can take place using a DC high voltage, only an initial displacement current results and the potential difference maintaining the plasma. The use of an AC high voltage is preferred, however, if the high-voltage potential switches between a positive voltage and a negative voltage. It is preferred, in this case, that the surface to be treated, for example the skin surface or the body, functions as a so-called floating counter electrode. It could only sluggishly follow the change in potential of the AC voltage and, therefore, due to the changing frequency, essentially remains at an average potential which will become the ground potential.

During the reaction with ozone, some benefice reactive species can occur. They can be deliver to the treatment area to this filter. This is an additional reaction.

Another object of the invention is a process for treating a body surface using a dielectric barrier plasma, a device according to the invention being moved on the body surface. The process of the invention is a dynamic process.

Preferably, a benefice agent is created during the absorption of ozone, and is delivered to treat the skin.

Another object of the invention is the use of a device according to the invention for preventing and/or treating aesthetic disorders of the healthy scalp or of the healthy skin.

MAIN DEFINITIONS

The “axis A” means the longitudinal axis A.

A “longitudinal section of axis A” is a section parallel to the axis A of the part.

A “cross section of a part of axis A” is a section perpendicular to the axis A of the part.

The expression “longitudinal axis of the part x” denotes the line connecting all of the centers of mass of the cross sections of the part x.

A “plasma” is an ionised gas which can also generate reactive species, produced by the discharge resulting in the plasma. A cold atmospheric plasma is a plasma which does not cause any excessive heating of the substrate exposed to the plasma.

Three families of cold atmospheric plasmas are available, namely direct, indirect and hybrid plasmas.

In direct plasmas, it is the substrate which acts as the counter electrode required for producing the plasma; the plasma is therefore generated between the electrode and the substrate. One of the main direct plasma technologies is the plasma known as DBD (Dielectric Barrier Discharge).

For the purposes of the present invention, the term "preventing" means reducing the risk of manifestation of the phenomenon under consideration.

A “porous ozone filter” comprises a material that reacts with ozone O_3 to provide oxygen gas O_2. Examples of such reactions are:

◦ Reaction with metal:

In the presence of moisture, ozone oxidizes all metals with the exception of gold, platinum and iridium.

$$2\ Cu+ + 2\ H_3O+ + O_3 \rightarrow 2\ Cu_2+ + 3\ H_2O + O_2$$

◦ Reaction with carbon:

$$C + 2\ O_3 \rightarrow CO_2 + 2\ O_2$$

A porous material comprises pores or voids. These voids can be filled with fluids (liquid, such as water or formula or gas). In this case, the reaction can take place with the liquid, which can serve as a filter. For example, the reaction can take place with water.

Porosity (P) is a numerical value defined as the ratio between void volume (V_{void}) and the total volume (V_{total}) of a porous medium:

$$P = V_{void}/ V_{total}$$

A porous material has a porosity (P) different from zero.

The porous ozone filter according to the invention comprises a porous material.

According to the invention, a porous material can be made by assembling filaments, wires, particles, sheets. It can be a woven, non-woven, sponge, fabric, porous polymer or a rigid non elastic product.

PREFERRED EMBODIMENTS

According to further advantageous aspects of the invention, the device comprises one or several of the following features taken in isolation or in any technically possible combinations:

- It comprises a dielectric barrier discharge plasma (DBD). This is a first embodiment according to the invention.
- It comprises a direct discharge plasma. This is a second embodiment according to the invention.
- The porous ozone filter comprises a compact powder or a porous solid compound. The device is compact, even portable.
- The porous ozone filter is a woven, a non-woven, a fabric. The filter can be removable and changed.
- The porous ozone filter comprises a metal, an alkali metal, a nitrogen compound, a carbon compound, a sulfur compound, a polymer loaded with metal powders, a polymer loaded with carbon powder and combinations thereof capable of containing aqueous solutions.
- The porous ozone filter forms a counter electrode of a direct plasma generator, that builds at least one part of an end wall facing the surface to be treated. Costs are saved.
- It comprises a spacer to set the distance between the plasma treatment electrode and the body surface, the spacer including the porous ozone filter. The device is safer. It can be used for many types of skins.
- It comprises an upper layer facing the surface to be treated, the upper layer including the porous ozone filter. The filtering is especially efficient.
- It comprises an intermediate layer between a conductive element and a dielectric element or an insulating element, the intermediate layer including the porous ozone filter. The filter is distant from the skin of the user.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be better understood from reading the following detailed description of non-limiting implementation examples thereof, and with reference to the appended drawing, schematic and partial, in which:

FIG. 1 shows a perspective view of a first embodiment of a treatment device according to the invention in the assembled state;

FIG. 2 shows a perspective view of a second embodiment of a treatment device according to the invention in the assembled state;

The device 1 shown in FIG. 1 and FIG. 2 comprises a hand piece 10 and a headpiece 11. It has a longitudinal axis X. The plasma generator is, for example, of DBD type, and in this case, the headpiece 11 may comprise an electrode 12 covered with a dielectric material.

The electrode 12 can be supplied with high-voltage pulses generated by a generator 100. On this figure, the projecting elements of the electrode are not represented.

The electrode 12 is covered with a dielectric wall 14, the external surface of which being provided with reliefs 13.

The skin of the person serves as a counter electrode, and receives a harmless electric current.

The hand piece 10 can be formed as a tube made of plastic or metal, while the hand piece 10 can be removably inserted in its proximal end.

The device can be turned on / off by pressing the on / off button 24.

The headpiece 11 shown in FIG. 2 and disposed on the skin 20 of a person, comprises an electrode 12 totally shielded by a dielectric wall 14 that forms an end wall 15 facing the surface to be treated.

On FIG. 1, a spacer 3 incorporating porous ozone filter 2 is used to set the distance between the plasma treatment electrode and the skin. The spacer/spacing means 3 can be provided around the periphery of the treatment electrode 12, in which case it can also surround or encapsulate the local gas. By surrounding the local gas, the structure can facilitate concentration of the heat and reactive species in the desired treatment area, during operation of the device. The spacer 3 is ring shaped but other shapes can be contemplated.

On FIG. 2, the porous ozone filter 2 has a grid shape or mesh shape to enhance its function. The grid 4 is placed above the dielectric wall 14. The plasma flows

through the holes of the grid and the generated ozone is trapped by the ozone filter before reaching the surface to be treated.

The dielectric wall 14 can be assembled to the electrode 12 by clamping, sticking, gluing. It can also be sprayed onto the electrode or be injected molded.

The porous ozone filter can be assembled by clamping, sticking, gluing.

The invention is not limited to the illustrative embodiments which have just been described, the characteristics of which may be combined with one another as parts of variants which are not illustrated. Any other shape of the porous ozone filter can be contemplated.

CLAIMS

1. A plasma treatment device (1) for a body surface to be treated, comprising a high-voltage generator connected to a headpiece (11) including a plasma treatment electrode (12), characterized by the fact that it further comprises a porous ozone filter (2).

2. A treatment device according to claim 1, characterized by the fact that it comprises a dielectric barrier discharge plasma (DBD).

3. A treatment device according to claim 1, characterized by the fact that it comprises a direct discharge plasma.

4. A treatment device according to any of the preceding claims, characterized by the fact that the porous ozone filter (2) comprises a compact powder or a porous solid compound.

5. A treatment device according to any of the preceding claims, characterized by the fact the porous ozone filter (2) is a woven, a non-woven, a fabric.

6. A treatment device according to any of the preceding claims, characterized in that the porous ozone filter (2) comprises a metal, an alkali metal, a nitrogen compound, a carbon compound, a sulfur compound, a polymer loaded with metal powders, a polymer loaded with carbon powder and combinations thereof capable of containing aqueous solutions.

7. A treatment device according to any of the preceding claims 3 to 6, characterized in that the porous ozone filter (2) forms a counter electrode of a direct plasma generator, that builds at least one part of an end wall (15) facing the surface to be treated.

8. A treatment device according to any of the preceding claims, characterized in that it comprises a spacer (3) to set the distance between the plasma treatment electrode (12) and the body surface, the spacer (3) including the porous ozone filter (2).

9. A treatment device according to any of the preceding claims, characterized in that it comprises an upper layer (4) facing the surface to be treated, the upper layer (4) including the porous ozone filter (2).

10. A treatment device according to any of the preceding claims, characterized in that it comprises an intermediate layer between a conductive element and a dielectric element or an insulating element, the intermediate layer including the porous ozone filter (2).

11. A cosmetic process for treating a body surface using a dielectric barrier plasma, characterized in that a device (1) according to any of the preceding claims is moved on the body surface.

12. A cosmetic process according to claim 11, characterized in that a benefice agent is created during the absorption of ozone, and is delivered to treat the skin.

13. Use of a device according to any of the preceding claims 1 to 11 for preventing and/or treating aesthetic disorders of a healthy scalp or of a healthy skin.

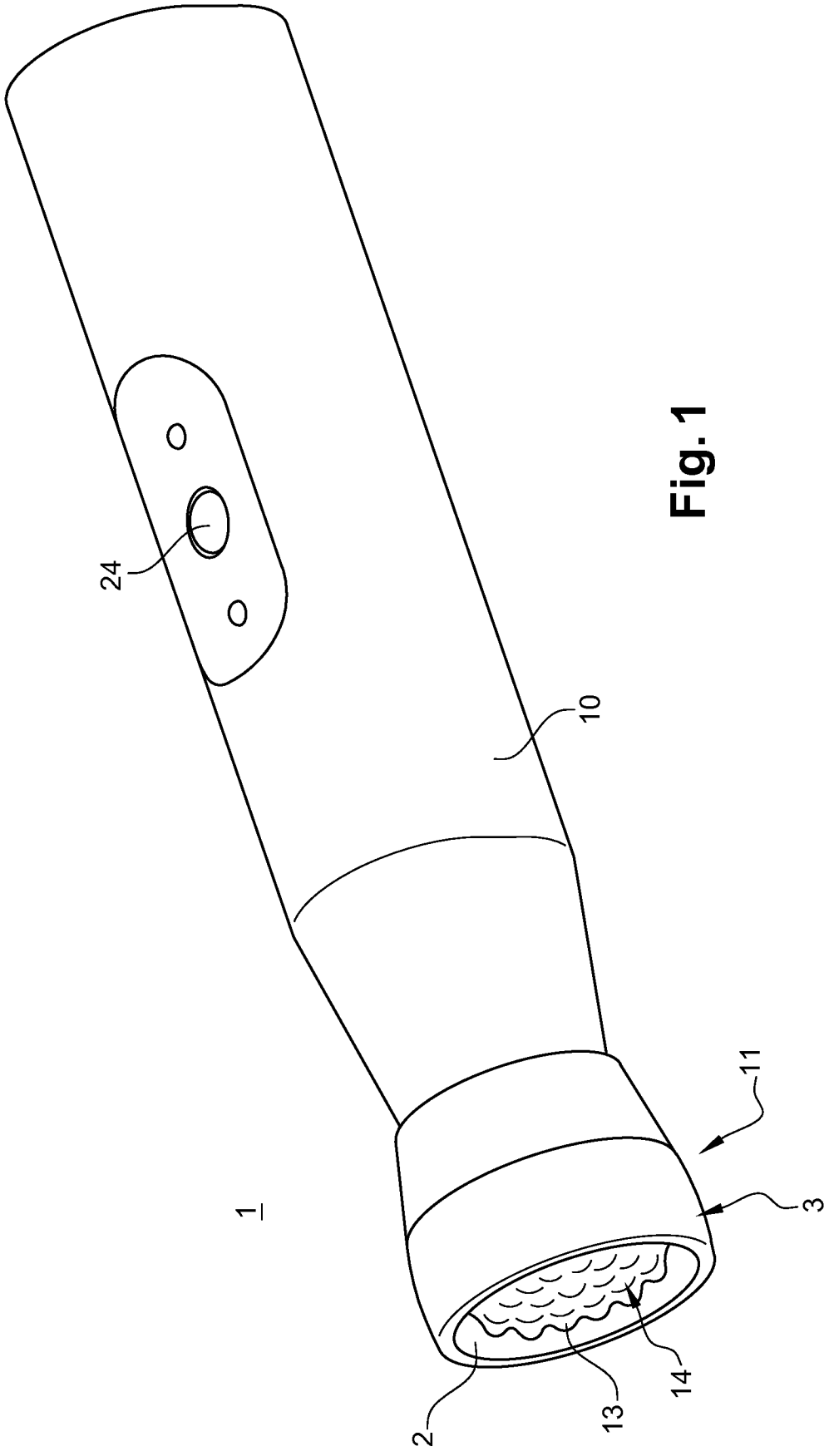

Fig. 1

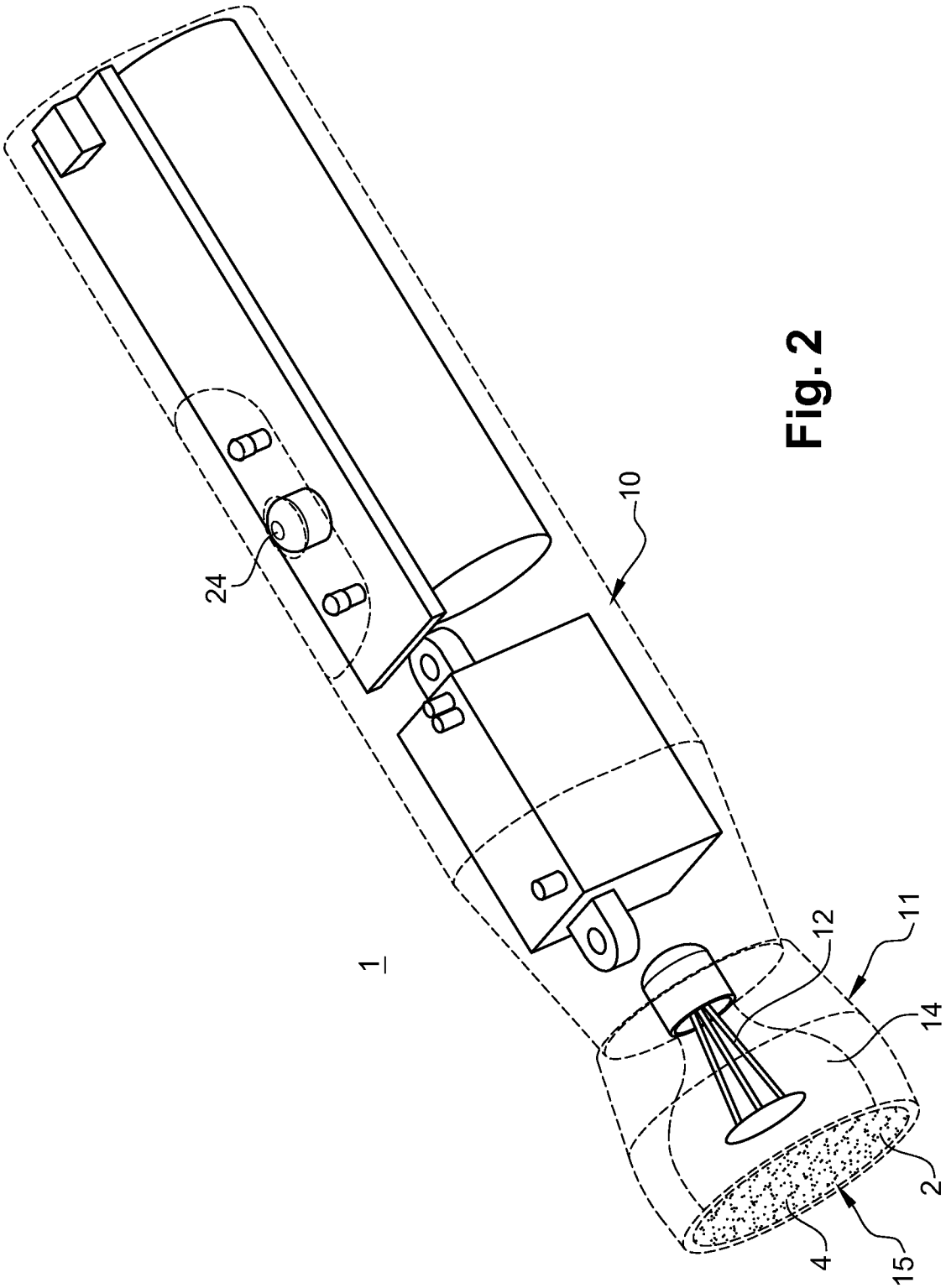

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/076168

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05H1/24 A61N1/44 A61B18/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05H A61N A61B A61L

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

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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