(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
05 March 2020 (05.03.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/043253 A1

(51) International Patent Classification:
A61N 5/06 (2006.01)

(21) International Application Number:
PCT/DK2019/050249

(22) International Filing Date:
28 August 2019 (28.08.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PA 2018 70556 30 August 2018 (30.08.2018) DK

(71) Applicant: **ENERGY LASER A/S** [DK/DK]; Sønderskovvej 12 A, 8520 Lystrup (DK).

(72) Inventors: **JENSEN, Henrik Ljungberg**; Ildvedvej 36, Ildved, 7300 Jelling (DK). **PEDERSEN, Leif Kvist**; Sønderskovvej 12A, 8520 Lystrup (DK). **PROSCH-JENSEN, Svend**; Spægbogade 4, 8700 Horsens (DK).

(74) Agent: **PATRADE A/S**; Ceresbyen 75, 8000 Aarhus C (DK).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) **Title:** A LASER HEAD AND LASER PROBE FOR LOW-LEVEL LASER THERAPY AND A METHOD OF CONTROLLING SUCH LASER PROBE

(57) **Abstract:** An object of the invention is achieved by a method of changing operational parameters of a laser probe. The method may comprise an act of recognising a connection pattern between the laser probe and a battery. The connection pattern between the laser probe and a battery could be connection, disconnection, connection. So if a user first connects a laser probe to a battery, then disconnects the laser probe and the battery, and within a time period reconnects the laser probe to the battery, then this connection-disconnection-connection pattern will be recognised and cause an act of set- ting the laser probe in a programmable mode.

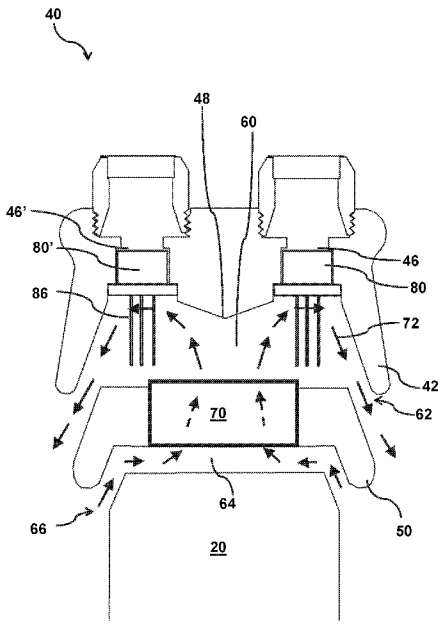


Fig. 1

WO 2020/043253 A1

A laser head and a laser probe for low-level laser therapy and a method of controlling such laser probe

Field of the Invention

The present invention relates to a low-level laser therapy (LLLT) laser probe and especially a laser head for increasing the efficiency of heat removal and a laser diode for decreasing heat production and increasing the efficiency of the laser probe.

The present invention also relates to a method for changing the operational parameters of a laser probe for low-level laser therapy.

Background of the Invention

Low-level laser therapy (LLLT) is a growing market where lasers or light-emitting diodes are used for pain relief, healing of tissues, inflammation, ulcers, skin disorders, acupuncture, zone therapy, immune therapy and, in general, activation of the immune system.

At present, the laser probe used in low-level laser therapy is connected by a cord to a power supply due to the high energy demand of the laser probe. The power supply makes the entire system heavy and not easily moveable. The heavy system makes the use of laser probes in private households less attractive.

Furthermore, the cord can be a source of irritation when working around the human body.

There is a need for a more efficient laser probe for LLLT, thereby enabling the laser probe to be powered by a battery having a size allowing the battery to be attached directly to the laser probe, such that the laser probe can be cordless.

Furthermore, a present day laser probe has an inefficient internal heat removal which causes the laser probe to often have a temperature that damages the one or more laser diodes. At present, this problem is solved by letting the laser probe cool or by changing the laser head.

Thus, the user is forced to have a longer treatment time or to have a series of extra laser heads.

This is also a limiting factor in the adoption of the laser probes in private households, because private household users are not experts and will typically not have more than one laser head and also may not follow the instructions.

The heat generation also prevents the use of the laser probe inside the human body, such as oral treatment, anal treatment and vaginal treatment as the temperature near the laser diodes can be over 37 degrees or 50 degrees Celsius or even higher.

Thus, there is a need for a more efficient heat removal system for increasing the operational time of the laser probe and/or for increasing the lifetime of the laser diode.

The laser probe may be used in therapeutic and non-therapeutic methods, such as pain relief healing of tissues, inflammation, ulcers, skin disorders and in general activation of the immune system. In all cases, the requirements for hygiene are strict and the laser probe must comply with these requirements.

At present, a laser probe is connected by a cord to a power supply. The power supply may be adapted such that the user can control the operational parameters of the laser probe at the power supply. The operational parameters could be power of the laser, treatment time and/or repetition rate of a beep sound.

This is not possible if the laser probe is cordless. The laser probe could in theory be equipped with buttons, but having buttons on the laser probe would reduce the level of hygiene as it is hard to clean buttons properly. This could be a source for infections.

Thus, there is a need for a method that can change the operational parameters of the laser probe without the use of buttons.

Object of the Invention

It is an object of the invention to provide a laser probe having an efficient heat removal.

It is an object of the invention to provide an efficient laser probe for low-level laser therapy where the laser probe can be powered by a battery attached to the laser probe, thereby making it cordless.

It is another object of the invention to provide a laser probe that meets a high hygienic standard.

Description of the Invention

The embodiments of the laser probes described in this document may be of any laser class, especially laser class 3B or laser class 4.

Both laser class 3B and 4 can provide enough energy to heat tissue, however there is a risk of a burn due to heat generated in the tissue if the laser light is greater than 500 mW/cm^2.

The embodiments of the laser probes described in this document may emit light in the range of 600-1000 nm. The range is also called the biological window as these wavelengths can penetrate the skin and affect the cells.

An object of the invention is provided by a laser head for a low-level laser therapy (LLLT) laser probe.

The laser head may comprise an outer cap and an inner cap connected to the outer cap and positioned partly within the outer cap, thereby forming a heat channel having an exhaust in-between the caps.

The outer cap may have a downwardly extending outer skirt along or near an outer periphery. Thereby, the outer cap may have a U-shaped cross-section.

The inner cap may have a downwardly extending inner skirt along or near an inner periphery. Thereby, the inner cap may have a U-shaped cross-section.

The skilled person would know how to connect the outer and inner cap, such that a heat channel having an exhaust is formed. The heat channel will make it possible to remove heat by convection, thereby increasing the heat removal.

The outer cap may comprise one or more bores for one or more laser diodes.

Each bore may be adapted for holding one or more lenses in front of a laser diode, such that the beam profiles can be either focused towards a common focal point or spread out.

By having a common focal point, each laser diode may generate a part of the emitted light needed for a wanted effect, and thus less heat will be generated at each diode. The heat generated is spread over a larger area, thereby keeping the temperature lower. The efficiency of a laser diode decreases with temperature and likewise the lifetime of a laser diode is temperature dependent, where higher temperatures causes a shorter lifetime.

Each lens may be a fibre rod, window or a lens for focusing the laser light, or a lens for spreading the laser light.

The inner cap may be adapted for enabling each laser diode to be connected to power through the inner cap. Thus, the inner cap may have punctures for accommodating pins from each laser diode.

The skilled person would know how to connect the one or more laser diodes to power.

The inner cap may comprise a neck connection part for interlocking with a body of a laser probe.

The inner cap may be adapted for forming an inlet channel having an intake between the inner cap and the body when the inner cap is connected to the body.

The inner cap may comprise a centrally positioned ventilator for creating a flow from the inlet channel through the heat channel.

The effect of the ventilator is that a flow is created which will increase the heat removal from the one or more laser diodes, and thus the temperature of the one or more laser diodes is decreased. This will enable the laser probe to be used for longer time periods.

Furthermore, the reduced temperature will increase the lifetime of the laser diodes.

The flow may be a turbulent flow, as the turbulent flow will increase the heat removal compared to a laminar flow. The ventilator can make the flow more turbulent by forcing more air through the heat channel.

The ventilator forcing air from the inlet channel through the heat channel decreases the need for passive cooling. Thus, the laser head can be made more compact, which decreases the overall weight of the laser probe and enables a user to use the laser probe for longer periods of time without tiring or getting shoulder injuries.
Furthermore, the laser head can be made more hygienic as the need for cooling grooves are removed. Cooling grooves are well-known for collecting grime.
The neck connection part may be threaded, or be a plug or a socket.

The skilled person would know how to adapt the inner cap, such that an inlet channel having an intake is formed between the inner cap and the body of a laser probe.

The inner cap may comprise means for electrically connecting the laser head with a controller and/or with power.

The laser head may comprise one or more laser diodes. The one or more laser diodes may emit light in the range of 600-1000 nm which is suitable for low-level laser therapy.

In an embodiment of a laser head for a low-level laser therapy (LLLT) laser probe. The laser head comprises an outer cap and an inner cap. The inner cap is connected to the outer cap and the inner cap is positioned partly within the outer cap. Thereby, the inner and outer cap form a heat channel which has an exhaust in-between the caps. The outer cap comprises one or more bores for one or more laser diodes. The inner cap comprises a neck connection part for interlocking with a body of a laser probe. The inner cap and the body form when connected an inlet channel which have an intake. The inner cap further comprises a centrally positioned ventilator for creating a flow from the inlet channel through the heat channel.

The embodiment of the laser head has such efficient heat removal that the laser head may be used inside the human body, e.g. for oral treatment, anal treatment and vaginal treatment.

In an aspect of the invention, the outer cap and the inner cap may be positioned such that the exhaust encloses the ventilator.

In an embodiment the inner cap is positioned within the outer cap while keeping a distance to outer cap.

The exhaust may be ring-shaped thereby enclosing the ventilator within.

When in use, the exhaust may be blocked or partly blocked by the user's hand. This problem is solved by having an exhaust enclosing the ventilator, such that air may flow out of the laser head in all directions. Thereby, the exhaust and heat channel cannot be completely blocked.

Furthermore, the one or more laser diodes will heat the laser head and especially the outer cap which is in direct contact with the one or more laser diodes. Thus, heat will dissipate in all directions from the laser head. By having an exhaust enclosing the ventilator it is ensured that air will dissipate over a large area.

In an aspect of the invention, the inner cap is adapted such that the intake encloses the ventilator.

The intake may be ring-shaped thereby enclosing the ventilator within.

When in use, the intake may be blocked or partly blocked by the user's hand. This problem is solved by having an intake enclosing the ventilator, such that air may be sucked in by the ventilator from all directions. Thereby, the intake and inlet channel cannot be completely blocked.

Furthermore, the ventilator may suck air from a relatively large area, thereby increasing the overall flow.

In an aspect of the invention, the exhaust and the intake may be offset relatively to each other such that the amount of recirculated air is reduced.

This will increase the heat removal as there will be a larger temperature gradient between the air and the laser head.

In an aspect of the invention, the one or more bores go through the outer cap.

Thereby, a housing of a laser diode inserted in a bore may be in direct contact with the heat channel. This enables heat to be removed directly from the heat-generating laser diode making the heat removal more efficient.

Likewise, this will lower the temperature of the one or more laser diodes, thereby prolonging the lifetime of the one or more laser diodes.

In an aspect of the invention the outer cap may have a cone facing the ventilator.
The cone will direct the air flow in all directions, thereby ensuring that the air flow is distributed relatively evenly to all parts of the heat channel. This will reduce the change of airflow dead zones.

Thus, the cone increases the heat removal.

In an aspect of the invention, the outer cap may be made of a heat-conducting material.

The outer cap is in direct contact with the heat-generating one or more laser diodes. Thus, the heat-conducting material can spread the generated heat over a large area along the heat channel. This will increase the efficiency of the heat removal.

The heat-conducting material could be a metal such as copper or aluminium. Both copper and aluminium have good heat-conducting characteristics.
The outer cap may be made of thermal plastic.

The inner cap may be made of heat-conducting material such as thermal plastic or copper or aluminium.

In an aspect of the invention, the ventilator may be a mini-fan. The mini-fan is an efficient and small fan, which is capable of being installed into the laser head, while being able to cause the airflow to create turbulence within the heat channel.

An object of the invention is achieved by a laser diode for a low-level laser therapy (LLLT) laser probe.

The laser diode may comprise an emitter, a housing for protecting the emitter having a window for emission of light, and pins connected to the emitter.

The laser diode may further comprise an insert lens positioned within the housing between the emitter and the window for adjusting beam divergence.

A laser diode usually emits laser light in an angle of 10 x 30 degrees. This makes it hard to utilize the laser diode without a considerable loss in energy. In theory the loss can be prevented by positioning a lens right in front of the laser diode; however this is rarely possible.

In the case of laser probes for low-level laser therapy, the lens is typically positioned at a distance of 10-15 mm from the laser diode. This may lead to a loss of the laser

light which can be up to 40 %. This decreases the efficiency of the laser probe and increases the heat generation, both of which are unwanted effects.

As an example, if 1 W of laser light is needed from the laser probe, then the one or more laser diodes must produce 1.67 W of laser light if the loss is 40 %. The 0.67 W of laser light will be converted to heat in the laser head which must be removed.

The effect of the insert lens is that the angle of the beam can be adjusted such that the loss of laser light is removed. This will increase the efficiency of the laser probe significantly, and furthermore the heat generated is reduced significantly.

The insert lens will, in some cases, enable the laser probe to be passively cooled.

This will likewise put less strain on the ventilator of the laser head described above, which will further increase the efficiency of the laser probe as a whole.

In an aspect of the invention, the insert lens may be made of glass or plastic.

Glass optics are preferred at high energy, because plastic optics can melt if an impurity is positioned on the surface of the optics.

The insert lens may be coated or uncoated.

A Fresnel insert lens may be used.

An object of the invention is achieved by a laser probe for low-level laser therapy. The laser probe may comprise a laser head including one or more laser diodes for providing laser light.

The laser head may further include one or more lenses for spreading or focusing the laser light.

Each lens may be a fibre rod or a converging lens for focusing the laser light or a diverging lens for spreading the laser light.

The laser probe may comprise a loudspeaker for informing the user when to move the laser probe.

The laser probe may comprise a controller for controlling different operational parameters of the laser probe, such as power of the laser light, treatment time and/or repetition rate of a loudspeaker providing a sound, for example once every 10 seconds.

The laser probe may comprise a body, which may function as a handle.

The body may be adapted for mechanical connection with a battery and/or a laser head.

The controller may comprise a first connector for connecting with the laser head and a second connector for connection with a battery.

The control may be positioned within the body.

The controller may control the functions of the laser probe such as power, ventilator speed, treatment time, etc.

This laser probe may be used in therapeutic and non-therapeutic methods, such as pain relief healing of tissues, inflammation, ulcers, skin disorders, acupuncture, zone therapy and immune therapy and in general activation of the immune system.

In an aspect of the invention, the laser probe may have one or more laser diodes, wherein at least one laser diode may comprise an emitter, a housing for protecting the emitter having a window for emission of light, pins connected to the emitter and an insert lens. The insert lens is positioned within the housing between the emitter and the window for adjusting beam divergence.

In an aspect of the invention the laser probe has a laser head for a low-level laser therapy (LLLT) laser probe. The laser head comprises an outer cap and an inner cap. The inner cap is connected to the outer cap, and the inner cap is positioned partly within

the outer cap. Thereby the inner and outer cap form a heat channel which has an exhaust in-between the caps. The outer cap comprises one or more bores for one or more laser diodes. The inner cap comprises a neck connection part for interlocking with a body of a laser probe. The inner cap and the body form, when connected, an inlet channel that has an intake. The inner cap further comprises a centrally positioned ventilator for creating a flow from the inlet channel through the heat channel.

The laser head enables the laser probe to be used inside the human body, e.g. for oral treatment, anal treatment and vaginal treatment as the temperature.

Furthermore, the intake and the exhaust have a general direction facing away from the treated patient, because the exhaust would otherwise cool the patient due to convection.

A laser probe having both a laser head as described above and a laser diode with an insert lens described above eliminates the heat problems known from the prior art. Thereby, the user may use the laser probe without a risk of overheating the laser diodes.

In an aspect of the invention, the laser probe may comprise a battery connected to the second connector.

In an aspect of the invention, the laser probe comprises one or more converging lenses which have a common focal point.

The common focal point may be 1.25-1.75 cm or 1.5 cm from the lenses. This would cause the laser beam or laser beams to be strongly divergent past the common focal point, thereby making the laser probe eye-safe as the intensity decreases quickly with distance from the common focal point.

This enables the laser probe to be used without the user having to wear safety glasses. This will further enable the adoption of LLLT in private households as the laser probe is eye-safe.

An object of the invention is achieved by a method of changing operational parameters of a laser probe.

The method may comprise an act of recognising a connection pattern between the laser probe and a battery.

The connection pattern between the laser probe and a battery could be connection, disconnection, connection.

So if a user first connects a laser probe to a battery, then disconnects the laser probe and the battery, and within a time period reconnects the laser probe to the battery, then this connection-disconnection-connection pattern will be recognised and cause an act of setting the laser probe in a programmable mode.

The laser may be in a CW (continuous wave)-mode or in a pulsed mode.

When the laser probe is in a programmable mode, the operational parameters may be changed. The operational parameters may be laser power or treatment time or repetition rate of a notification sound or a laser pulse repetition rate.

The laser pulse repetition rate may be between 1-10,000 Hz.

The laser power may be between 0-100 %.

The treatment time can be from seconds to hours.

The method may comprise an act of receiving instructions for changing the operational parameters of the laser probe.

The laser probe may receive instructions wirelessly, thereby causing a change in the operational parameters of the laser probe.

The laser probe may comprise sets of preset operational parameters.

The laser probe may receive instructions by the user repeating the connection pattern, thereby shifting between the sets of preset operational parameters. Thereby, the user may change the operational parameters using only the laser probe and the battery.

The method enables the user to control a laser probe without the use of any buttons. Thus, a laser probe capable of performing the method may be made without any buttons, thereby hygiene is increased.

In an embodiment, the laser probe may comprise sets of preset operational parameters. The method of changing operational parameters may cause the laser probe to switch between the sets of preset operational parameters, when the method repeatedly recognises the connection pattern.

The method enables the user to control a laser probe without the use of any buttons. Thus, a laser probe capable of performing the method may be made without any buttons, thereby hygiene is increased.

The method may comprise an act of pairing the laser probe with a remote via Bluetooth.

The Bluetooth function may be approved for R&TTE Directive 1999/5/EC Essential Requirements for Health and Safety.

The method enables the user to control a laser probe without the use of any buttons. Thus, a laser probe capable of performing the method may be made without any buttons, thereby hygiene is increased.

An object of the invention is achieved by a laser probe for low-level laser therapy. The laser probe may comprise a controller adapted to measure a connection between the laser probe and a battery.

If a user connects the laser probe to a battery, then the laser probe will be set in an on-mode and begin to generate a laser beam as determined by the operational parameters of the laser probe, such as laser power, laser on-time and/or laser off-time.

If a user disconnects the laser probe and the battery, then the laser probe loses power and the laser is set in an off-mode.

If a user first connects a laser probe to a battery, then disconnects the laser probe and the battery, and within a time period reconnects the laser probe to the battery, then the controller will measure this as a change in voltage as a function of time. If this change corresponds to the connection pattern, then the controller will recognise the pattern and perform an act setting the laser probe in a programmable mode.

Afterwards, the laser probe will perform an act of receiving instructions for changing the operational parameters of the laser probe.

The user may provide the instructions wirelessly or by repeating the connection pattern, thereby shifting between sets of preset operational parameters.

The operational parameters may be laser power or treatment time or repetition rate of a notification sound. The notification sound will provide the user with information of when to change position of the laser probe.

The laser probe may have means adapted to execute the acts of changing operational parameters of a laser probe.

The controller may comprise a Bluetooth device adapted to perform an act of pairing the laser probe with a remote via Bluetooth.

The remote may be a laptop or smart phone or tablet or any other device capable of pairing with the controller and sending instructions to the laser probe.

An object of the invention is achieved by a computer program comprising instructions to cause the laser probe to execute the acts of the method of changing operational parameters of the laser probe.

An object of the invention is achieved by a computer-readable medium on which the computer program is stored.

Laser probe	10
Body	20
First connector	22
Second connector	24
Controller	30
Bluetooth device	32
Laser head	40
Outer cap	42
Bores	46
Cone	48
Inner cap	50
Heat channel	60
Exhaust	62
Inlet channel	64
Intake	66
Ventilator	70
Flow	72
Laser diodes	80
Housing	82
Window	84
Pins	86
Emitter	88
Insert lens	90
Battery	100
Operational parameters	110
Connection pattern	120
Programmable mode	130
Remote	140
Skin	200

Penetration depth	210
Method of changing operational parameters of a laser probe	1000
Act of recognising	1100
Act of setting	1200
Act of receiving	1300
Act of pairing	1400

Description of the Drawings

Fig. 1 illustrates a cross-sectional view of a laser head;

Fig. 2 illustrates a bottom view of a laser head;

Fig. 3 illustrates a laser diode with and without an insert lens;

Fig. 4 illustrates a laser diode with and without an insert lens and with an external lens;

Fig. 5 illustrates skin penetration without direct skin contact;

Fig. 6 illustrates skin penetration with direct skin contact;

Fig. 7 illustrates a battery connecting with a laser probe;

Fig. 8 illustrates a method of changing operational parameters of a laser probe; and

Fig. 9 illustrates a laser probe communicating with a remote.

Detailed Description of the Invention

Fig. 1 illustrates a cross-sectional view of a laser head 40 for a low-level laser therapy (LLLT) laser probe 10 (not shown).

The laser head 40 comprises an outer cap 42 and an inner cap 50 connected to the outer cap 42 and positioned partly within the outer cap 42, thereby forming a heat channel 60 having an exhaust 62 in-between the caps 42, 50.

The outer cap 42 comprises two bores 46, 46' for the two laser diodes 80, 80'.

The pins 86 of each laser diode 80, 80' are connected through the inner cap 50, such that the laser diodes 80, 80' can be powered.

Each bore 46, 46' has a threaded part for holding a lens in front of the laser diode 80, 80'.

The inner cap 50 comprises a not shown neck connection part for connection with a laser probe body 20.

The inner cap 50 and the laser probe body 20 form an inlet channel 64 having an intake 66 formed in-between the inner cap 50 and the laser probe body 20.

The inner cap 50 comprises a centrally positioned ventilator 70 for creating a flow 72 from the intake 66 of the inlet channel 64 through the heat channel 60 and out of the exhaust 62.

The ventilator 70 has a not shown means for connecting with power.

The arrows only illustrate the general direction of the flow 72 as the flow 72 can be turbulent.

The outer cap 42 has a cone 48 facing the ventilator 70.

Fig. 2 illustrates a bottom view of a laser head 40.
The bottom view discloses an outer cap 42 enclosing the rest of the laser head 40.
The outer cap 42 is followed by a not shown exhaust 62 enclosing the rest of the laser head 40.

The not shown exhaust 62 is followed by an inner cap 50 enclosing the rest of the laser head 40. The inner cap 50 has an extent which blocks for a bottom view of an exhaust 62, the extent ensures that less air circulates from the exhaust 62 to an intake 66.

The inner cap 50 is followed by the intake 66 enclosing the rest of the laser head 40.

The intake 66 is followed by a neck connection part 52.

The laser head 40 also has a ventilator 70.

Fig. 3 illustrates a laser diode 80 with (B) and without (A) an insert lens 90.

Fig. 3A discloses a prior art laser diode 80 comprising an emitter 88, a housing 82 for the emitter, pins 86 for connecting with power, and a window 84 in front of the emitter 84. The prior art laser diode 80 will typically emit light with an angle of 10 x 30 degrees.

Fig. 3B discloses a laser diode 80 comprising an emitter 88, a housing 82 for the emitter, pins 86 for connecting with power, a window 84 in front of the emitter 84 and an insert lens 90 between the emitter 88 and the window 84. The laser diode 80 may emit light with an angle of 10 x 10 degrees, however this depends on the insert lens 90.

The laser diode 80 with the insert lens 90 could emit light having an angle of 15 x 15 degrees or any other angle.

Fig. 4 illustrates a laser diode 80 with (B) and without (A) an insert lens 90 and with an external lens. Fig. 4A illustrates that a large part of the laser light is lost due to laser light not hitting the lens. Fig. 4B illustrates that the light is not lost due to the correction of the insert lens 90.

In practice, the setup shown in Fig. 4A will have a loss of 40 %, when the external lens is positioned at a distance of 15 mm from the laser diode 80.

Fig. 5 illustrates skin penetration 210 without direct skin contact.

The skin penetration 210 will only be superficial due to a large reflection from the skin if the laser lenses in Fig. 5A-C are not in direct contact with skin 200.

The fibre rod (Fig. 5A) and divergent lens (Fig. 5B) must be used at a distance if the intensity is larger than 500 mW/cm^2 at the skin in order to avoid burn in the tissue.

If a burn is wanted, a converging lens (Fig. 5C) is used such that the laser intensity can become large enough to cause a burn. This can be used for burning of tissue, e.g. plantar wart or corn.

Fig. 6 illustrates skin penetration 210 with direct skin contact.

The skin penetration 210 is significantly larger here than that in Fig. 5, because the skin reflects less when the lenses are in direct contact with the skin 200.

The fibre rod (Fig. 5A) and the divergent lens (Fig. 5B) will both have a wide skin penetration 210.

The converging lens (Fig. 5C) will surprisingly not cause a local burn in the tissue as the skin/tissue will disperse the laser light, but the converging lens will have a larger degree of skin penetration 210 compared to the fibre rod and the divergent lens.

Fig. 7 illustrates a battery 100 connecting with a laser probe 10. The laser probe 10 comprises a laser head 40 including a laser diode 80, a body 20, and a controller 30 positioned within the body 20. The controller 30 comprises a first connector 22 for connecting with the laser head 40, and a second connector 32 for connection with a battery 100. The battery 100 and the laser probe 10 have complementary threads to ensure good mechanical connection between the battery 100 and laser diode 10.

In Fig. 7B the battery 100 and the laser probe 10 are connected. The thread makes it easy for a user to disconnect and reconnect the battery 10 with the laser probe 10.

Fig. 8 illustrates a method 1000 of changing the operational parameters of a laser probe 10. The method 1000 of changing operational parameters 110 of a laser probe 10 comprises one or more acts of:

- an act of recognising 1100 a connection pattern 120 between the laser probe 10 and a battery 100;
- an act of setting 1200 the laser probe 10 in a programmable mode 130; and
- an act of receiving 1300 instructions for changing the operational parameters 110 of the laser probe 10.

The method 1000 may further comprise an act of:
- pairing 1400 the laser probe 10 with a remote 140 via Bluetooth.

Fig. 9 illustrates a laser probe 10 communicating with a remote 140. The laser probe 10 comprises a laser diode 80 and a connector 30. The connector comprises a first connector 22 connected to the laser diode 80, a second connector 24 for connection with a battery 100, a Bluetooth device 32 for paring with the remote 140, and operational parameters 110 stored on the controller determining the operation of the laser probe.

The remote 140 may be a smart phone, tablet, computer or any other electronic device capable of communicating with the laser probe 10 via Bluetooth.

The laser probe 10 further comprises a battery 100, thereby making the laser probe 10 cordless.

Furthermore, the battery 100 enables a user to control the laser probe 10 without buttons as the controller 30 has means for recognizing a connection pattern between the battery 100 and laser probe 10.

The connection pattern could be connection, disconnection, connection within a short time period. If the controller 30 recognizes the connection pattern, then the Bluetooth device 32 will try to pair with a remote 140.

After pairing, the remote 140 can change the operational parameters 110 by sending instructions to the connector 30.

ITEM LIST

Item 1
A laser diode (80) for a low-level laser therapy (LLLT) laser probe (10), the laser diode (80) comprising an emitter (88), a housing (82) for protecting the emitter (88) having a window (84) for emission of light, pins (86) connected to the emitter (88)

and an insert lens (90) positioned within the housing (82) between the emitter (88) and the window (84) for adjusting beam divergence.

Item 2

A laser diode (80) according to item 1, **characterised in that** the insert lens (90) is made of glass or plastic.

CLAIMS

1. A method (1000) of changing operational parameters (110) of a laser probe (10), the method (1000) comprising one or more acts of:

- an act of recognising (1100) a connection pattern (120) between the laser probe (10) and a battery (100);
- an act of setting (1200) the laser probe (10) in a programmable mode (130); and
- an act of receiving (1300) instructions for changing the operational parameters (110) of the laser probe (10).

2. The method (1000) according to claim 1, wherein the laser probe (10) comprises sets of preset operational parameters (110A,...,110Z) which can be shifted between by repeating the connection pattern (120).

3. The method (1000) according to claim 1 or 2, the method (1000) further comprising:

- an act of pairing (1400) the laser probe (10) with a remote (140) via Bluetooth.

4. A laser probe (10) for low-level laser therapy, the laser probe (10) comprising a controller (30) adapted to measure a connection between the laser probe (10) and a battery (100) and means adapted to execute the acts of the method of one or more of claims 1-2.

5. The laser probe (10) according to claim 4, wherein the controller (30) comprises a Bluetooth device (32) adapted to execute an act of pairing (1400) according to the method of claim 3.

6. A computer program comprising instructions to cause the laser probe according to claim 4 or 5 to execute the steps of the method of one or more of claims 1-3.

7. A computer-readable medium on which the computer program of claim 6 is stored.

8. A laser head (40) for a low-level laser therapy (LLLT) laser probe (10), the laser head (40) comprising an outer cap (42) and an inner cap (50), the inner cap (50) being connected to the outer cap (42) and positioned partly within the outer cap (42), there-

by forming a heat channel (60) having an exhaust (62) in-between the caps (42,50), the outer cap (42) comprises one or more bores (46) for one or more laser diodes (80), the inner cap (50) comprises a neck connection part for interlocking with a body (20) of a laser probe (10) and when the inner cap (50) is connected to the body (20) an inlet channel (64) having an intake (66) is formed between the inner cap (50) and the body (20), the inner cap (50) further comprises a centrally positioned ventilator (70) for creating a flow (72) from the inlet channel (64) through the heat channel (60).

9. The laser head (40) according to claim 8 **characterised in that** the outer cap (42) and the inner cap (50) are positioned such that the exhaust (62) encloses the ventilator (70).

10. The laser head (40) according to claim 8 or 9 **characterised in that** the inner cap (50) is adapted such that the intake (66) encloses the ventilator (70).

11. The laser head (40) according to one or more of claims 8-10 **characterised in that** the exhaust (62) and intake (66) are offset relatively to each other.

12. The laser head (40) according to one or more of claims 8-11 **characterised in that** the one or more bores (46) are going through the outer cap (42).

13. The laser head (40) according to one or more of claims 8-12 **characterised in that** the outer cap (42) has a cone (48) facing the ventilator (70).

14. The laser head (40) according to one or more of claims 8-13 **characterised in that** the outer cap (42) is made of a heat-conducting material.

15. The laser head (40) according to one or more of claims 8-14 **characterised in that** the ventilator is a mini-fan.

16. A laser probe (10) for low-level laser therapy, the laser probe (10) comprising a laser head (40) including one or more laser diodes (80), a body (20) connected to the laser head (40) and a controller (30) positioned within the body (20), the controller

(30) comprising a first connector (22) for connecting with the laser head (40) and a second connector (24) for connection with a battery (100).

17. A laser probe (10) according to claim 16, **characterised in that** at least one of the one or more laser diodes (80) have an insert lens (90) inside a housing (82) of the laser diode (80).

18. A laser probe (10) according to claim 16 or 17, **characterised in that** the laser probe (10) further comprises a laser head (40) according to one or more of the claims 8-15.

19. A laser probe (10) according to one or more of claims 16-18, **characterised in that** the laser probe (10) comprises a battery (100) connected to a second connector (24).

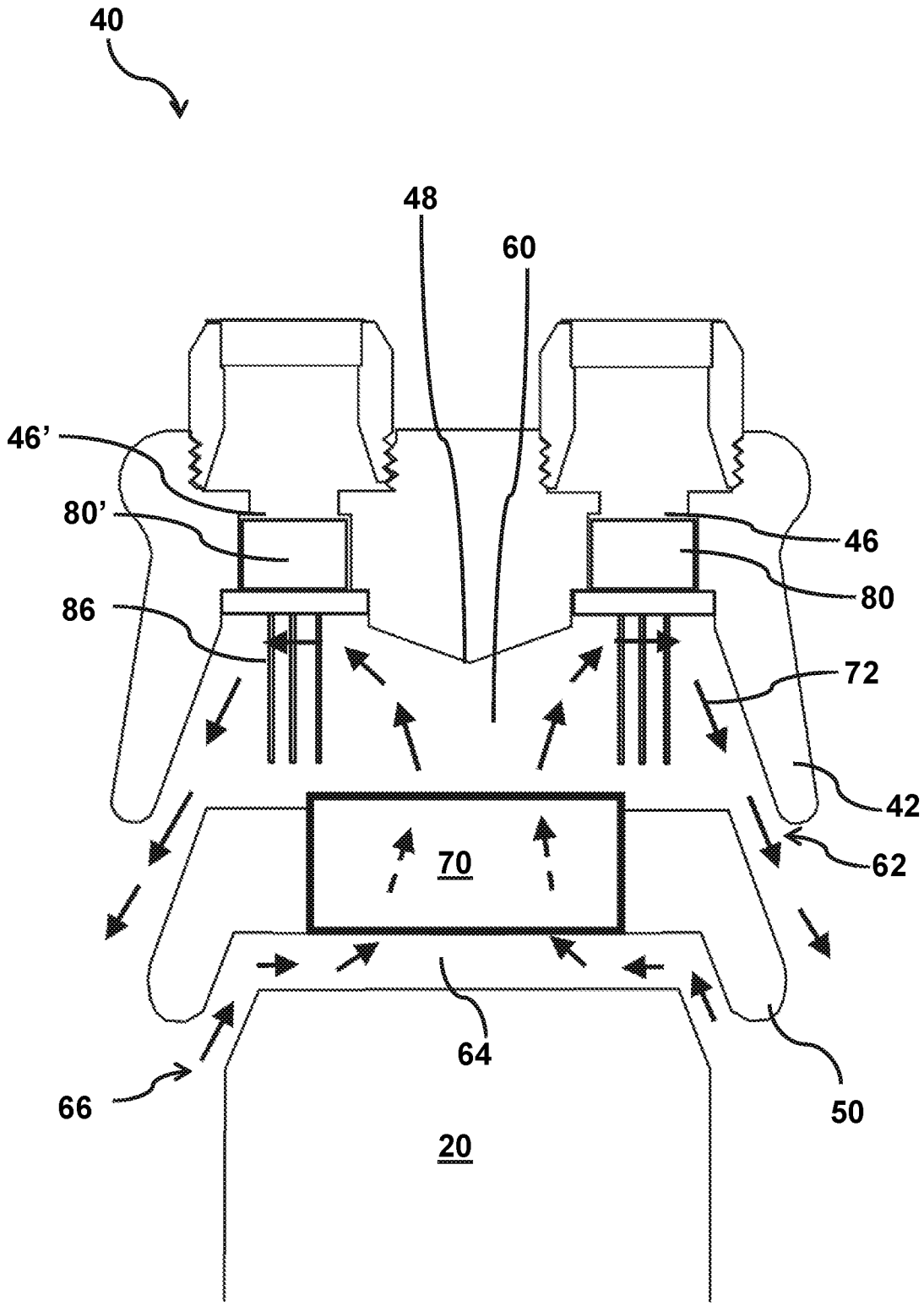


Fig. 1

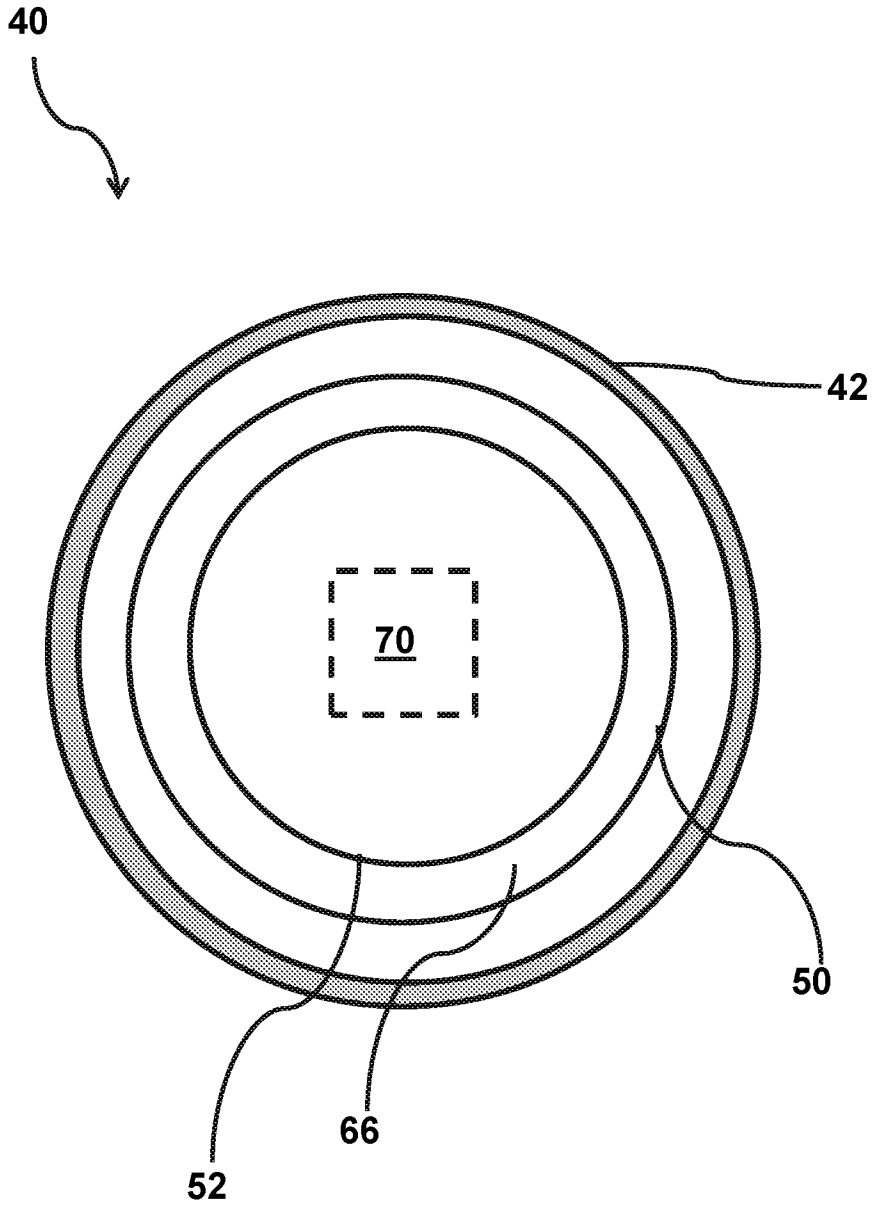
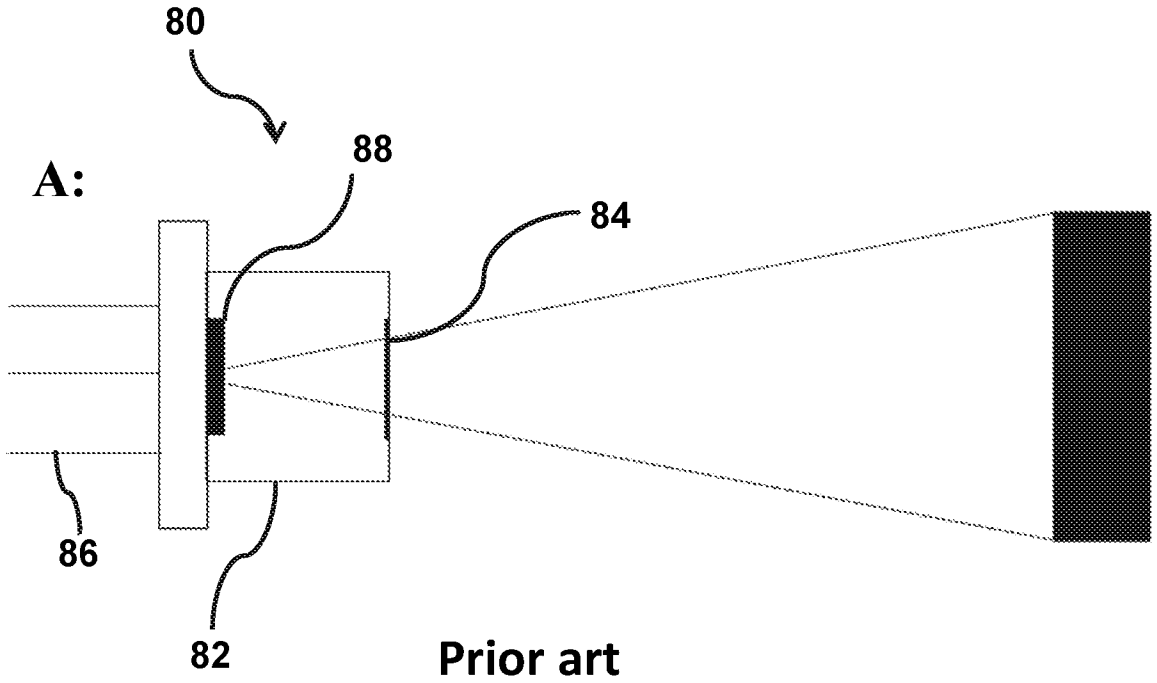


Fig. 2



Prior art

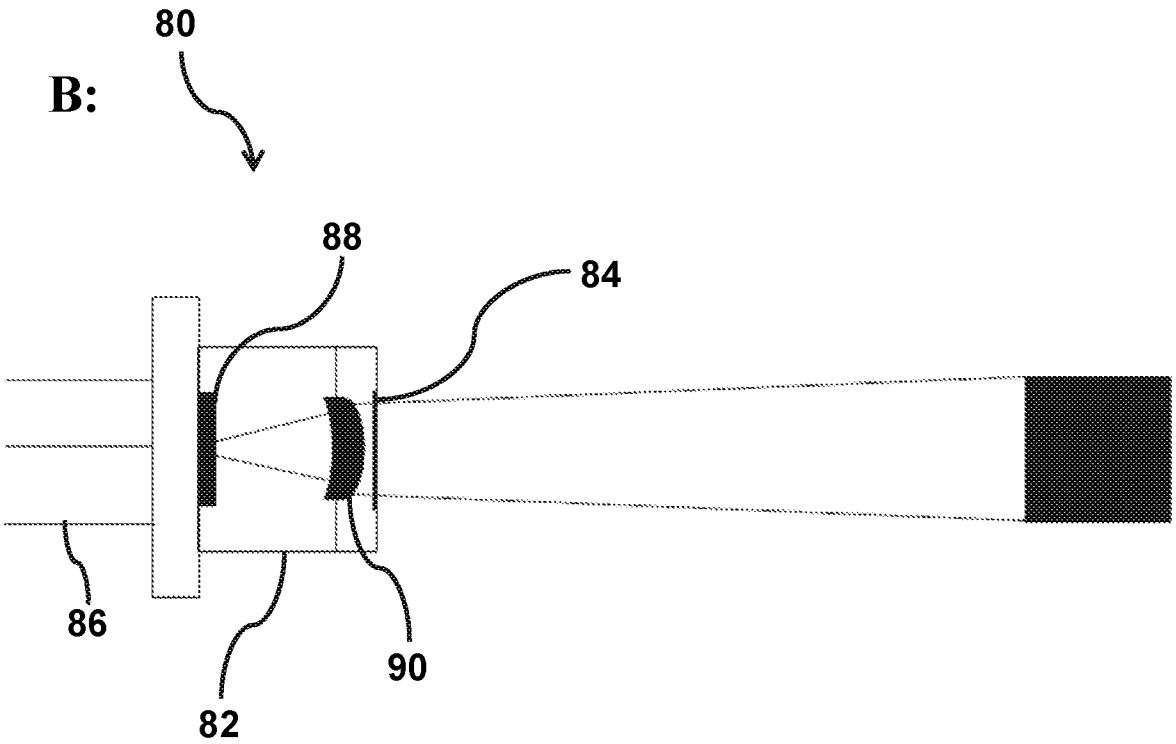
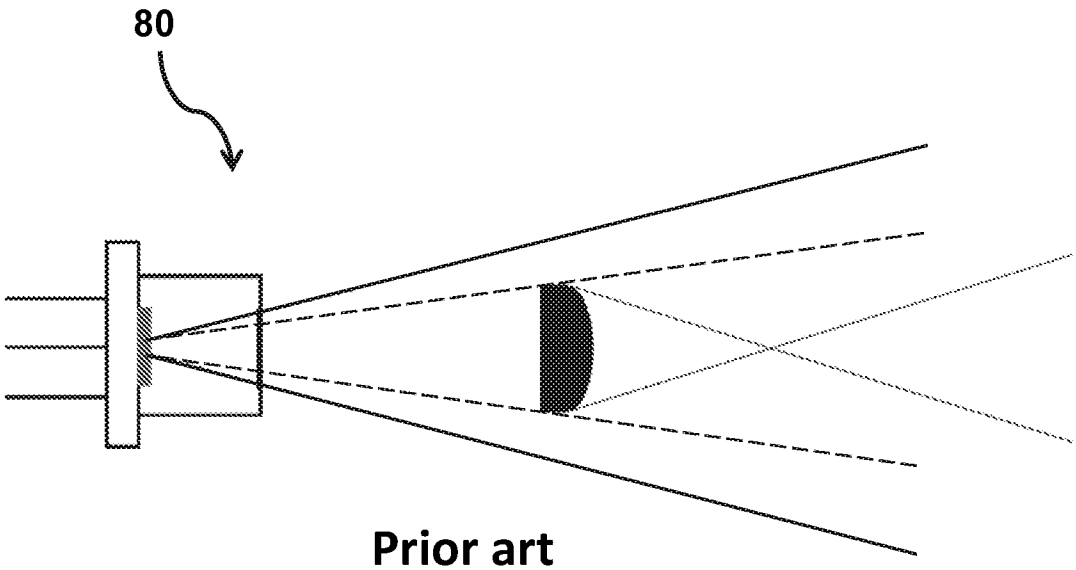


Fig. 3



Prior art

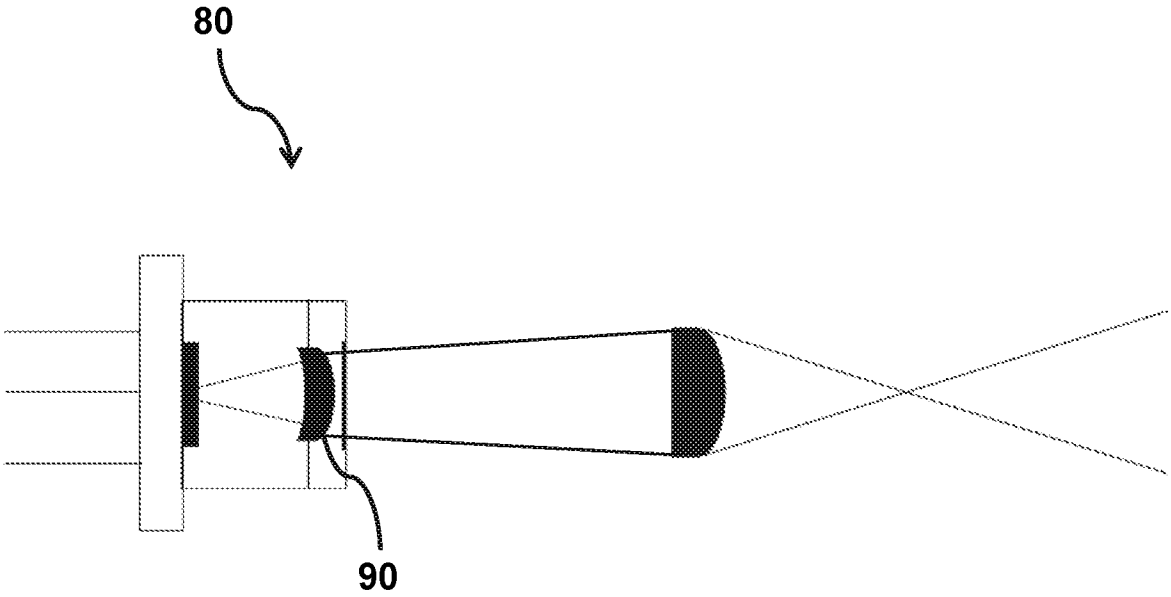


Fig. 4

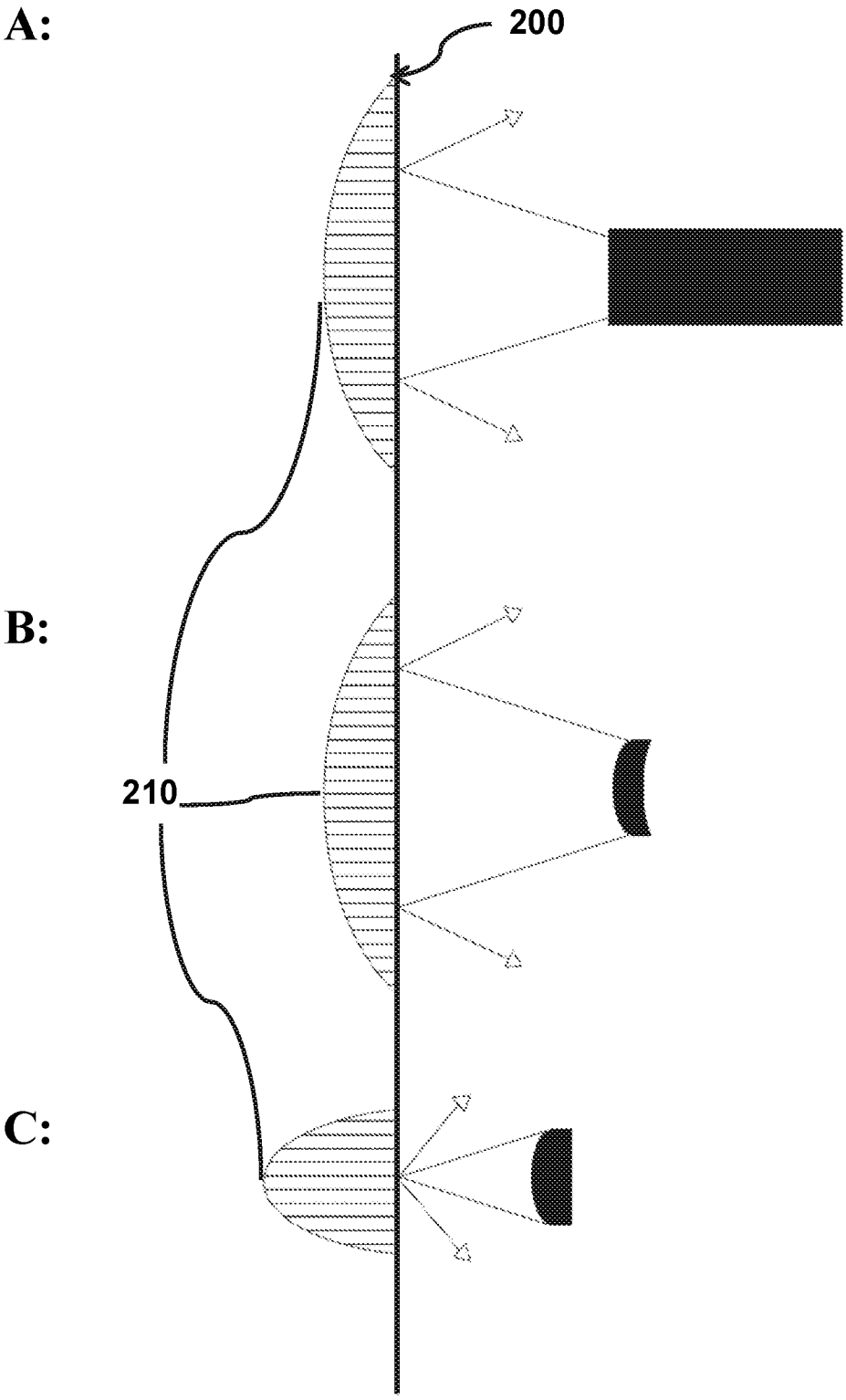


Fig. 5

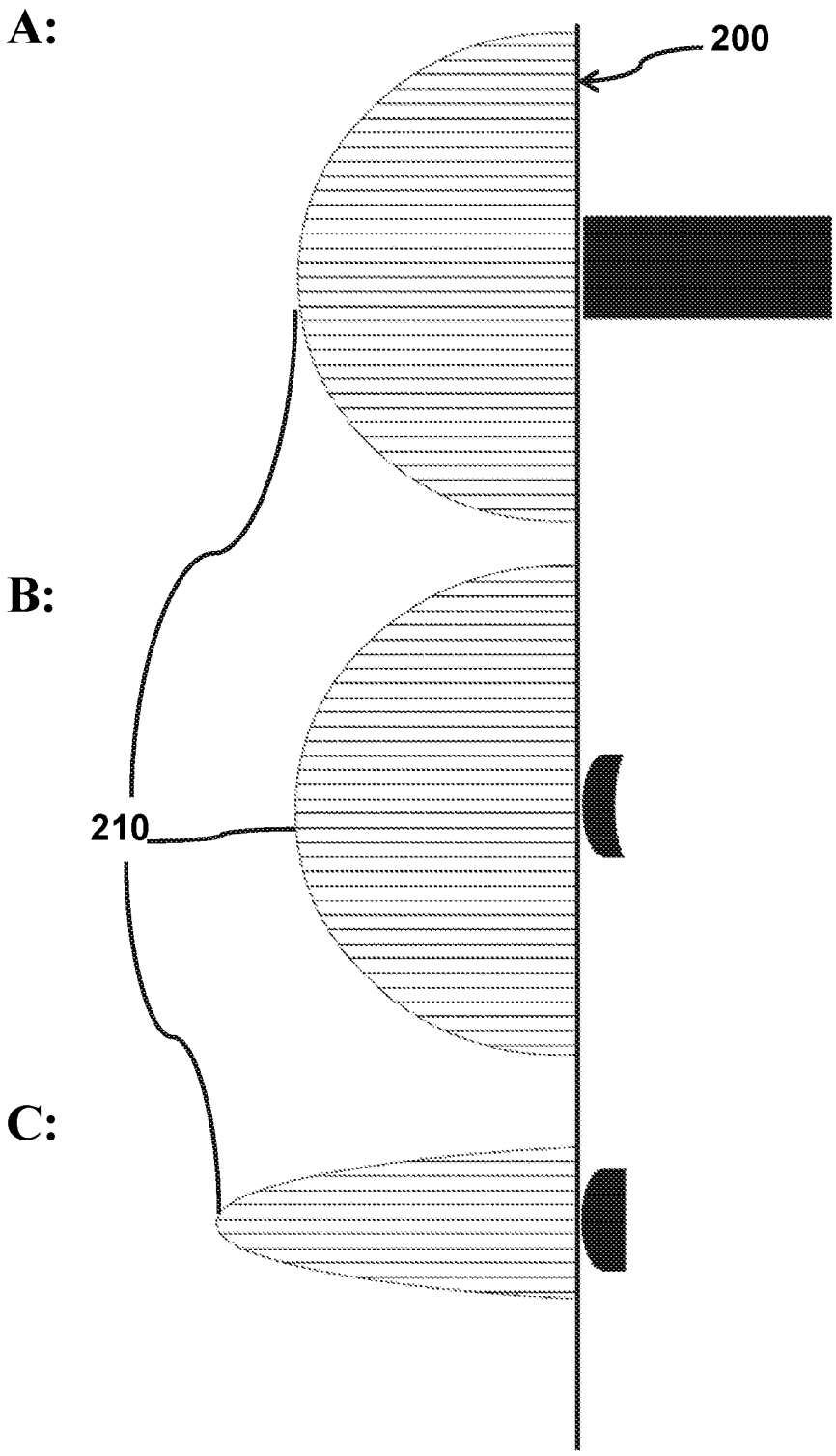
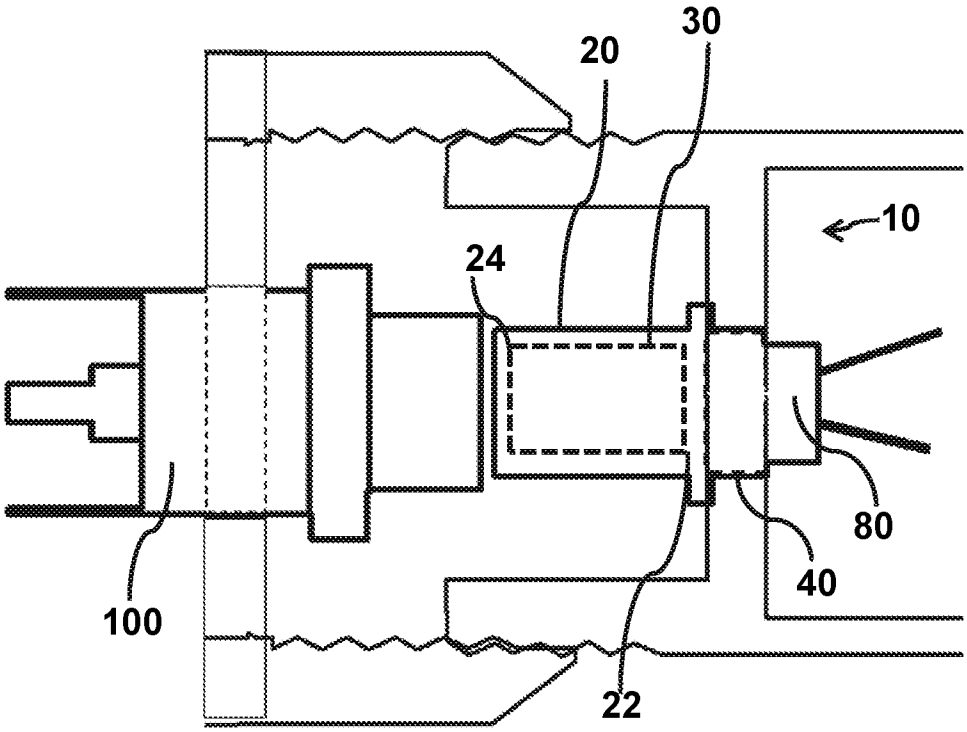


Fig. 6

A:



B:

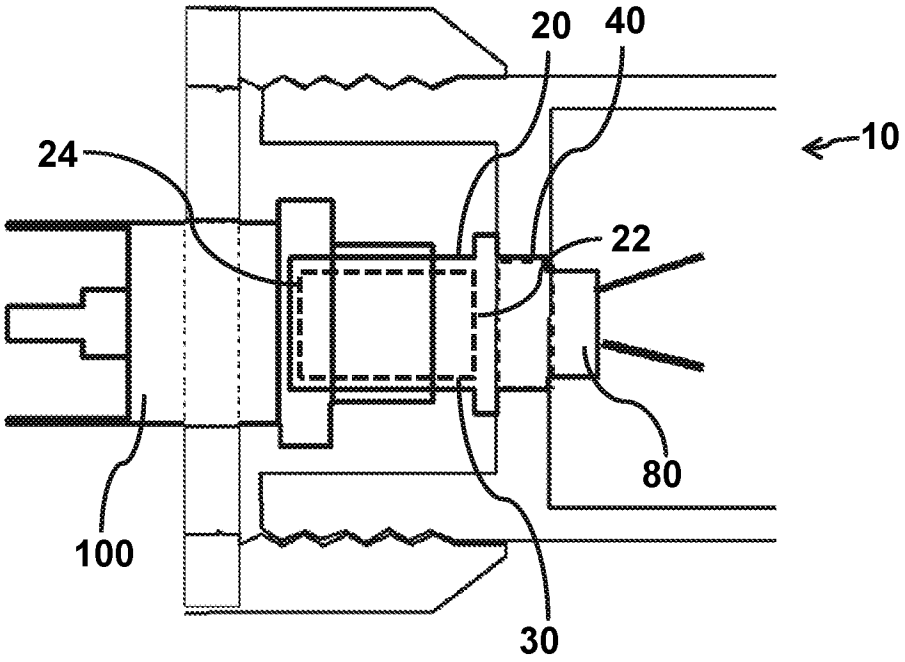


Fig. 7

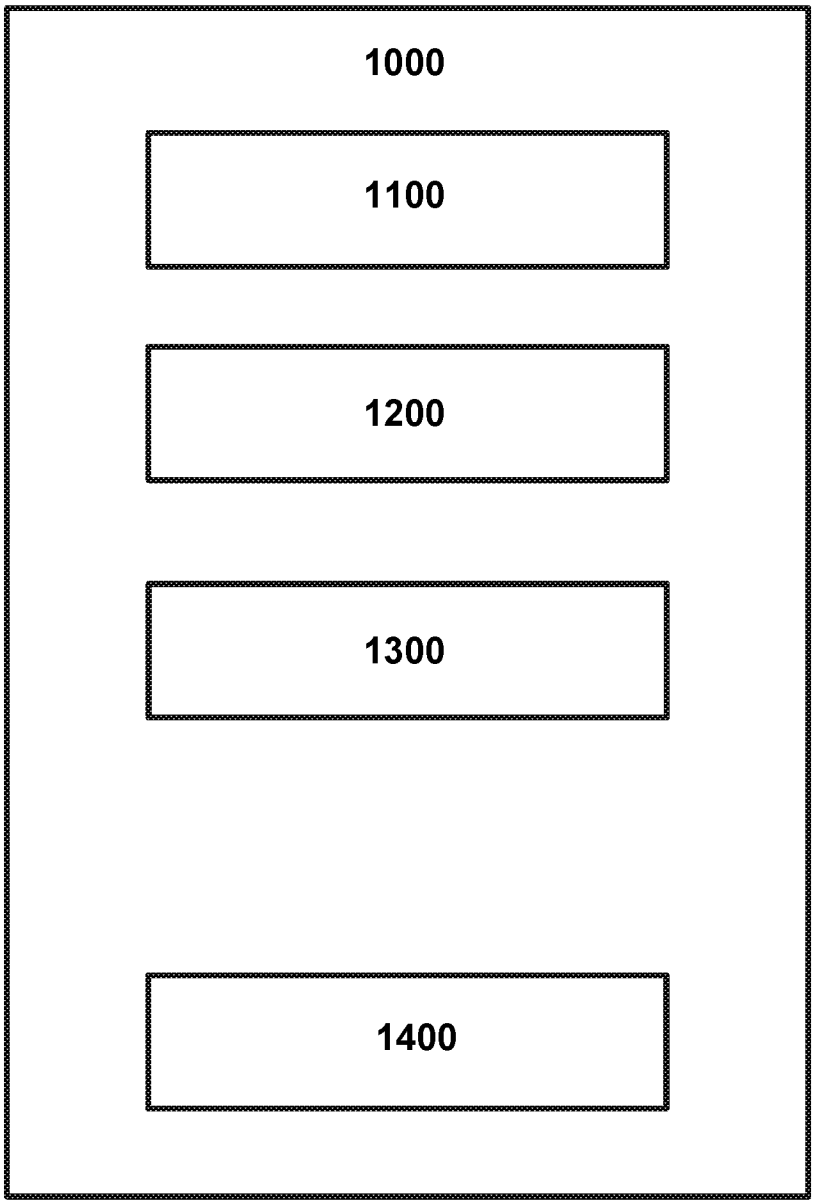


Fig. 8

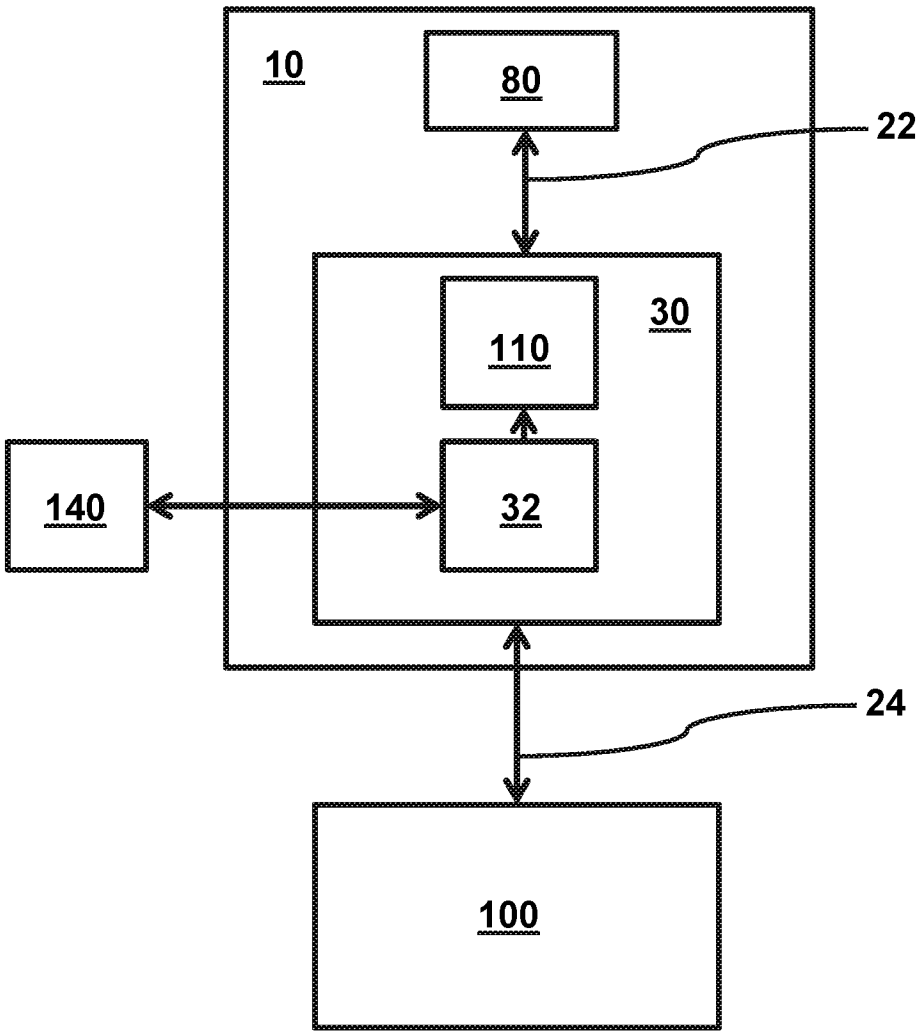


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2019/050249

A. CLASSIFICATION OF SUBJECT MATTER

A61N 5/06 (2006.01)

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/CPC: A61N

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

DK, NO, SE, FI: Classes as above.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI, FULL-TEXT: English

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006095098 A1 (SHANKS STEVEN C et al.) 2006.05.04 See in particular paragraphs [0001], [0007] and [0023].	1-19
A	US 2013197495 A1 (KOIFMAN IGAL et al.) 2013.08.01 See in particular Fig. 1, 4B, 8 and paragraphs [0005], [0035], [0052]	1-19
A X	US 2015112411 A1 (BECKMAN FRANCES et al.) 2015.04.23 See in particular paragraph [0060] and Fig. 5B.	1-15, 18 16, 17 and 19
A X	US 2008125835 A1 (LAURENT RICHARD) 2008.05.29 See in particular Fig. 1A, 2 and paragraphs [0018], [0023], [0025], [0027], [0060]	1-15, 18 16, 17 and 19
A X	US 2013035746 A1 (BOUBOULIS DENIS) 2013.02.07 See in particular Fig. 4A and paragraphs [0015], [0040] and [0049].	1-15, 18 16, 17 and 19

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15/10/2019	22/10/2019
Name and mailing address of the ISA Nordic Patent Institute Helgeshøj Allé 81 DK - 2630 Taastrup, Denmark. Facsimile No. -	Authorized officer Nis Søbjerg Madsen Telephone No. +45 43 50 84 93

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2019/050249

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 3009081 A1 (ETHICON ENDO-SURGERY INC) 2016.04.20 See in particular paragraph [0079] and Fig. 25.	1-7
A	CN 107872967 A (ETHICON ENDO SURGERY LLC) 2018.04.03 See in particular paragraphs [0251], [0267]-[0268].	1-7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2019/050249

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

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

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

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

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

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

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

Invention I:
Claims 1 – 7 concern a method of changing operational parameters of a laser probe by first recognising a connection pattern between the laser probe and a battery, setting the laser probe in a programmable mode, and finally receiving instructions for changing the operational parameters of the laser probe.

Invention II:
Claims 8 – 15 concern a laser head for a low-level laser therapy laser probe, the laser head comprising an outer cap and an inner cap, the inner cap being connected to the outer cap and positioned partly within the outer cap thereby forming a heat channel having an exhaust in-between the caps, together with additional constructional details.

Invention III:
Claims 16 – 19 concern a laser probe for low-level laser therapy, comprising a laser head, a body, and a controller positioned within the body, the controller comprising a first connector for connecting with the laser head and a second connector for connection with a battery.

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

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

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

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/DK2019/050249

Patent document cited in search report / Publication date	Patent family member(s) / Publication date
US 2006095098 A1 2006.05.04	NONE
US 2013197495 A1 2013.08.01	US 9149332 B2 2015.10.06 US 2013197494 A1 2013.08.01 US 9078681 B2 2015.07.14 WO 2013114290 A1 2013.08.08 EP 2809397 A1 2014.12.10 EP 2809397 B1 2017.07.12 US 2015272675 A1 2015.10.01 US 9526578 B2 2016.12.27 US 2017056110 A1 2017.03.02 IL 233912 A 2018.06.28
US 2015112411 A1 2015.04.23	WO 2015058131 A1 2015.04.23 EP 3057658 A1 2016.08.24 EP 3057658 A4 2017.05.31
US 2008125835 A1 2008.05.29	US 2007179573 A1 2007.08.02
US 2013035746 A1 2013.02.07	US 9265967 B2 2016.02.23 WO 2013022661 A1 2013.02.14 EP 2739354 A1 2014.06.11 EP 2739354 A4 2014.12.03 US 2016166848 A1 2016.06.16 ES 2640439T T3 2017.11.03
EP 3009081 A1 2016.04.20	EP 3010080 A2 2016.04.20 EP 3010080 A3 2016.06.22 EP 3009081 B1 2018.02.21 US 2016106425 A1 2016.04.21 US 9833239 B2 2017.12.05 US 2016106424 A1 2016.04.21 US 9974539 B2 2018.05.22 WO 2016060830 A1 2016.04.21 WO 2016060829 A1 2016.04.21 JP 2017535038 A 2017.11.24 BR 112017007631 A2 2017.12.19 BR 112017007650 A2 2017.12.19 JP 2017538460 A 2017.12.28 CN 108370072 A 2018.08.03 PL 3009081T T3 2018.08.31 CN 108601593 A 2018.09.28 US 2018310933 A1 2018.11.01
CN 107872967 A 2018.04.03	EP 3062383 A2 2016.08.31 EP 3062383 A3 2016.11.30 EP 3061411 A1 2016.08.31 EP 3061411 B1 2019.04.24 EP 3062366 A1 2016.08.31 EP 3062366 B1 2019.04.17 EP 3061407 A2 2016.08.31 EP 3061407 A3 2016.11.09 EP 3062417 A1 2016.08.31 EP 3061406 A1 2016.08.31 EP 3062416 A1 2016.08.31 US 2016249917 A1 2016.09.01 US 10159483 B2 2018.12.25 US 2016249916 A1 2016.09.01 US 10321907 B2 2019.06.18 US 2016249910 A1 2016.09.01 US 2016249918 A1 2016.09.01 US 10182816 B2 2019.01.22 US 2016249908 A1 2016.09.01 US 9931118 B2 2018.04.03 US 2016249919 A1 2016.09.01 US 10045779 B2 2018.08.14 US 2016249909 A1 2016.09.01

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/DK2019/050249

Patent document cited in search report / Publication date	Patent family member(s) / Publication date
	US 10245028 B2 2019.04.02 WO 2016138058 A1 2016.09.01 WO 2016138057 A1 2016.09.01 WO 2016138055 A1 2016.09.01 WO 2016138059 A1 2016.09.01 WO 2016137812 A2 2016.09.01 WO 2016137812 A3 2016.11.03 WO 2016137813 A1 2016.09.01