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(19) **United States**(12) **Patent Application Publication**
Larsen(10) **Pub. No.: US 2005/0075703 A1**(43) **Pub. Date: Apr. 7, 2005**(54) **PHOTODYNAMIC STIMULATION DEVICE
AND METHODS**(52) **U.S. Cl. 607/88; 607/100**(76) **Inventor: Eric Larsen, Schaffhausen (CH)**(57) **ABSTRACT**

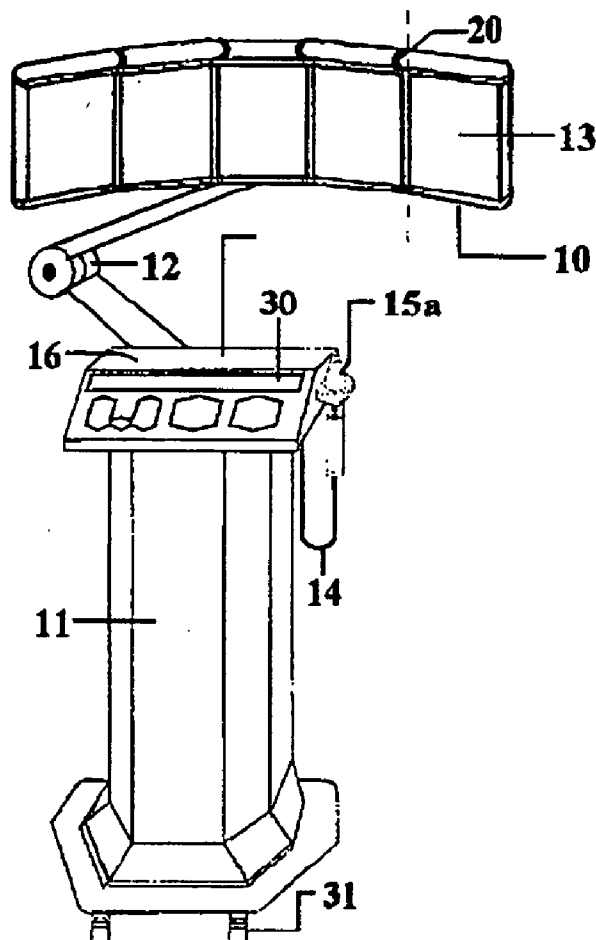
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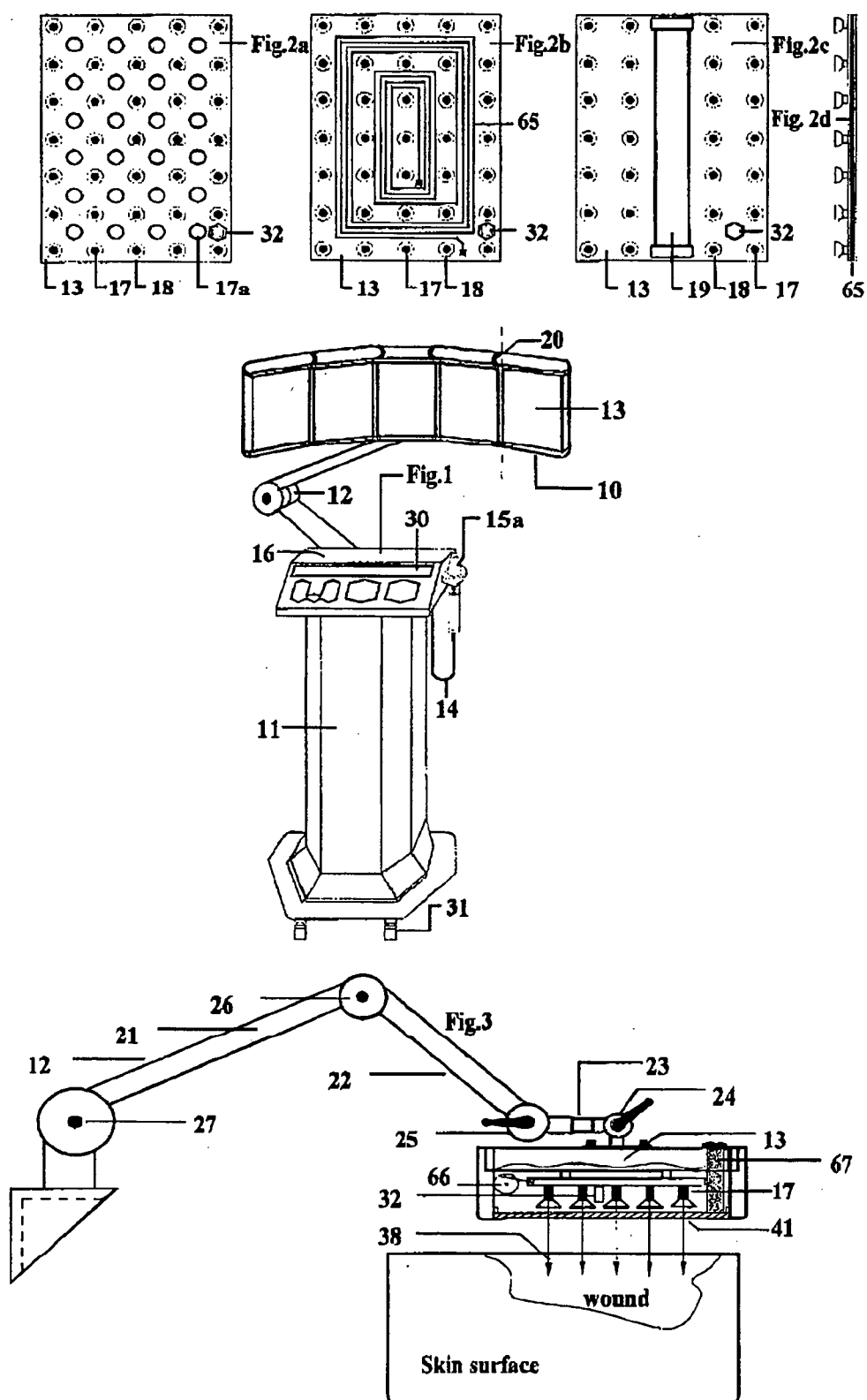
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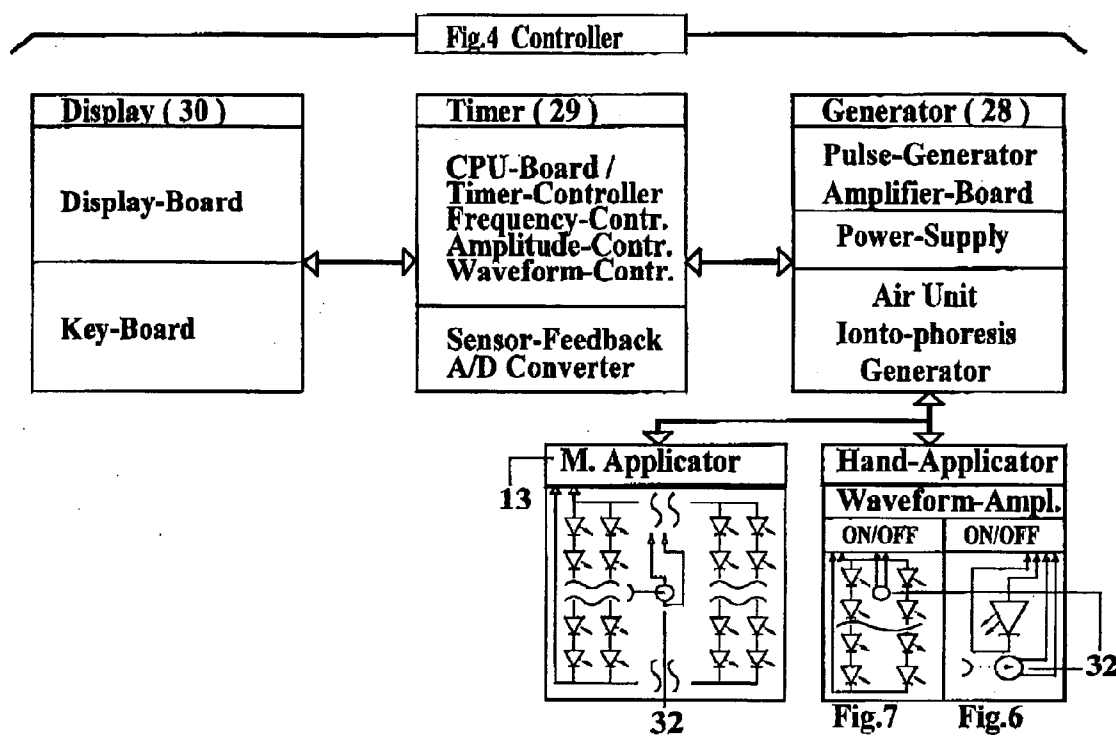
A treatment device which uses a light radiation of multiple wavelengths and pulse-shaped electromagnetic fields for the photodynamic stimulation of cells, especially cells of human tissue, and also for the activation and stimulation of light sensitive substances (PTD). The device produces energy radiation by the use of semiconductor and/or laser diodes, which emit light in several separate wavelengths due to a special operation mode and the use of tuneable diodes. The equipment consists of a stand, with which machine applicators are connected via a jointed arm. The stand is freely moveable on wheels and includes a control mechanism whereby the various parameters for therapy can be adjusted and switched on and off. The stand is also connected to a hand applicator for treatment of small tissue-areas, e.g., acupuncture points. Photodynamic substances are introduced into the tissue with a special hand applicator.

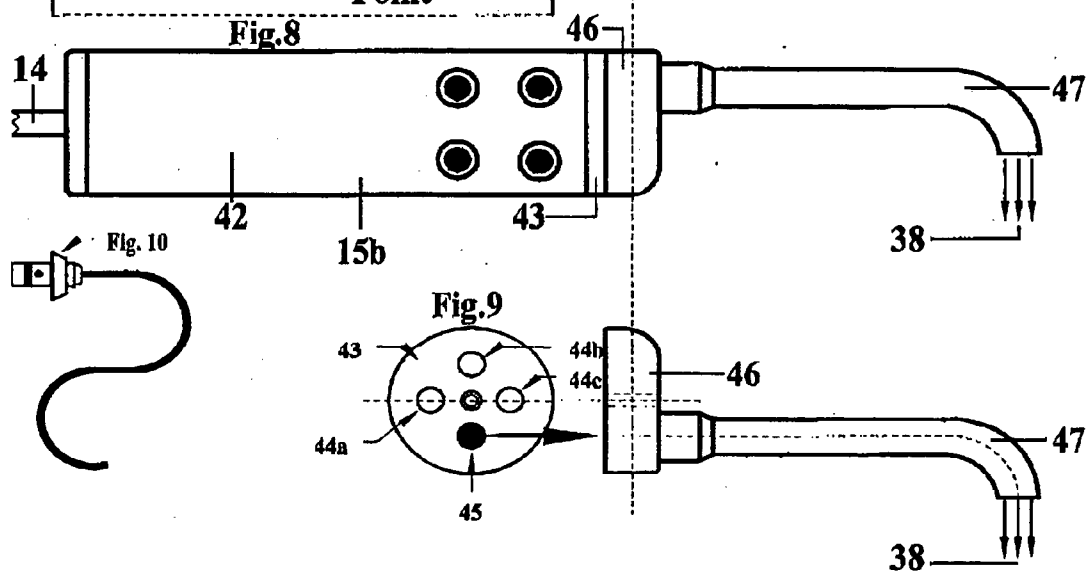
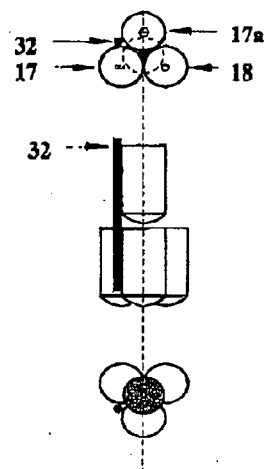
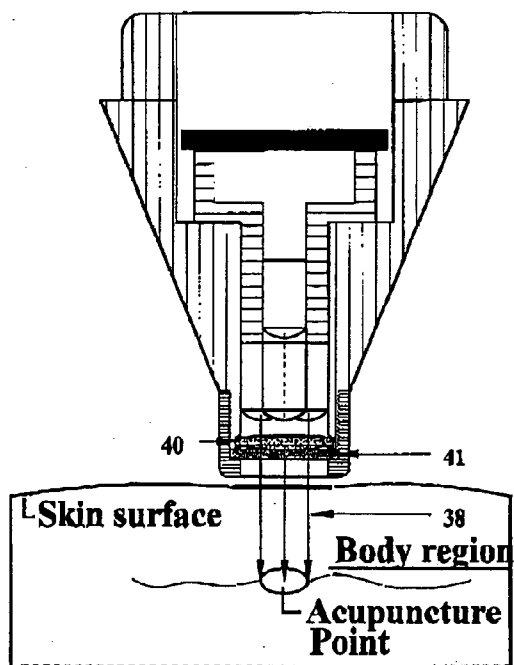
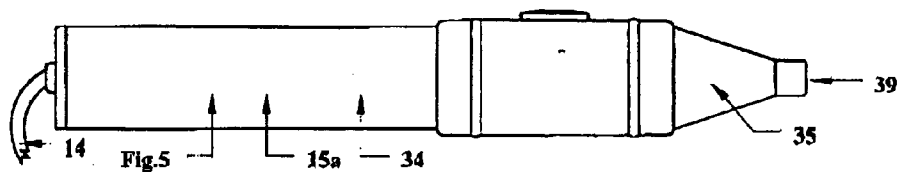
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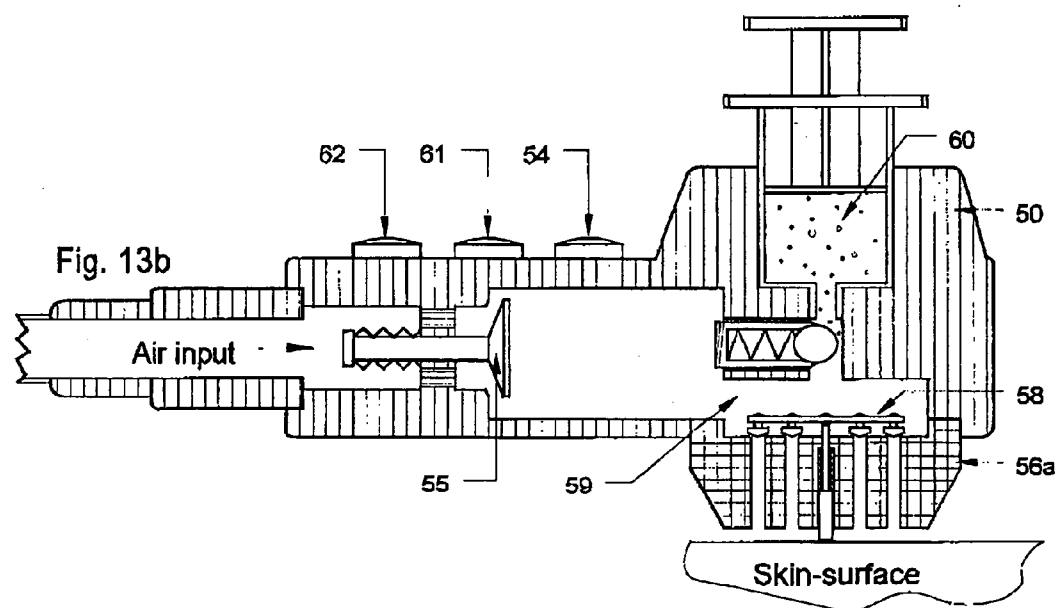
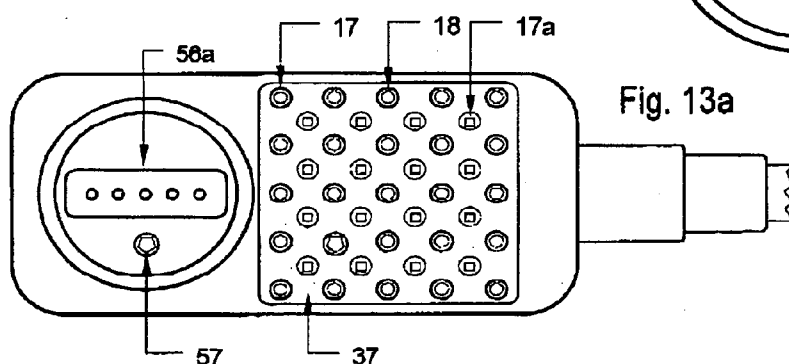
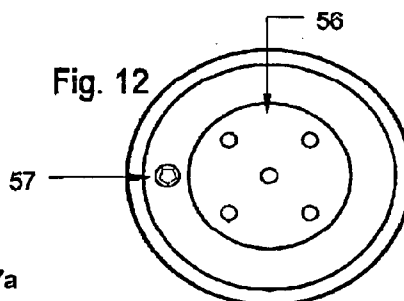
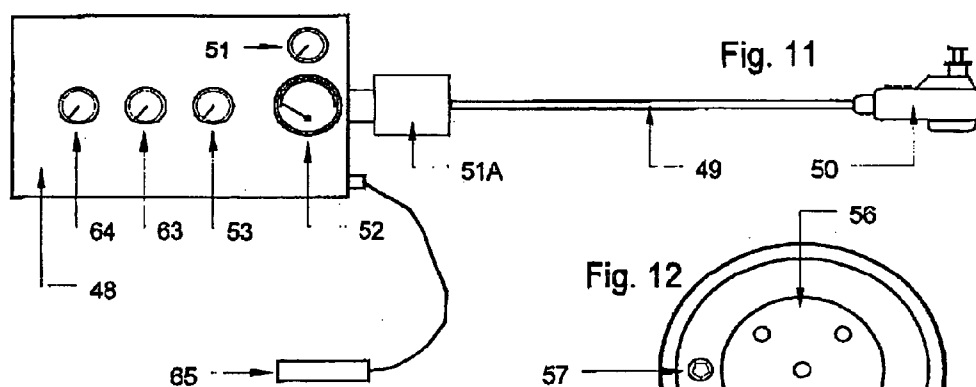
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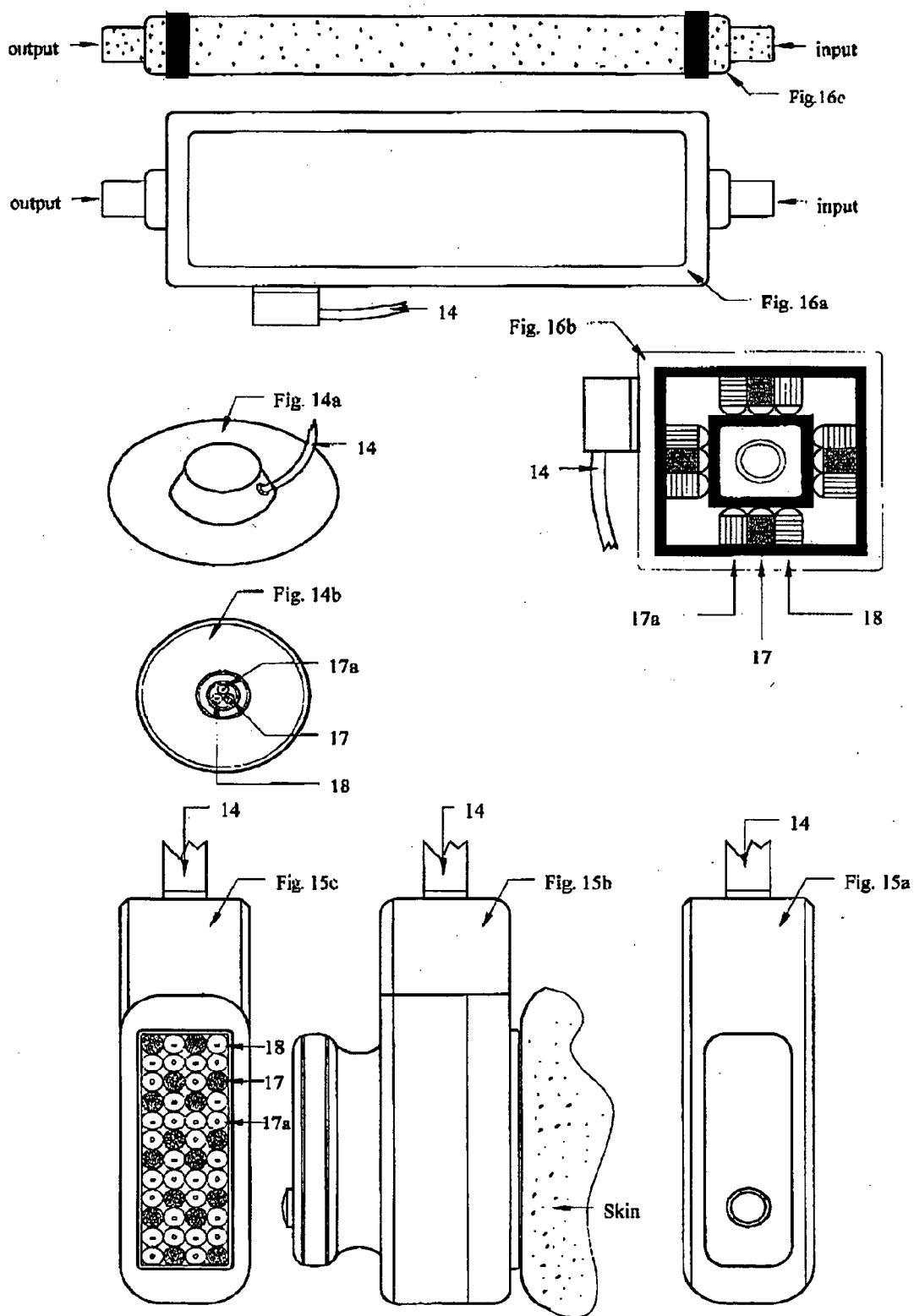
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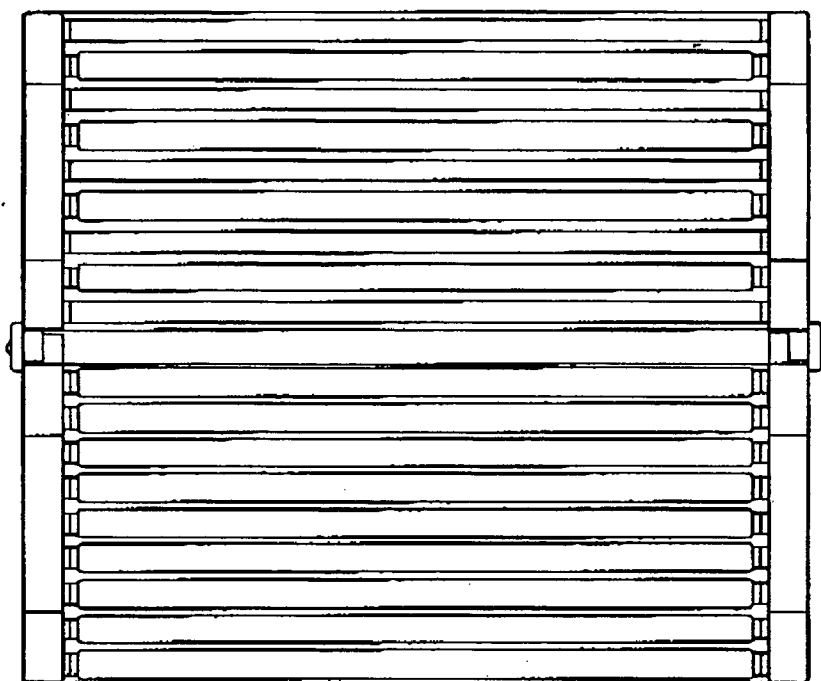


Fig. 17b

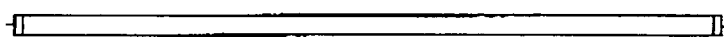


Fig. 18a



Fig. 18c

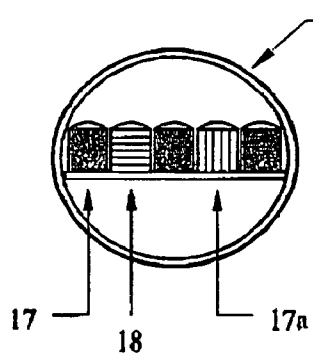


Fig. 18b

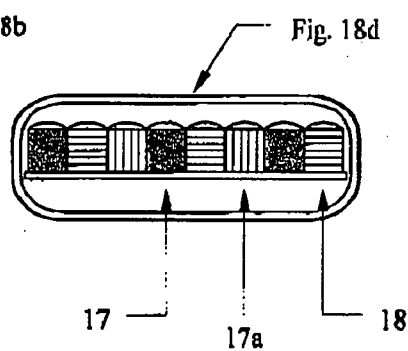


Fig. 18d

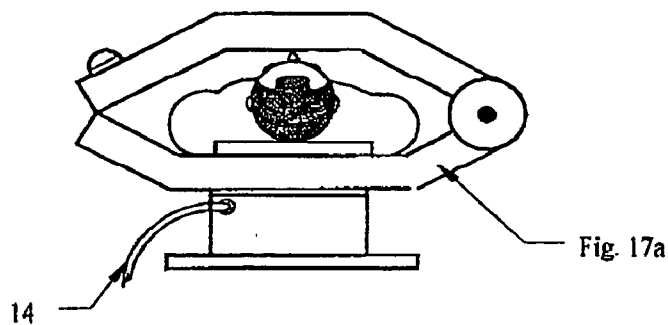


Fig. 17a

PHOTODYNAMIC STIMULATION DEVICE AND METHODS

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates in general to electrotherapy devices and more particularly to devices and methods for photodynamic and electromagnetic stimulation of living tissue, directly and also indirectly, by stimulation of photosensitive substances introduced into or onto living tissue.

DESCRIPTION OF RELATED SCIENCE

[0002] The mitochondria within the cells of protozoa and metazoa are sources of energy produced by cell respiration. They are moreover capable of synthesizing proteins, because they have a genetic system of DNA and RNA independent of the cell nucleus.

[0003] The mitochondria's main function, however, is vesicular respiration. This is the transformation within the cells of nutrients and oxygen (supplied, amongst other ways, via the bloodstream) into energy and endogenous substances, whereby through this transformation, waste products like water, carbon dioxide, alcohol and lactic acid are produced. Of great importance is adenosine-triphosphoric acid (ATP), which is synthesized by the mitochondria into adenosinediphosphoric acid (ADP) and orthophosphate. Complicated chemical compounds are of great importance as reaction catalysts.

[0004] Stimulation of the vesicular respiration, especially a stimulation of the ATP production by cells, is used therapeutically to meet strong demands on cell energy during healing processes, and for weight-reduction, wound-healing and reduction of pain sensitivity due to illness or weakness caused by hypo- or depolarization of the cell membrane. In general, weakening of cells caused by an increase of vesicular respiration due to stress, illness or by old age can be counteracted. In order to achieve stimulation of the mitochondria through optical radiation, two conditions must be fulfilled. The radiation must be of appropriate wavelengths in order to be effective, and a pulse frequency must be chosen to penetrate to an appropriate tissue depth without causing tissue damage or pain.

[0005] Moreover, pulsating electromagnetic fields have been shown to exert a positive influence on the bodies of both animals and humans. With the help of pulsating electromagnetic fields it is possible to send protons from electrolytic internal body fluids such as blood or lymph directly and in controlled measures into the surrounding vessel walls and membranes. This is normally not possible, since the lipids in the membranes of the blood vessel walls, which are in contact with the blood, carry a negative charge creating a surface potential which hinders the protons and ions from entering the vessel walls. The pulsating electromagnetic field enables the protons to enter the cell and vessel walls in spite of the barrier. When this occurs, the increased concentration of protons within the cell and vessel walls reverses the polarity of the barrier, thereby hindering the protons and ions from exiting through the cell and vessel walls again. In turn, this phenomenon causes a beneficial change in the local pH value, especially within the vessel walls. Additionally,

prolonged exposure to pulsating electromagnetic fields has other effects, such as the electrical constriction of the membranes and vessel walls, the adjustment of polyvalent ion chains, the tangential displacement of absorbed counter ions, the force effect on dielectric bodies in homogeneous and non-homogenous fields, and electro-osmosis.

[0006] A device is known (Patent DE-U-8-13852/ Normed, E. Larsen), which uses infrared radiation for the photodynamic stimulation of energy in living cells, cells at the surface of the skin and especially cells lying deeper down. The device consists of a supply and control mechanism and an applicator on which infrared radiating (from 900 nm [1 nm=1 nanometer]) semiconductor diodes are mounted with reflectors for the bundling of the IR radiation from the applicator (IR=infrared). In this known device, a generator containing a control-mechanism supplies the semiconductor diodes with current pulses of a frequency within the range of 500-5000 Hz. A disadvantage of the known device is that the semiconductor diodes tend to overheat during use, which causes a decrease in the effectiveness of the device.

[0007] The known device therefore does not deliver a constant effect during use. Another disadvantage is that only inared radiation within a range of 900 nm is available, while other wavelengths may be called for to achieve cell stimulation.

[0008] Another device (Patent EPA 0568 666) is used for the photodynamic stimulation of cells. The semiconductor and/or laser diodes radiate light of different wavelengths. With the aid of light sensors the advanced control-system is able to test the patients for the required radiation dose in order to avoid over-stimulation. Furthermore, the radiation outlets in the applicators are covered with a polarization filter, which enhances absorption in the irradiated tissue. The basic equipment consists of a mobile stand, to which machine applicators are connected with a jointed arm. The machine applicators are adapted for the treatment of large tissue-areas, for example the back of humans. The device also includes a control-mechanism, whereby the various parameters for therapy can be adjusted and switched ON and OFF. The device is also connected to a hand applicator designed for the treatment of small tissue-areas, e.g. acupuncture points or dental treatment with the aid of a connectable fibre.

[0009] Another device is (EPA Patent 0570 544), which uses electromagnetic fields for therapy on humans and animals. The pulse-shaped electromagnetic fields cause protons to migrate out of the electrolytic internal body fluids into the surrounding vessel walls and membranes. The device produces the electromagnetic pulse-bundles in a certain pulse-rhythm, in which each pulse-bundle is followed by a pause. The basic device consists of a generator for producing the electro-magnetic pulses, connected with a transmitter coil, whose windings are placed on the surface of the base plate. The base plates are manufactured from light, flexible insulating material and mounted in a flat applicator housing placed on a jointed arm connected to the basic device.

[0010] In the fields of dermatology and rehabilitation, light is used as a stand-alone therapy for wounds, leg ulcers, eczema, burns, pain, rheumatic disorders etc., and as such is used to stimulate tissue directly. Techniques are known for

introducing agents for altering the light absorbing qualities of tissue to enhance the effect of light (for example, U.S. Pat. No. 5,226,907 to Tankovich teaches contamination of hair follicles with a dark particulate material to enhance light-induced heating in the follicles for hair removal).

[0011] Treatments have included the application of substances such as photoflim, 5-aminolevulinic acid, hematoporphyrin, verteporfin, chlorins, phthalodyanines, phenothiazine, and benzoporphyrin-derivative monoacid-A (ATMPn) onto or into tissue for healing solar keratoses, basal cell carcinoma, melanomas, etc. Such substances are known as "biopharmaceuticals" and treatment with these substances has been called biopharmaceutical therapy. Therapy involving the application of biopharmaceuticals and their subsequent activation by light after they have been absorbed into tissue has been called photodynamic therapy (PDT).

[0012] PDT has been used successfully in the treatment of internal inoperable cancers. A biopharmaceutical (specifically, hematoporphyrin) is injected into the tumor tissue, and an optical method known as photodynamic diagnosis (PD) is used to determine when the biopharmaceutical has been absorbed by the entire tumor. Then the tumor tissue is irradiated with light typical for a dye laser, which activates the photosensitive reactors in the hematoporphyrin, whereby singlet oxygen is liberated. Singlet oxygen is toxic to protein and phospholipids in the tumor tissue, whereby the tumor is destroyed without destroying the surrounding tissue.

[0013] For treatment of skin keratosis (pre-cancerous tissue), trials with, for example, 5-aminolevulinic acid have shown that it can be used effectively in PDT if introduced into oil in a water suspension which is then applied to skin keratosis and then irradiated with a light source. A fast and cosmetically perfect healing has been attained with a very low rate of recurrence compared to conventional treatments, such as cryo-therapy. In view of these favourable test results, it is anticipated that pharmaceutical companies will be marketing the next generations of PDT chemicals in convenient forms, such as creams, suspensions, sprays, etc.

[0014] The light source typically used to irradiate PDT chemicals is commonly known as the surgical laser, a solid-state laser which is bulky, and which is expensive both to purchase and to operate. Surgical lasers are designed primarily for cutting, i.e., they output very high energy in a very small spot, and are thus difficult to adapt to the requirements of irradiating a more generalized area for PDT. Further, they generally radiate at a single wavelength. Radiation at several wavelengths is desirable in PDT, for several reasons: a single wavelength may cause the patient to experience burning pain in adjacent tissue during treatment; some photosensitive chemicals respond to two different wavelengths; and, some pigmented melanomas do not respond to visible radiation due to absorption in the pigment (typically melanin), and must be irradiated with near-infrared light.

[0015] Common dermatological diseases like acne, warts, and onychomycosis (nail fungus) can successfully be treated with light as a stand-alone treatment, but recent work indicates that treatments using PDT (with ALA/5-aminolevulinic acid) give excellent results with only two or three treatments.

[0016] In a recent pilot study using PDT to treat acne, the cosmetic results were excellent, and oil gland activity which

causes acne, and the resultant inflammation, were reduced for as much as twenty weeks after a series of PDT treatments. (The PDT treatments precipitated immediate but short-term inflammatory reactions.) In general the photodynamic stimulation used in physiotherapy is producing very good results, but in the area of long-term chronic diseases such as gout, arthritis, etc. there is often a need for many treatments, as many as 12-20 treatments spaced over a period of time. Also, initial phases of such treatment often cause reactions, which in turn cause pain and discomfort. A recent trial study showed that using a light and/or laser radiation combined with an electromagnetic field emission resulted in better results, without reactions to the intensive therapy. It seems that the combined radiation has a better penetration due to the electromagnetic fields removing the blocking potential and the vasodilatation of the capillaries, whereby the increased ATP energy is better utilized.

[0017] A recent trial in post-surgery light and/or laser therapy after coronary angioplasty and stenting, where the restenosis rate is normally quite high, showed promising results, and here again it is expected that the results can be improved using a light sensitive biopharmaceutical for regeneration and stabilisation of the vessel walls.

[0018] Studies also support the theory that a light and/or laser radiation of blood can provide an effective therapy for chronic diseases such as leukemia and cancer, our tests on athletes also support the theory that this therapy improves the immune system and the vitality.

[0019] A number of erythrocytes are often damaged in artificial heart-lung machines, but blood irradiated with light and/or laser showed less deformability and the ATP levels were significantly higher. Here too we expect an increased activity of the leukocytes and lymphocytes by using light sensitive biopharmaceuticals.

[0020] For many years large-surface therapy systems for dermatological diseases like psoriasis have been equipped with UV radiation sources, for example UV tubes. Prior to the treatment the patients have received various types of photo-chemical substances like 8-MOP (Oxsoresalen), 5-MOP or Meladine (bathing therapy). Due to the risk of skin cancer and other side effects the use of PUVA therapy has declined during recent years. When more studies have been completed it is expected that PDT will in future be the procedure of choice for treating most chronic dermatological diseases, due to its effectiveness and lack of side effects.

[0021] Also due to the risk of skin cancer, tanning on sun-beds has declined much during recent years. Among other side effects is the erythema that follows the first treatments, and most patients, especially those with fair skin, find that their skin becomes very dry and irritated.

[0022] Our tests have showed that by using a combination of UV light and photodynamic light produced by semiconductor diodes, we can avoid all the side effects of using sun-beds. It is also expected that the increased vitality (high ATP level) of the skin can counteract the risk of skin cancer.

[0023] In classical acupuncture a technique called moxibustion is commonly used for the treatment of deep-lying acupuncture points, especially in chronic diseases. Needles with a special metal handle are used and, after the needles are inserted in the patient, a herbal substance is placed on the handle and combusted, whereby the needle is heated and

leads the heat deep into the tissues. The effect is excellent, but western doctors do not like this praxis because of the strong smell, which may linger for several days.

[0024] This method can now be replaced by the application of topical light-sensitive lotions over the acupuncture points, which are subsequently radiated with a suitable light and/or laser radiation. Looking at the current state of technology, devices are available for the photodynamic stimulation of human cell energy in the form of red and infrared radiation emitted by laser diodes and semiconductor diodes. These devices are not suitable for intensive, invasive and whole body treatments mainly due to the lack of applicators with suitable adjustable radiation sources for fill surface treatment with combined diagnostic abilities during treatment. The same can be said for existing devices for treatment with pulsating electromagnetic fields. Moreover, a combined treatment with both red/infrared and blue light together with electromagnetic fields is not possible with these devices for the stimulation of light sensitive substances.

[0025] A device able to deliver an intensive light radiation with selective multiple wavelengths within the wavelength area of 300-2000 nm and electromagnetic fields is not at present available. Thus the invention is aimed at creating a device for intensive photodynamic therapy, which is capable of stimulating photodynamic energy of selective multiple light and/or laser radiation within a wavelength range of 300-2000 nanometers, capable of treatment with pulsating electromagnetic fields, and can also be used for stimulating light sensitive biopharmaceuticals.

SUMMARY OF THE INVENTION

[0026] The present invention provides a device with changeable applicators using a light and/or laser radiation of several wavelength ranges suited for the photodynamic stimulation of the cell energy in living cells, in particular human cells of both surface and underlying tissue. The light and/or laser radiation especially enhances vesicular respiration, most particularly stimulation of the ATP production in cells, thus increasing the therapeutic capabilities of the device. Furthermore, it is also possible to stimulate the activity of the cytochromes and the enzyme activity of the cells.

[0027] The device consists of a stand, to which machine applicators are connected by means of a jointed arm. The stand, freely moveable on wheels, consists of a control mechanism, on which the desired therapy data can be adjusted and the device can be switched ON and OFF. The plain surface applicators can consist of several applicators placed side by side and flexibly connected with each other through hinges, whereby the applicators are suitable for the treatment of large-area tissues such as the human back.

[0028] The applicators contain printed circuit boards mounted with semiconductor diodes and/or laser diodes (in large numbers), and the diodes are mounted with reflectors, which collect the radiation and bundle them in front of the applicator. The applicators also contain one or more transmitter coils for the emission of pulse-shaped electromagnetic radiation. The applicators are also equipped with an adjustable scan system, which permits an even and gap-free radiation of the surface with the multiple wavelengths of light.

[0029] A diagnostic system (PD) containing a fluorescent light source and optics for photodiagnosis during the treatment is also included in the applicator.

[0030] At least one of the applicator elements is equipped with feedback sensors for controlling the patient's response to the therapy, and via an automatic regulation system in the control mechanism it is possible to optimise the therapy results. The applicator contains a polarization filter, which is placed directly in front of the diodes. The control mechanism is also connected with a hand applicator, which is constructed for treatment of small tissue areas, e.g. acupuncture points and trigger points (pain points).

[0031] The hand applicator includes a cylindrical shaft to which a headpiece is connected. A printed circuit board is fastened to the headpiece, mounted with semiconductor diodes or laser diodes.

[0032] The light radiation is emitted from an axial opening in the front, equipped with a polarization filter and a lens for the focusing of the light rays.

[0033] A second version hand applicator, which is especially invented for dental and/or invasive treatment, including (PD) diagnosis, contains at the front end of its shaft a printed circuit board, where 4 light and/or laser diodes of different wavelengths are placed at 90° intervals. One of these radiation sources can be selected as a fluorescent light for diagnostic purposes (PD) related to PDT therapy using light reactive biopharmaceuticals. The headpiece in front of the printed circuit board can be rotated in steps of 90° so that the expander, which is connectable with various types of optical fibres, can be positioned in front of either radiation source. The applicator may selectively emit blue light for the bonding and hardening of composite plastic fillings or infrared light for the treatment of dental pain, gingivitis, and wounds. In order to optimise bonding with the blue light, the output of the hand applicator is supplied at 25% of full power for the first ten seconds of the radiation time, and then is switched to full power.

[0034] Acupuncture applicators made as small heads mounted on self-adhesive pads connected to the control mechanism, allow a certain number of applicators to be connected corresponding with the usual number of points utilised in classical acupuncture. The control mechanism can be programmed for a randomised acupuncture programme with changing frequency, modulation and amplitude instead of a programme with classical needling and Moxa treatment.

[0035] Two applicator types are made for the stimulation of blood, either of venous blood or integrated in a heart/lung-machine. The first applicator allows radiation of blood passing the applicators' radiation sources in a 5 mm infusion lead, and the second version provides an intensive radiation of a quadrant tube, where the blood passes and receives radiation from 4 sides from light and/or laser diodes mounted on print-boards also containing transmitter coils radiating pulse-shaped electromagnetic emission.

[0036] The applicators can also be designed as standard 2 meter and 15 cm long light tubes of the type commonly used in sun-beds for whole body therapy. Here it is advantageous to make the applicator in the form of a flat oval tube in order to achieve a better radiation surface. The tube applicators contain print-boards mounted with a suitable number of semiconductor light and/or laser-diodes as well as transmit-

ter coils for the emission of pulse-shaped electromagnetic fields. The applicators are then mounted in a large body treatment arrangement like a sun-bed, where the patient lies on the lower part beneath a top part covering the whole body. Applicators of this type could be useful for treating office workers suffering from SAD disorders caused by too little exposure to natural light.

[0037] The invention provides multiple wavelength stimulation that is also effective in conjunction with photodynamic therapy (PDT) chemicals. Such chemicals are applied or injected into or onto tissue to be treated, and subsequent photo-stimulation of them causes reactions in them that result in treatment of the tissue. Irradiation at multiple wavelengths enhances the effects of PDT chemicals while reducing discomfort to the patient.

[0038] The present invention provides an apparatus including a semiconductor light source including a hand applicator. The hand applicator can selectively emit light of various wavelengths and introduce the light-sensitive substances into the tissue by means of air-pressure and electrical impulses (iontophoresis). The absorption time, depending on the type of light-reactive substances, may vary from 1 to 24 hours without this technique. Other advantages with the described technique are that the light-sensitive substances can be applied very precisely and the absorption dose can be improved and more accurately regulated.

[0039] Other advantages of the invention will become evident from the following description of the invention and from the appended drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] FIG. 1 is a perspective drawing of the invented device,

[0041] FIGS. 2a, 2b, 2c, 2d illustrate details of the machine applicator of the invented device;

[0042] FIG. 3 illustrates a jointed arm used for the movable connection of the machine applicators;

[0043] FIG. 4 is a circuit block diagram of a control unit, which supplies the applicators.

[0044] FIG. 5 depicts a hand applicator according to the present invention;

[0045] FIG. 6 depicts an applicator conforming to FIG. 5 with axial light emission;

[0046] FIG. 7 depicts the light sources with a lens of FIG. 6;

[0047] FIG. 8 an applicator with a rotary headpiece;

[0048] FIG. 9. shows details of a printed circuit board for the applicator of FIG. 8; and

[0049] FIG. 10 depicts the flexible light fibre cable with adaptor,

[0050] FIG. 11 shows the air unit with the hand applicator belonging to this part of the invention.

[0051] FIG. 12 illustrates an exchangeable round head for the hand applicator.

[0052] FIG. 13a shows the hand applicator for light-sensitive substances viewed from below.

[0053] FIG. 13b illustrates the hand applicator in side view.

[0054] FIG. 14a shows the acupuncture applicator in top view,

[0055] FIG. 15b depicts the acupuncture applicator from the underside, showing the light sources.

[0056] FIG. 15a illustrates a rectangular hand-applicator in a top view;

[0057] FIG. 15b shows the hand applicator in side view with skin contact used for hair removal;

[0058] FIG. 15c illustrates the hand applicator viewed from below, showing the light sources;

[0059] FIG. 16a illustrates a tube applicator for the radiation of blood;

[0060] FIG. 16b shows the applicator-like quadratic tube viewed from the end;

[0061] FIG. 16c shows the quadratic tube used for blood radiation;

[0062] FIG. 17a shows the body applicator viewed from the end, in closed mode;

[0063] FIG. 17b shows the body applicator open, with the radiation surface of the lower and upper part;

[0064] FIG. 17c illustrates the closed body applicator in a side view.

[0065] FIG. 18a illustrates a round light tube as seen from above;

[0066] FIG. 18b illustrates the round light tube viewed from the end;

[0067] FIG. 18c shows the light tube formed as a flat oval and viewed from above;

[0068] FIG. 18d shows the flat oval light tube viewed from the end;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0069] As shown in FIG. 1, the invented device 10 for the stimulation of cells with the aid of (PDT) photodynamic light and electromagnetic fields combined with light sensitive substances consists of a stand 11, with which machine applicators 13 (in the following just called applicators 13) are connected through a jointed arm 12. The stand 11 is also connected by an electric circuit 14 with a hand applicator 15. The stand 11, freely movable on wheels, includes control mechanism 16 (described in FIG. 4), whereby the function of the control mechanism 16 can be adjusted and switched ON/OFF at a control panel 30 (also called description equipment 30).

[0070] The FIGS. 2a, 2b and 2c show plain surfaced printed circuit boards with light sources mounted in the applicators 13. These can be used in the working model according to FIG. 2a to 2c individually, side by side (in large numbers) or in combination with an applicator. Furthermore the printed circuit boards on which the light sources are mounted can favourably be produced as multilayer, also containing the electromagnetic field transmitter coils 65 shown in FIG. 2d. According to FIG. 2a, the applicators 13

in the working model are mounted in a shifting order with semiconductor diodes (LED) and/or laser diodes **17** and **17a** (the following called light sources), whereby shifting the order of the light sources **17** means, that the respective light source **17a** of one row is placed at the point of intersection of the two diagonals through the two respective light sources **17**, which are placed adjoining on both sides. The light sources **17** and **17a** are mounted with reflectors **18**, which collect the radiation and bundle it in front of the applicator **13**. The applicator contains a polarization filter, which is placed directly in front of the light sources **17** and **17a**, whereby the radiation can be better absorbed by the irradiated tissue.

[0071] According to **FIGS. 2b** and **2c** the light sources **17** are placed in regular row arrangements, i.e., **20** equidistant from each other, whereby, according to **FIG. 2c**, one applicator **13**, in addition to the diodes **17**, has a light source **19**. The light sources **17** are adjustable and can radiate light in at least three wavelengths within the wavelength area 300-2000 nm. The light source **19** formed as a tube can be selected for radiating blue light or fluorescent light within the wavelength area of 300-450 nm for photodiagnostics (PD). A diagnostic system (PD) containing optics **67** with a magnifier for photodiagnosis during the treatment is also included in the applicator. The light sources **17a** (**FIG. 2a**) radiate light with a wavelength of 350-500 nm, i.e., blue light.

[0072] For the treatment of large-area tissues according to **FIG. 1**, several applicators **13** are flexibly connected to each other through hinges **10**, respectively connecting one edge with the other, whereby the applicators are suitable for the treatment of for example, the backs of humans and so become adjustable for an equidistant positioning of the applicators **13** above the skin. In each applicator the printed circuit board carrying the light sources is connected to a small electrical scan engine **66**, which can move the light sources with linear movements, whereby a correctly adjusted scan length and frequency gives the radiated surface a total radiation at the necessary wavelengths without leaving any unradiated gaps.

[0073] The joint arm **12**, shown in **FIG. 3**, connects one or more applicator(s) **13** with the stand **11**. The jointed arm **12** has three joint carriers **21**, **22**, **23**, where the joint carrier **21**, together with the stand **11** and the joint carrier **23** are moveable at a free end through a fixing joint **24** connected with one or more applicators **13**. Another fixing joint **25** connects the joint carrier **23** with **21**, while the joint carrier **22** is connected with the joint carrier **21** with a hinge **26**. The joint carrier **21** is connected with the stand **11** through a joint **27** and one or more joints can also be produced as friction-adjustable ball-joints, which gives almost unlimited adjustment possibilities and user comfort. The jointed arm **12** thereby allows the positioning of the applicators **13** in front of, or above, a tissue area while maintaining a correct positioning distance. The jointed arm **12** also carries the electrical circuits **14** (not further described) from the control mechanism **16**, which is integrated in stand **11**, to the applicator(s) **13**.

[0074] According to **FIG. 4** the controller mechanism **16** consists of a generator **28**, a timer **29**, and a display **30**. With help of the generator **28** the current impulses necessary to the production of light and the current pulses for the supply

to the transmitter coils emitting the electromagnetic fields are contributed, while with the aid of timer **29**, all time functions are adjustable, e.g. the duration of treatment. Display **30** shows pertinent treatment data, such as current pulse frequency, pulse length, pulse amplitude and pulse modulation. With the help of the control mechanism **16**, the invented device is adjustable within a relatively large range with reference to duration, amplitude and frequency of surge of current, so that the semiconductor diodes **17**, **17a** and **18**, as well as laser **17** diodes with the same realisation as semiconductor diode **17**, can be used as light sources. For that purpose the control mechanism is equipped with a switch select system for operating different types of semiconductor diodes **17** and/or with laser diodes. Both semiconductor diodes and/or laser diodes with tuneable wavelengths can be operated, which is a great advantage, and therefore the printed circuit boards can be equipped with a more intensive radiation effect.

[0075] The semiconductor diodes and laser diodes are tuneable in wavelength by means of various methods such as resonators, piezo elements or by the help of special current modes.

[0076] The semiconductor diodes and/or laser diodes useable in this invention emit a light radiation with either SPE (single photon emission), TPE (Two photon emission) and/or MTE (multiple photon emission) within the wavelength area of 300-2000 nanometers in order to correspond with available light sensitive substances (PDT).

[0077] The useable light sources in the form of semiconductor diodes and/or laser diodes are supplied with current pulse lengths of ms, ns and/or fs (femto-seconds) within a frequency range of 1 KHz-100 MHz.

[0078] The transmitter coil (transducer) for transmitting the pulse-shaped electromagnetic fields is supplied with basic pulses having a frequency between 2 and 500 Hz; ON times of about four-tenths of a period; OFF times of about six-tenths of a period and non-instantaneous rise and fall times. Furthermore, the basic pulses can be superimposed with pulse-bundles at a frequency off about 10 KHz and, optionally, also with pulse-bundles of a frequency between 20-30 MHz.

[0079] The applicators **13**, according to the **FIGS. 2a, 2b** and **2c** are equipped with sensors **32** arranged between the semiconductor and/or laser diodes **17**. For therapeutic uses it is typically intended to apply a given amount of energy (Joule/cm²) per irradiated surface of tissue, which can be adjusted at the control mechanism **16**. Sensors **32** measure the amount of energy radiated away from the skin surface, which is indicative of the total energy penetrating into the tissue. Taking into account individual variations from patient to patient, the exposure can be determined according to the measurements taken by the sensors **32** so that the correct amount of therapeutic energy (Joule/cm²) reaches the tissue. An increase of the registered amount of energy can be achieved by the invented device by increasing the operating potential (and thereby the pulse amplitude) or the pulse frequency and/or prolonging the duration of the treatment time through an adjustment of the control mechanism **16**.

[0080] A sensor **32a** is also contained in at least one of the machine applicators, measuring the temperature change of the radiated tissue, whereby the control unit can react with

a feedback regulation of the radiation parameters depending on the therapy indication, location and (PDT) light sensitive substance used.

[0081] While the applicators **13** according to **FIGS. 2a, 2b** and **2c** are constructed for the treatment of larger tissue areas, the hand applicators **15a, 15b** according to **FIGS. 5** and **8** are constructed for the treatment of small tissue areas.

[0082] The hand applicator **15a** includes a cylindrical shaft **34**, with a handle to which a headpiece **35** is connected. At the headpiece **35** a printed circuit board **36** is fastened with light sources **17** of tuneable wavelengths (not described). In headpiece **35**, in front of the opening **39**, are placed a lens **40** for the focusing of the light rays and a polarization filter **41**. The device with this kind of light **38** emission is especially designed for the treatment of small tissue areas, e.g. acupuncture points and triggerpoints.

[0083] **FIG. 8**, in connection with **FIG. 9**, describes a hand applicator **15b**, which is especially intended for dental treatment and internal medical treatment. The applicator **15b** shows at the front end of the shaft **42** a printed circuit board **43**, where three different light sources **44** with tuneable wavelengths within the wavelength area of 300-2000 nm and a light source **45** for photodiagnostics (PD) are placed. In front of the printed circuit board **43** a headpiece **46** is placed, connected with an interchangeable fastened hollow expander **47**, in which an optical fibre is sealed (not shown). The head piece **46** is in front of the printed circuit board **43** so it can be rotated 360° in steps of 90°, so that the expander **47** can be positioned in front of either one of the three light sources **44a, 44b, 44c**, depending on the required wavelength for therapy, or in front of the light source **45** if fluorescent light for photodiagnostics (PD) is needed. If the expander **47** is positioned, for example, in front of the diode **44b**, light within the infrared wavelength area is transmitted through the optical fibre in expander **47** and ultimately strikes the tissue, e.g. gum tissue, through which painful gingival diseases can be treated. Through a positioning of the expander **47** in front of the **44a**, blue light with a wavelength of 470 nm is conducted through the expander **47**, with which plastic fillings in teeth can be hardened. It is obvious that the light rays with this form of execution can also be conducted through polarization fibres. Furthermore, the two hand applicators are equipped with sensors **32** for the same purpose as described for the applicators **13**. The hand applicator **15b** can also be very useful in the case of internal medical diseases, where the flexible fibre cable can be used together with a video-cable, which is produced with an internal opening for instrumentation, laser fibre etc. In this situation the flexible light fibre cable is connected, whereby first the light source **45** is used for photodiagnosis and hereafter one of the light sources **44a, 44b, 44c** is selected for the treatment.

[0084] **FIG. 11** Shows a diagram of the air-pressure unit **48**, which can either be built into the control mechanism of the device or produced as a separate device connectable with the invented photodynamic stimulation device. The air unit can either be produced as a rechargeable air-tank or as a small air-compressor with container. The container outlet is equipped with a reduction valve **51**, combined with a pressure meter **52**, of familiar sort. The electronic valve **51a** in the air tube **49** leading to the hand applicator **50** can be switched on from the hand applicator and the ON impulses

can be regulated at the control mechanism **53**. The current impulses **63** and amplitude **64** for the iontophoresis treatment are also adjustable at the control mechanism.

[0085] **FIG. 12** illustrates an interchangeable round head **56** for the hand applicator, which can be changed via a click in bracket (not illustrated). The treatment head **56** is interchangeable according to the purpose of radiation, so that a round head could be used for treating round spots, while a rectangular head **56a** would be preferable for treating wrinkles.

[0086] In **FIG. 13a** the hand applicator is illustrated seen from below, mounted with a rectangular treatment head **56a**. Next to treatment head the semiconductor and or laser diodes **17, 17a, 18** are placed in rows covered by a polarization filter **37** and/or lens system. A sensor **32** for feedback measurement is also integrated.

[0087] **FIG. 13b** shows a drawing of the hand applicator **50**, which can be used for the following purposes:

[0088] Introducing light-reactive substances to the tissue with the aid of air-pressure pulses

[0089] Introducing light-reactive substances to the tissue with the aid of iontophoresis

[0090] Radiating the tissue with a mixture of light radiation, which can be selected on the control mechanism.

[0091] The hand applicator contains a valve **55** placed just after the air inlet, prohibiting the substances from running back into the air tube **49**. The treatment head is mounted with a sensor **57** permitting exposure only on skin contact and furthermore the head also contains a valve-system **58**, which opens only on skin contact, thus preventing the substances from running out of the head before it touches the skin.

[0092] The chamber **59** containing the substances is placed next to the air duct in the hand applicator **50** and the chamber is connected with a dosage pump **60**, so that the amount of substance per air-shot can be dosed very accurately.

[0093] The hand applicator **50** housing is made of an insulating material, and the treatment head **56** is made of an electrically conductive material so that it can also be used for iontophoresis treatment combined with air-pressure treatment in order to attain maximum absorption.

[0094] Around the treatment head the semiconductor and/or laser diodes **17, 17a, 18** are placed for the selective light radiation.

[0095] The ON/OFF switches **54, 61, 62** for operating the hand applicator are placed on the top of the applicator. During the iontophoresis treatment the patient must hold an electric conductor **65** handle in his hand.

[0096] **FIG. 14a** illustrates an acupuncture applicator made with a small head containing the light sources mounted on a self-adhesive pad connected to the control mechanism, which allows a certain number of applicators to be connected corresponding with the usual number of needles used in a classical acupuncture treatment. **FIG. 14b** shows the acupuncture applicator from the radiation side and the lens placed in this version over the three light sources **17**,

17a, 18. The control mechanism can be programmed for a randomised acupuncture programme with changing frequency, modulation and amplitude. This method can easily replace the well-known Moxa method; Western doctors do not like Moxa treatment because of the smell it produces, although it is very effective for treating chronic diseases.

[0097] This form of light acupuncture is without any risk of infection as no needles are used. It is completely pain free and the benefit can be greatly augmented by applying a topical light sensitive lotion before radiation (PDT). The radiation of trigger points and/or acupuncture points with strong light sources can cause pain, but by choosing low frequencies and intensities in the start phase and successively increasing the frequency and intensity, the treatment is pain free and more efficient.

[0098] **FIG. 15a** shows a rectangular hand applicator with start-stop switch connected to the control mechanism with a cable. **FIG. 15b** shows an illustration of the hand applicator in side view, where the upper part is formed as a handle and the lower part is rounded for application directly onto the tissue to be treated, for example hair removal after application of light sensitive substances (PDT-hair reduction). **FIG. 15c** depicts the hand applicator from the application side, where the rectangular optic covers the printed circuit board mounted with multiple various selectable light sources **17, 17a, 18**. The size and form make it very suitable for hair reduction treatment where the radiation outlet can cover the whole area above the upper lip.

[0099] **FIG. 16a** illustrates an applicator, connected with a cable to the control mechanism, produced in the form of a quadrant tube, through which the blood to be treated passes and receives radiation from all four sides of the quadrant. **FIG. 16b** shows how the inner sides are equipped with printed circuit boards with light sources **17, 17a, 18** also containing transmitter coils, radiating pulse-shaped electromagnetic emission.

[0100] **FIG. 16c** illustrates the blood tube designed for inner radiation room in the applicator, through which the blood is passed during the treatment. The illustrated version is designed for the radiation of venous blood, for example in combination with infusions of light sensitive biopharmaceuticals (PDT therapy), but other applicator types are also available for use in artificial heart/lung machines (not illustrated).

[0101] **FIG. 17a** shows a large body applicator connected with a cable to the control mechanism. The applicator is made of a lower and upper part hinged together and, in this illustration, shown closed, in an end view, ready for treatment.

[0102] **FIG. 17b** is an illustration where the applicator is opened and the radiation surface shows the light sources available for therapy. This model shows in the upper part every second light source as a standard UV light tube, and in between, the flattened oval tubes containing the light sources for the photodynamic therapy (PDT). The lower part is equipped only with the light tubes containing the light sources for the photodynamic therapy (PDT).

[0103] **FIG. 17c** illustrates the body applicator in a side view, where the applicator is closed and placed on the ground, with a solid socket system.

[0104] **FIG. 18a** illustrates one version of an emitter for the body applicator, shaped like an ordinary round light tube of standard length, 2.15 meters, with a connector in each end for the supply.

[0105] **FIG. 18b** shows how the printed circuit board equipped with the light sources **17, 17a, 18** is placed in the round tube.

[0106] **FIG. 18c** illustrates another version of an emitter for the body applicator, preferably formed as a flattened oval tube in a standard length of 2.15 meters and equipped with a standard connector in each end for the supply. **FIG. 18d** shows an end view of the tube with the printed circuit board equipped with light sources **17, 17a, 18**. The same printed circuit board can also contain a transmitter coil for the emission of pulse-shaped electromagnetic fields. The light tube is preferably mounted with a polarization **41** filter on the emitting side.

[0107] In the field of dermatology, light is used as a stand-alone therapy for wounds, leg ulcers, eczema, burns, etc., and as such is used to stimulate tissue directly. Light and the emission of pulse-shaped electromagnetic fields may also be used to treat tissue using photodynamic therapy (PDT) by activating chemical reactions in photosensitive chemicals introduced into or onto the tissue, such as photofrin, 5-aminolevulinic acid, hematoporphyrin, verteporfin, chlorins, phthalocyanines, phenothiazine, and benzoporphyrin-derivative monoacid-A (A TMPn) etc. for healing solar keratoses, basal cell carcinoma, melanomas, etc.

[0108] PDT substances may be administered in various forms: lotion or cream for topical application, tablets or capsules for oral injection, and local injection of solutions or infusion.

[0109] Dimethylsulfoxide (DMSO) is a solution, which has the property of breaking down the barrier of the skin and is often used before administering PDT substances in order to increase the absorption thereof. Alternatively, PDT substances may be mixed with DMSO for application to the skin.

[0110] An instrument consisting of a handle with a head, wherein a number of needles are connected to a spring arrangement, can be used to pierce small, closely distanced holes in the upper layer of the skin before the PDT substances are applied, in order to increase and accelerate the absorption.

[0111] Treatment by light irradiation with the invented device should not commence until sufficient absorption by the target tissue is obtained. Simply waiting for empirically determined times to elapse can suffice, or photodynamic diagnostics (PD) may be employed to determine absorption. PD comprises viewing the target area under illumination of a particular spectral content (such as from a fluorescent light) and observing apparent colour change of the target tissue.

[0112] High-intensity treatments (higher doses of PDT substances and strong irradiation) are used where it is desired to destroy tissue, as in destroying tumor tissue to cure cancer, or in hair removal where it is desired to destroy the hair follicle. Low-intensity treatments are used where it is desired to energize affected cells and to stimulate the local immune system, as in the rehabilitation of epicondylitis,

tendinitis, arthritis, arthroses, gout, and pulmonary diseases; or in the treatment of acne, actinic keratoses, warts, onychomycosis, psoriasis, dermatitis, and basal carcinoma; and in improving the appearance of wrinkles, cellulite, and fat deposits.

[0113] Low-intensity treatments have been observed to activate aspects of the local immune system such as the macrophages, which produce prostaglandin E2 (PGE2) and TNF (pro-inflammatory cytokines). There have also been observed an accumulation of leucocytes in the venules, and higher activity of the lymphocytes and plasma cells in the skin. The residual 5 content TNF- α of pro-inflammatory cytokines has been detected in the urine of patients after having PDT treatment.

[0114] Treatment with the invented device further enhances the efficacy of medicinal substances by photophoresis, a process of propelling fluids into the skin or tissue and propelling molecules through cell walls. The absorption process is accelerated, and the amount of PDT substance absorbed is increased. Other methods of phoresis are in use, such as galvanic iontophoresis, exchange phoresis, and phono-phoresis. These methods create a concentration gradient across the skin, and a resultant Brownian molecular motion creates a thermal influence which enhances transfer of medicaments.

[0115] Photofrin is a PDT substance which is administered by injection, at a dosage of 1-2 mg. per kg. of the patient's weight. 48 hours is allowed for absorption of the photofrin by the tissue to be treated, during which time the patient is kept in dim light. The treatment consists of irradiation by the invented device. The patient remains photosensitive for 6 to 8 weeks, and should avoid strong light and direct sunlight during that time.

[0116] ALA (5-Aminolevulinic acid) is externally applied as a 10 to 20 percent mixture in an oil in water emulsion or in a cream. 4 to 6 hours is allowed for absorption, during which time the patient should remain in dim light. After treatment by irradiation from the invented device, the patient remains photosensitive for 24 to 48 hours, during which time he should avoid strong light and direct sunlight.

[0117] L-Phenylalanine is applied in liquid form as a lotion or a spray or in a cream form, in a 5 to 30 percent mixture according to the severity of the condition to be treated. Optical irradiation with the invented device may begin almost immediately. Alternatively, doses of 50 to 100 mg may be taken orally 30 to 60 minutes before irradiation. The patient is photosensitive for 24 hours after application.

[0118] PDT has been used successfully in the treatment of internal inoperable cancers. A biopharmaceutical (specifically, hematoporphyrin) is injected into the tumor tissue, and an optical method known as photodynamic diagnostics (PD) is used to determine when the biopharmaceutical has been absorbed by the entire tumor. Then the tumor tissue is irradiated with light typical for a dye laser, which activates the photosensitive reactants in the hematoporphyrin, whereby singlet oxygen is liberated. Singlet oxygen is toxic to protein and phospholipids in the tumor tissue, whereby the tumor is destroyed without destroying the surrounding tissue.

[0119] For treatment of skin keratosis (precancerous tissue), trials with, for example, 5-aminolevulinic acid have shown that it can be used effectively in PDT if introduced

into oil in a water suspension which is then applied to skin keratosis and then irradiated with a light source. A fast and cosmetically perfect healing has been attained with a very low rate of recurrence compared to conventional treatments, such as cryotherapy.

[0120] Common dermatological conditions, such as acne, warts, onychomycosis (nail fungus) and wrinkles, can be successfully and effectively treated using PDT (with ALA/5-aminolevulinic acid) at a lower concentration than has conventionally been used. The treatment works not by causing cell death as light treatment has historically done, but instead works by stimulating the immune system so as to enable it to better control the inflammatory reaction to oil gland activity. The irradiation at multiple wavelengths as provided by the present invention enhances the efficacy of treatment in this manner.

[0121] Stimulating the immune system so as to reduce inflammatory reactions has also been found effective in the therapy of many other conditions, for example, epicondylitis (tennis elbow), tendinitis, gout, arthritis, arthroses, pulmonary diseases, and numerous other muscular and joint symptoms. Good results have been obtained with PDT in conjunction with the present invention's multiple wavelength output. Studies indicate that the patient often is pain-free after only one treatment, and the number of treatments can be reduced to 3-4, instead of 12-20 as required without the invented therapy.

[0122] The PDT substance is applied topically as cream or oil in water suspension, typically a 10-20 percent solution. Augmented action may be obtained by use of injection instead of or in addition to topical application. A large joint such as the knee requires 10-12 subcutaneous or intramuscular injections, preferably at the trigger points, while for a smaller joint such as the elbow 5-6 injections is sufficient. First the trigger points are found and irradiated for 30 seconds with the hand applicator of the present invention. This gives an anaesthetic effect, which is useful for lessening discomfort from the injections. (Injection of the trigger points is a known method for pain reduction). Then, after determination that the PDT substance has been absorbed by the target tissue, the surface applicator of the present invention is folded around the target joint and irradiation takes place for 30 minutes.

[0123] Good results have also been obtained in physiotherapy and physical rehabilitation with the present invention's ability to radiate visible light together with several wavelengths of infrared light and pulse-shaped electromagnetic radiation which, in combination, give a much better effect in deep tissue affected by chronic disorders.

[0124] Thus, while the fundamental novel features of the invention have been shown and described in this prototypic application, it should be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art, without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method-steps that perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or procedures shown and/or described in connection with any disclosed form or embodiment

ment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

[0125] The invention is intended for medical/dental invasive treatment, physiotherapy/rehabilitation therapy, dermatological and cosmetic skin treatment.

1. A device for the (PDT) photodynamic therapy and electromagnetic field stimulation of light sensitive substances and human cells, comprising:

light sources with suitable strength, suitable wavelength, a light conductor, an applicator, an optic lens, a polarization filter, an electromagnetic field transmitter coil, and a control and power unit, characterized by the following:

the light source consists of at least one semiconductor diode and/or at least one laser diode,

the wavelength of the light source is adjustable to correspond with the light sensitive substance and the indication type,

the supply of the light sources are adjustable and selectable in modes like a continuous and a pulsed mode, wherein the frequency, pulse-length and amplitude of the current pulses are selected to correspond with the type of indication and/or light sensitive substance,

the frequency, pulse-shape and amplitude of the electromagnetic field pulses are adjustable to correspond with the type of indication and the light sensitive substance, wherein the light sensitive substances is introduced to the tissue to be treated by help of a hand applicator of the inventive device using a method of air-pressure and/or iontophoresis and/or photophoresis.

2. A device according to claim 1, wherein the light source contains at least one adjustable laser diode.

3. A device according to claim 1, wherein the light source contains at least one semiconductor diode, which produces light of different wavelengths.

4. A device according to claim 1, wherein the light-source contains several semiconductor and/or laser diodes, which emit light of different wavelengths.

5. A device according to claim 1, wherein the light sources are individually selected—switched ON or OFF.

6. A device according to claim 1, wherein the applicator contains a feedback photosensor for the light reflected from the skin surface.

7. A device according to claim 1, wherein the applicator contains a feedback sensor measuring the temperature changes of the treated tissue.

8. A device according to claims 4, 5 or 6, wherein the light sources and sensors are located on a printed circuit board.

9. A device according to claim 8, wherein the electromagnetic field transmitter coil is placed in the same printed circuit board on which the light sources are placed.

10. A device according to claim 1, wherein the at least one applicator is mounted to the control unit by means of a movable jointed arm.

11. A device according to claim 10, wherein the at least one applicator comprises several single applicators hinged together so as to be adjustable at angles with respect to one another.

12. A device according to claim 11, wherein the radiation outlet is covered by a polarization filter.

13. A device according to claim 11, wherein the at least one applicator contains sensors connected to the control mechanism for measurement of reflected light for feedback control and automatic adjustment.

14. A device according to claim 11, wherein the printed circuit board, on which the light sources is located, is moved linearly and/or rotated by help of a scan mechanism.

15. A device according to claim 11, wherein at least one of the applicators is mounted with a light source emitting a fluorescent light for photo diagnosis (PD).

16. A device according to claim 15, wherein the applicator contains an optic system with magnifier for photo diagnostic (PD).

17. A device according to claim 1, further comprising a hand-held applicator containing at least one second light source connected to said pulse generator and at least one light outlet.

18. A device according to claim 17, wherein the hand-held applicator is equipped with a shaft and a head and a printed circuit board equipped with semiconductor diodes.

19. A device according to claim 17, wherein the at least one light outlet is equipped with a mounted lens and a polarization filter.

20. A device according to claim 1, further comprising a hand-held applicator containing four selective light sources and a conductor for a light fibre cable.

21. A device according to claim 20 wherein:

on the circular printed circuit board four different light sources are placed at 90° intervals;

there is at least one light source emitting a fluorescent light for the photodiagnosis (PD);

the head comprises a light conductor rotatable in four steps to selectively conduct light for photo diagnosis (PD) or one of the three selectable and adjustable light sources of suitable wavelengths for therapy to said at least one light outlet.

22. A device according to claim 21, wherein the conductor mounted with an expander includes a fibre optic cable suitable for dental use.

23. A device according to claim 21, wherein the conductor is mounted with an expander with a flexible fibre cable for internal medical treatment.

24. A device according claim 1, wherein the hand-held applicator is formed as a rectangle with a handle at the upper part equipped with a start/stop switch.

25. A device according claim 1, wherein the applicator has a circular housing containing at least one light source equipped with a lens.

26. A device according claim 25, wherein the applicator housing is equipped with a self-adhesive pad for placing the applicator on the patient's skin when radiating acupuncture points.

27. A device according claim 1, wherein the applicator is formed as a rectangular tube containing the printed circuit boards with light sources placed at all four inner walls for intensive radiation of the blood in the inner rectangular tube.

28. A device according to claim 1, wherein the applicator for whole body treatment is made of a lower part like a bed with a hinged upper part.

29. A device according to claim 28, wherein the printed circuit boards mounted with multiple light sources are placed in a housing formed like a normal round light tube in the length of 2.15 m.

30. A device according claim 28, wherein the light tubes containing the multiple light sources are favourably produced in the form of a flat oval tube in the length of 2.15 m.

31. A device according to claim 28, wherein the light tubes containing the multiple light sources, including the electromagnetic transmitter coils, can also be built as a separate unit also containing the control unit.

32. A device according to claim 28, wherein both under and upper parts are equipped with a multiple number of light tubes of 2.15 m length containing a multiple number of said light sources of which every second could be mounted with normal UV light tubes.

33. A device according to claim 1 for introducing light sensitive substances into the tissues, comprising:

a pressurized air-supply system connected by an air-supply tube to a hand applicator a chamber containing the light-sensitive substances, which is integrated in the hand applicator.

34. A device according to claim 33, wherein the air pressure can be regulated and displayed on an instrument.

35. A device according to claim 33, wherein the length of the air impulses can be regulated by means of an electronic or manual valve-system.

36. A device according to claim 33, wherein the hand applicator contains a mechanical or electrical switch system to activate the treatment.

37. A device according to claim 33, wherein the hand applicator contains a valve by the air inlet.

38. A device according to claim 33, where the treatment head is exchangeable to suit the treatment area.

39. A device according to claim 33, where the treatment head is equipped with a skin contact sensor system to protect from excessive treatment.

40. A device according to claim 33, wherein the treatment head contains a valve-system which opens up automatically upon skin contact.

41. A device according to claim 33, wherein a chamber containing the light sensitive substance is integrated in the side of the treatment head.

42. A device according to claim 33, wherein the hand applicator contains a dosage pump for the light-sensitive substance.

43. A device according to claim 33, where the housing of the hand applicator is made of insulating material and the treatment head is made of a conducting material.

44. A device according to claim 33, where the treatment head is connected to the iontophoresis generator in the control mechanism and used as an iontophoresis electrode.

45. A device according to claim 33, where the patient, during the iontophoresis treatment, holds an electric conductor handle in his hand.

46. A device according to claim 33, where the iontophoresis amplitude and frequency can be regulated on the control mechanism.

47. A device according to claim 33, wherein the hand applicator contains at least one second light source connected to said pulse generator and at least one light outlet

48. A device according claim 33, wherein the hand applicator contains a printed circuit board equipped with semiconductor diodes and a feedback sensor.

49. A device according to claim 33, wherein the at least one light outlet is equipped with a mounted lens and/or polarization filter.

50. A method of treating tissue, comprising the steps of: introducing a photosensitive substance to the tissue;

determining when the tissue has absorbed a predetermined level of the photosensitive substance; and

irradiating the tissue with a device according to claim 1.

51. A method according to claim 50, wherein the photosensitive substance is one of photofrin, 5-aminolevulinic acid, hematoporphyrin, verteporfin, chlorins, phthalodicyanines, phenothiazine, benzoporphyrin-derivative mono acid-A (A TMPn), L-Phenylalanine.

52. A method according to claim 50, wherein the step of determining when the tissue has absorbed a predetermined level of the photosensitive substance consists in observing that the tissue undergoes a predetermined colour change when viewed under a predetermined illumination.

53. A method according to claim 52, wherein the predetermined illumination consists of an optic system and a fluorescent light source.

54. A device according to claim 28, wherein the printed circuit boards mounted with multiple light sources are placed in a housing formed like a normal round or oval light bulb.

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