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(54) **AESTHETIC METHOD OF BIOLOGICAL
STRUCTURE TREATMENT BY MAGNETIC
FIELD**

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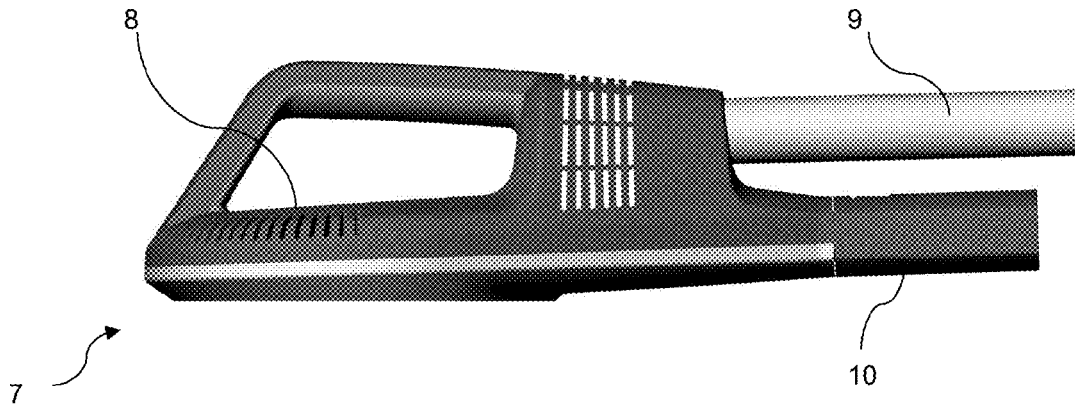
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(57) **ABSTRACT**

Methods and devices producing time varying magnetic field
treats a patient. The device contains a coil made of insulated
wires, an energy storage device, an energy source and a
switch. The coil is flexibly attached in a case. The device has
at least one blower for cooling the coil. The methods and
devices can be used in for example in physiotherapy, neu-
ropsychiatric therapy, aesthetic therapy, urology or urogy-
necology.



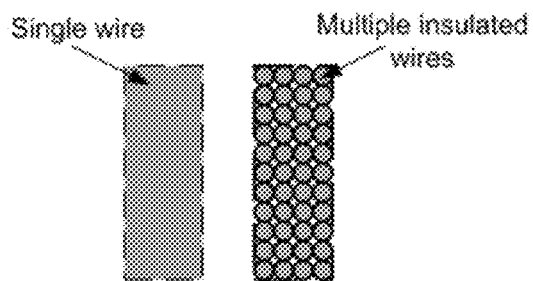


Fig. 1

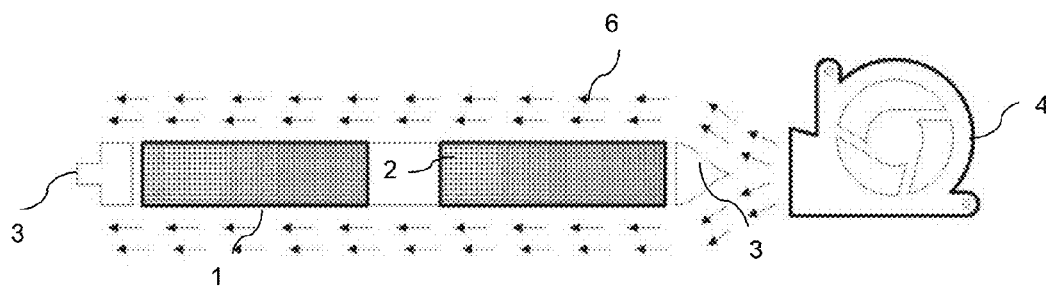


Fig. 2

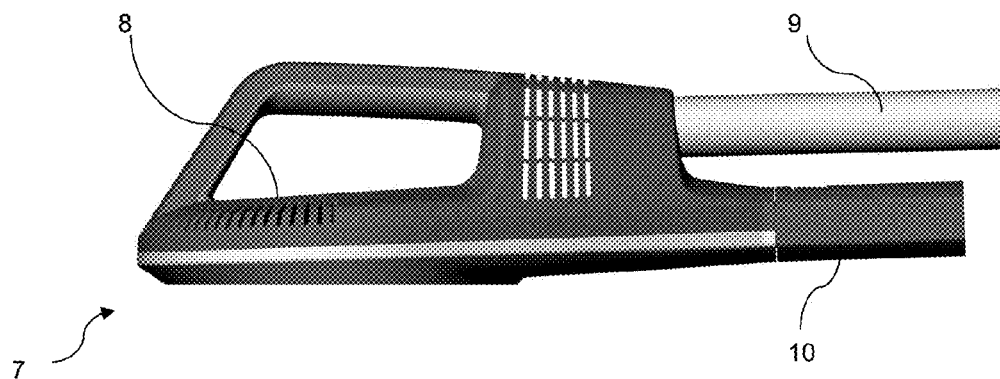


Fig. 3

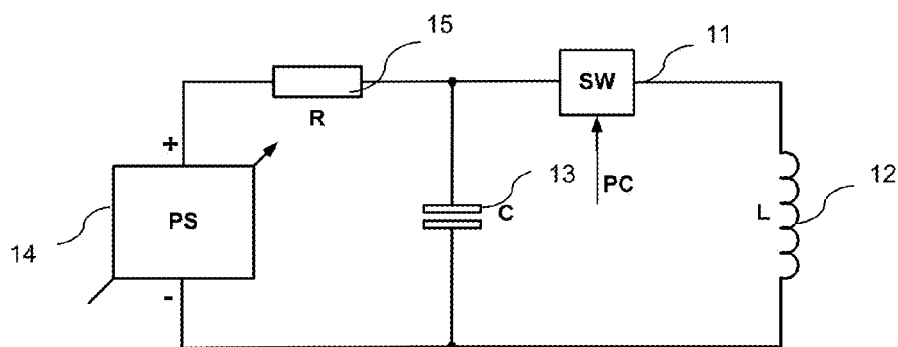


Fig. 4A

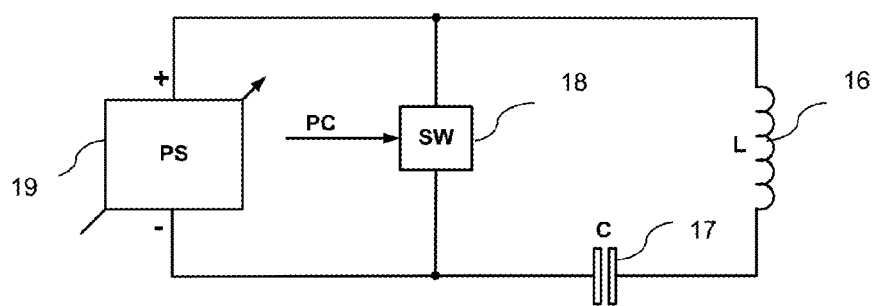


Fig. 4B

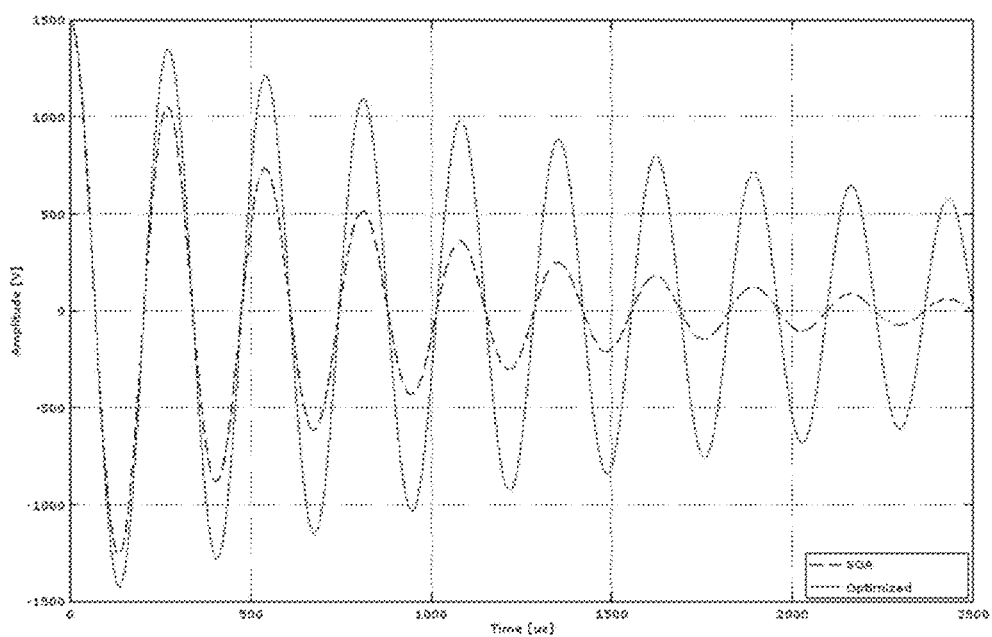


Fig. 5

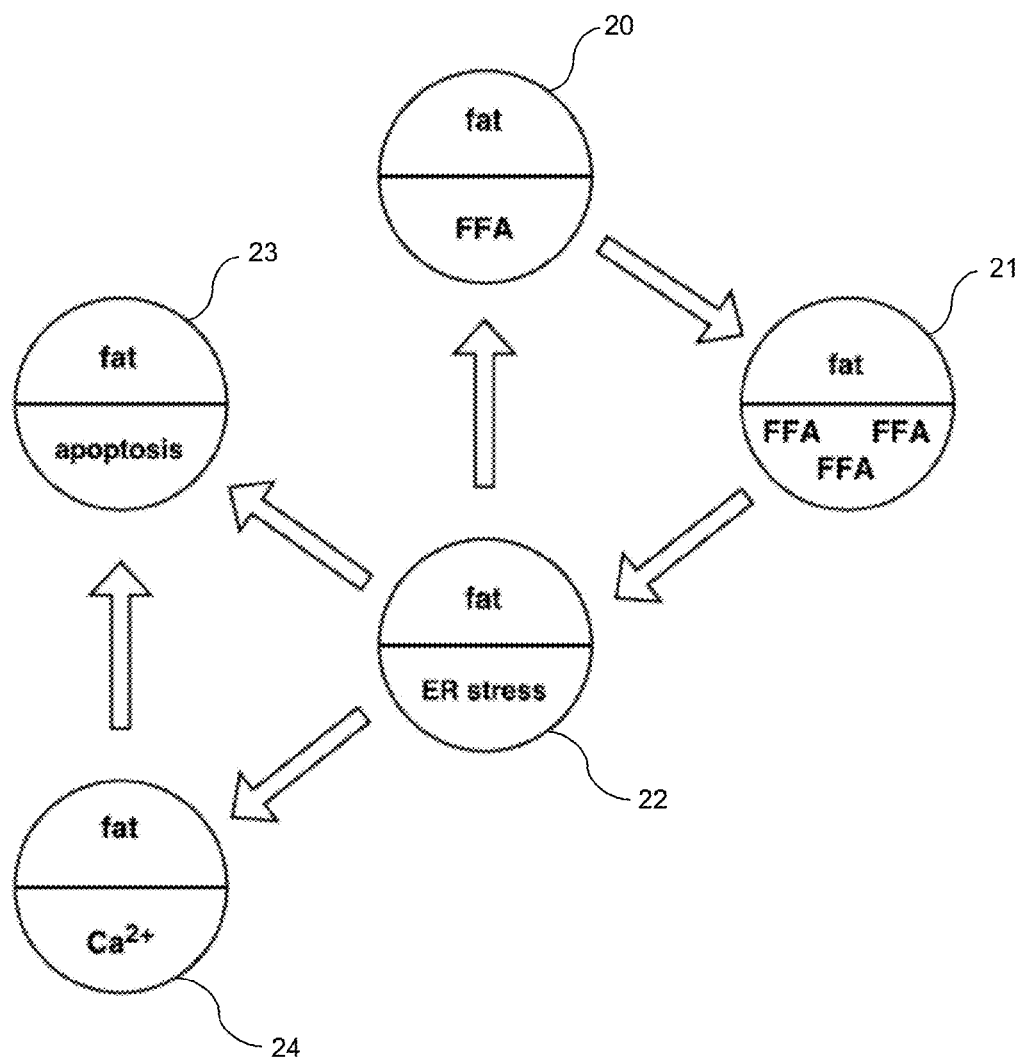


Fig. 6

AESTHETIC METHOD OF BIOLOGICAL STRUCTURE TREATMENT BY MAGNETIC FIELD

PRIORITY CLAIM

[0001] This application claims priority to U.S. Provisional Patent Application Nos. 62/357,679 filed Jul. 1, 2016 and now pending; 62/440,905 filed Dec. 30, 2016 and now pending; and 62/440,922 filed Dec. 30, 2016 and now pending. These applications are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention generally relates to methods using the influence of magnetic and induced electric field on biological structure. The magnetic field is time-varying and high powered therefore the method is based on a value of magnetic flux density sufficient to induce at least partial muscle contraction.

BACKGROUND OF THE INVENTION

[0003] Aesthetic medicine includes all treatments resulting in enhancing a visual appearance and satisfaction of the patient. Patients want to minimize all imperfections including body shape and effects of natural aging. Indeed, patients request quick, non-invasive procedures providing satisfactory results with minimal risks.

[0004] The most common methods used for non-invasive aesthetic applications are based on application of mechanical waves, e.g. ultrasound or shock wave therapy; or electromagnetic waves, e.g. radiofrequency treatment or light treatment, such as intense pulsed light or laser treatment. The effect of mechanical waves on tissue is based especially on cavitation, vibration and/or heat inducing effects. The effect of applications using electromagnetic waves is based especially on heat production in the biological structure.

[0005] Skin tissue is composed of three basic elements: epidermis, dermis and hypodermis or so called subcutis. The outer and also the thinnest layer of skin is the epidermis. The dermis consists of collagen, elastic tissue and reticular fibers. The hypodermis is the lowest layer of the skin and contains hair follicle roots, lymphatic vessels, collagen tissue, nerves and also fat forming a subcutaneous white adipose tissue (SWAT). The adipose cells create lobules which are bounded by connective tissue, fibrous septa (retinaculum cutis).

[0006] Another part of adipose tissue, so called visceral fat, is located in the peritoneal cavity and forms visceral white adipose tissue (VWAT) located between parietal peritoneum and visceral peritoneum, closely below muscle fibers adjoining the hypodermis layer.

[0007] Existing devices have low efficiency and they waste energy, which limits their use. Eddy currents induced within the coil create engineering challenges. Existing devices contain coils which are made of metallic strips, electric wires or hollow conductors. Since the therapy requires large currents, significant losses are caused by induced eddy currents within the coil. Eddy currents lead to production of unwanted heat and therefore there is need to sufficiently cool the coil. Also, the energy source must be protected during reverse polarity of resonance. This requires using protective circuits which consume significant amounts of energy.

[0008] Current magnetic aesthetic methods are limited in key parameters which are repetition rate and/or magnetic flux density. All known methods use low values of magnetic flux density and/or low repetition rates which does not allow satisfactory enhancement of visual appearance. As a result, new methods are needed to enhance the visual appearance of the patient.

[0009] The currently used aesthetic applications don't provide any treatment combining the effect of time-varying magnetic field treatment and conventional treatment, e.g. treatment by electromagnetic field such as radiofrequency treatment. The currently used radiofrequency treatment includes many adverse events such as non-homogenous thermal temperature, insufficient blood and/or lymph flow during and/or after the treatment. Additionally several adverse event such as panniculitis may occur after the treatment.

SUMMARY OF THE INVENTION

[0010] The present methods and devices as described below produce a time varying magnetic field for patient treatment which better optimizes energy use, increases the effectiveness of the treatments and provide a new treatment. The magnetic pulses may be generated in monophasic, biphasic or polyphasic regimes. In a first aspect, the device has one or more coils; a switch; an energy storage device and a connection to an energy source. The coil may be made of insulated wires with a conductor diameter less than 3 mm even more preferably less than 0.5 mm and most preferably less than 0.05 mm. Smaller diameter and individual insulation of the wires significantly reduces self-heating of the coil and therefore increase efficiency of magnetic stimulation device. The coil may be flexibly attached in a casing of device. The casing may comprise a blower or blowers which ensure cooling of the coil.

[0011] The present methods provide new aesthetic applications for focused remodeling of the patient's body. The coil of the magnetic stimulation device may be flexibly attached to casing of the device. The blower or blowers may be arranged to blow air on both sides of coil. Optionally, the coil may be a flat type coil.

[0012] The method of treating a biological structure uses a combination of non-invasive methods for enhancing human appearance. The invention utilizes electromagnetic field. Methods may be used for targeted remodeling of adipose tissue, focused treatment of cellulite, body contouring, skin tightening or skin rejuvenation. The invention relates to focused heating of the target tissue by electromagnetic waves, whereas the effect of focused heating of the target tissue is amplified by the effect of a magnetic treatment.

[0013] The magnetic treatment induces the muscle contraction at higher repetition rates and the contraction is stronger. Therefore the treatment is more efficient for reducing the number and/or volume of adipocytes and enhancing the visual appearance of the treated body region via targeted muscle contraction. Further the temperature homogeneity of is improved. Additionally, strong muscle contractions at higher repetition rates cause mechanical movement of all the layers in proximity of the contracted muscle. The methods therefore cause remodeling and/or neogenesis of the collagen and elastin fibers.

[0014] The methods enable new treatments by magnetic and/or electromagnetic field. The repetition rate of the

magnetic field is in the range of 1 to 300 Hz with high magnetic flux density up to 7 Tesla. The frequency of the electromagnetic field is 13.56 or 40.68 or 27.12 MHz or 2.45 GHz.

Glossary

[0015] Conventional non-invasive and/or invasive aesthetic medicine applications refer to aesthetic medicine applications based on application of mechanical waves, e.g. acoustic wave, ultrasound or shock wave therapy; or electromagnetic waves, e.g. radiofrequency or diathermy treatment or light treatment, such as intense pulsed light or laser treatment; or mechanical stimulation, e.g. positive or negative pressure, rollerball, massage etc.; or thermal treatment, e.g. cryotherapy; or electrotherapy method; or mesotherapy method and or any combination thereof.

[0016] Biological structure is at least one neuron, neuromuscular plate, muscle fiber, adipose cell or tissue, collagen, elastin, pigment or skin.

[0017] Remodeling target biological structure refers to reducing the number and/or volume of the adipocytes by apoptosis and/or necrosis, cellulite treatment, body shaping and/or contouring, muscle toning, skin tightening, collagen treatment, skin rejuvenation, wrinkle removing, reducing stretchmarks, breast lifting, lip enhancement, treatment of vascular or pigmented lesions of the skin or hair removing.

[0018] Body region includes muscle or muscle group, buttocks, saddlebags, love handles, abdomen, hips, thighs, arms, limb and/or any other tissue.

[0019] Muscle includes at least one of muscle fiber, muscle tissue or group, neuromuscular plate or nerve innervating the at least one muscle fiber.

[0020] Adipose tissue refers to at least one lipid rich cell, e.g. adipocyte.

[0021] Bolus refers to a layer of fluid material, e.g. water or fluid solution of ceramic particles, preferably enclosed in a flexible sac made of biocompatible material.

[0022] Impulse refers to a single magnetic stimulus.

[0023] Pulse refers to a period of treatment by a magnetic field of at least one magnetic stimulus and time duration of no stimulation, i.e. time duration between two impulses from rise/fall edge to next rise/fall edge.

[0024] Repetition rate refers to frequency of firing the pulses; it is derived from the time duration of a pulse.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] FIG. 1 is a cross section view of a coil winding.

[0026] FIG. 2 is a cross-section of a magnetic applicator.

[0027] FIG. 3 is a side view of a casing of a magnetic applicator.

[0028] FIGS. 4A and 4B illustrate circuits for providing high power pulses to a stimulating coil.

[0029] FIG. 5 is a graph showing voltage drop in the energy storage device

[0030] FIG. 6 is a diagram of a biological effect.

DETAILED DESCRIPTION

[0031] FIG. 1 illustrates a cross section of winding of a coil for a magnetic stimulation device. The coil may be constructed from litz-wire, wherein each wire is insulated separately. Each individual conductor is coated with non-conductive material so the coil constitutes multiple insulated wires. Unlike existing magnetic coil conductors, the present

coil is not made of bare wire e.g. litz-wire without insulation, or conductive tapes, conductive strips, or copper pipe with hollow inductors. The insulation of wires separately is a substantial improvement, since this leads to a significant reduction of the induced eddy currents. Power loss due to eddy currents, per single wire, is described by Equation 1 below. The small diameter of wires significantly reduces self-heating of the coil and therefore increases efficiency of the present magnetic stimulation device.

$$P_{EDDY} = \frac{\pi^2 \cdot B_p^2 \cdot d^2 \cdot f^2}{6 \cdot k \cdot \rho \cdot D}, \quad \text{Eq. 1}$$

[0032] where: P_{EDDY} is power loss per unit mass ($\text{W} \cdot \text{kg}^{-1}$); B_p is the peak of magnetic field (T); f is frequency (Hz); d is the thickness of the sheet or diameter of the wire (m); k is constant equal to 1 for a thin sheet and 2 for a thin wire; ρ is the resistivity of material ($\Omega \cdot \text{m}$); D is the density of material ($\text{kg} \cdot \text{m}^{-3}$).

[0033] The individual insulation of each wire reduces eddy currents. The individually insulated wires may be wound either one by one or in a bundle of individually insulated wires so as to form a coil, which will serve as a magnetic field generator. The coil provides an improvement in the efficiency of energy transfer in the LC resonant circuit and also reduces or eliminates unwanted thermal effects.

[0034] The coil may have a planar coil shape where the individually insulated wires may have cross-section wires with conductor diameter less than 3 mm even more preferably less than 0.5 mm and most preferably less than 0.05 mm. The wires are preferably made of materials with higher density and higher resistivity e.g. gold, platinum or copper. The diameters of the single wires should be minimal. On the other hand the total diameter should be maximal because of inverse proportion between the cross-section of all wires forming the coil and the electrical resistance. Therefore the ohmic part of the heat is then lower. Eq. 2 describes power loss of the coil:

$$P_R = \frac{\rho \cdot \frac{l}{S} \cdot I^2}{m} \quad \text{Eq. 2}$$

[0035] Where: P_R is the power loss heat dissipation (W); ρ is the resistance ($\Omega \cdot \text{m}$); l is the length of wire (m); S is the surface area (m^2); I is the current (A) and m is 1 kg of wire material.

[0036] Total power loss is (Eq.3):

$$P_{TOT} = P_{EDDY} + P_R, \quad \text{Eq. 3}$$

[0037] Where: P_{TOT} is the total power losses ($\text{W} \cdot \text{kg}^{-1}$); P_{EDDY} is the power dissipation of eddy currents ($\text{W} \cdot \text{kg}^{-1}$); P_R is the power loss heat dissipation ($\text{W} \cdot \text{kg}^{-1}$).

[0038] Dynamic forces produced by current pulses passing through the wires of the coil cause vibrations and unwanted noise. The individual insulated wires of the coil may be impregnated under pressure so as to eliminate air bubbles between the individual insulated wires. The space between wires can be filled with suitable material which causes unification, preservation and electric insulation of the system. Suitable rigid impregnation materials like resin, and

elastic materials like PTE can be also used. With the coil provided as a solid mass, the vibrations and resonance caused by movements of the individual insulated wires are suppressed. Therefore noise is reduced.

[0039] The coil may be attached to the case of the applicator, such as a hand held applicator of the magnetic stimulation device; build-in applicator in e.g. chair, bed; or stand-alone applicator e.g. on mechanical fixture. The attachment may be provided by an elastic material e.g., silicone, gum; or other flexible manner. Connection with the coil of the applicator's case can be ensured by several points. The several fastening points ensure the connection of the coil to the casing by flexible material so that the main part of the coil and the main part of the casing of applicator are spaced apart. The spacing should be at least 0.1 mm so that air can easily flow. The gap between the coil and the casing can be used either for spontaneous or controlled cooling. The coil may optionally be connected to the case of the applicator by only one fastening point. The fastening points eliminate vibrations of wires which could be transferred to housing of the applicator and therefore reduce noise of the magnetic stimulation device.

[0040] FIG. 2 is a cross-section of the magnetic applicator which allows better flow on the lower and upper sides of the coil and thus more efficient heat dissipation. The magnetic stimulation device includes a coil 1, the circuit wires 2 and the fastening points 3 for connection of the coil to the casing of the applicator (not shown). The fastening points 3 are preferably made of flexible material however the rigid material may be used as well. The fastening points 3 may be located on the outer circumferential side of the coil. However, alternatively it is possible to put these fastening points to a lower or upper side of the coil.

[0041] The fastening points 3 connect the coil to the case of the applicator in at least one point. The fastening points 3 maintain the coil and the main part of the case of the applicator spaced apart so that fluid (which may be air or any liquid) can flow between them. At least one blower 4 can be placed around the circumference of the coil, or perpendicular to the coil. The blower can be any known kind of device for directing the fluid e.g. outer air directed into the case of the applicator. This arrangement of the blower allows air to bypass the coil from upper and lower (patient's) sides. In still another embodiment the outer air can be cooled before directing into the case. The blower can have an inlet placed around the circumference of the coil for injecting air, to remove heat from the coil. A connecting tube (not shown) can ensure connection of the applicator 5 with the energy source and/or control unit of magnetic stimulation device. The connecting tube may also contain a conduit of the fluid.

[0042] The arrows 6 indicate the air flow through the applicator 5. This arrangement of the blower allows the air to bypass the coil from upper and lower (patient's) side. Outlet may be preferably placed on upper side of the casing. By placing the blower around the circumference of the coil instead of on the top/below the coil, the blower 4 does not interfere with the magnetic flux peak and therefore its lifespan and reliability is increased.

[0043] FIG. 3 is an illustrative embodiment of a casing of the magnetic applicator. The overview drawing contains casing itself 7, which might contain an outlet 8 preferably placed on upper side of the casing 7. A connecting tube 9 may not only ensure connection of the applicator with the energy source and/or control unit of magnetic stimulation

device, but also connection to a source of the fluid; however the conduit of the fluid 10 may also be connected separately.

[0044] FIG. 4A and FIG. 4B illustrate circuits for providing high power pulses to the stimulating coil. FIG. 4A shows a circuit for providing high power magnetic pulses. FIG. 4B shows a circuit for providing high power pulses.

[0045] The state of art magnetic stimulation device achieves magnetic flux density of a few tenths to several ones of Tesla. To achieve this level of magnetic flux density, the energy source used generates sufficient voltage. This voltage can reach thousands of volts. In FIG. 4A the circuits for providing high power pulses to the stimulating coil contain a series connection to the switch 11 and the coil 12. The switch 11 and the coil 12 together are connected in parallel with an energy storage device 13. The energy storage device 13 is charged by the energy source 14 and the energy storage device 13 then discharges through the switching device 11 to the coil 12.

[0046] During second half-period of LC resonance, the polarity on the energy storage device 13 is reversed in comparison with the energy source 14. In this second half-period, there is a conflict between energy source 14, where voltage on positive and negative terminals is typically thousands of Volts. The energy storage device 13 is also charged to the positive and negative voltage generally to thousands of Volts. As a result, there is in the circuit, consequently, twice the voltage of the energy source 14. Hence the energy source 14 and all parts connected in the circuit are designed for a high voltage load. Therefore, the protective resistors and/or protection circuitry 15 must be placed between energy source 14 and energy storage device 13. Disadvantage of state of art solution is large amount of energy transformed to undesired heat in protective resistors and/or protection circuitry 15.

[0047] FIG. 4B shows a circuit for providing high power pulses for improved function of the magnet stimulation device. The coil 16 and an energy storage device 17 are connected in series and disposed in parallel to the switch 18. The energy storage device 17 is charged through the coil 16. To provide an energy pulse, controlled shorting of energy source 19 takes place through the switch 18. In this way the high voltage load at the terminals of the energy source 19 during the second half-period of LC resonance associated with known devices is avoided. The voltage on the terminals of energy source 19 during second half-period of LC resonance is a voltage equal to the voltage drop on the switch 18.

[0048] The switch 18 can be any kind of switch such as diode, MOSFET, JFET, IGBT, BJT, thyristor or their combination. Depending on the type of component the load of energy source 19 is reduced to a few Volts, e.g., 1-10 volts. Consequently, it is not necessary to protect the energy source 19 from a high voltage load, e.g., thousands of Volts. The use of protective resistors and/or protection circuits is reduced or eliminated. The present designs simplify the circuits used, increase efficiency of energy usage and provide higher safety.

[0049] FIG. 5 show an exponential voltage drop in the energy storage device. Energy savings during time-varying magnetic therapy may be characterized by reduced voltage drop in the energy storage device between the first, second and subsequent maximums of the resonant oscillation. The magnitude of the individual voltage oscillations is exponentially dampened up to establishing the energy balance. This allows increasing the maximum possible frequency/repeti-

tion rate of magnetic pulses, since the frequency/repetition rate is dependent on the speed with which it is possible to recharge the energy storage device. Since the energy storage device is recharged by the amount of energy loss during the previous pulse, it is possible to increase the frequency/repetition rate of the device up to hundreds of magnetic pulses per second without the need to increase the input power. The voltage drop between any of the successive amplitudes is not higher than 21%, even more preferably not higher than 14% and most preferably not higher than 7%.

[0050] The device can be used for treatment/successive treatments in continual, interrupted or various duty cycle regime. The duty cycle may be higher than 10%, which means interrupted regime with the ratio up to 1 active to 9 passive time units. The ratio may possibly change during the therapy. The device enables operation defined by the peak to peak magnetic flux density on the coil surface at least 3 T, more preferably at least 2.25 T, most preferably at least 1.5 T at repetition rates above 50 Hz, more preferably at repetition rates above 60 Hz, even more preferably at repetition rates above 70, most preferably at repetition rates above 80 Hz with treatment/successive treatments lasting several seconds or longer, for example, for at least 5, 10, 30, 60, 120 or 240 seconds, or longer. The total power consumption is below 1.3 kW and the width of pulses is in the range of hundreds of μ s.

[0051] The device enables achieving repetition rates above 100 Hz, more preferably repetition rates above 150 Hz, most preferably repetition rates above 200 Hz with the magnetic flux density providing a therapeutic effect on neurons and/or muscle fibers and/or endocrine cells (e.g. at least partial muscle contraction, action potential in cell). Based on achievement of repetition rates in order of few hundreds the device also enables assembling the magnetic pulses into the various shapes (e.g. triangular, rectangular, exponential), with the shape widths from 6 ms to several seconds or longer.

[0052] During last few decades patient have not only wanted to be in good health, they have also wanted to look well, i.e. to be well shaped, without any unattractive fat and to have a young appearance, without wrinkles, stretchmarks or sagging breasts. This has resulted in a progressive evolution of invasive aesthetic methods such as surgical removing of fat and remodeling the human body by invasive and potentially dangerous methods, e.g. liposuction or inserting implants into human body. The side effects of invasive methods may be scars, swelling or bruising. The side effects resulted in the rapid progress in non-invasive method, e.g. lipolysis or removing skin imperfections. One example of the last few years may is rapid increase of patients' demand for enhancing the visual appearance of buttocks. This has resulted in a higher percentage of these operations by plastic surgeons.

[0053] Electric current may be induced in the treated biological structure during pulsed magnetic treatment. Due to the high value of magnetic flux density the biological structure may be targeted and treated more specifically. A distribution of magnetic field is uniform in the biological structure. Particles (e.g. atoms, ions, molecules etc.) in the biological structures are influenced by the magnetic field and permeability of a cell membrane may also increase.

[0054] Due to increased permeability of the cell membrane, the pulsed magnetic treatment may induce following effects: at least partial muscle contraction; reduction of

adipose tissue—volume and/or number of the adipose cells; neogenesis and/or remodeling of collagen and/or elastin fibers. Further magnetic treatment may improve circulation of blood and/or lymph and improve local and/or adipose tissue metabolism.

[0055] With the present methods, factors for enhancing visual appearance of the body include: treatment of major muscle, e.g. gluteus maximus; treatment of deep muscle which may be enabled by high value of magnetic flux density; non-contact application of magnetic flux density, it may be applied even through clothing; stronger muscle contraction due to higher value of magnetic flux density; higher-quality of muscle targeting; treatment may not be influenced by small movements during treatment; treatment time duration may be shortened due to high value of magnetic flux density and/or higher repetition rate; no delays may occur.

[0056] It is to be understood that the method is not limited to the particular applications and that the method may be practiced or carried out in various ways.

[0057] Present method may be applied for enhancing the visual appearance of body parts including or proximate to major muscle structures. Further the method may be applicable for enhancing the visual appearance of patients with high value of BMI. The patient may be preferably healthy without any life-threatening conditions such as circulatory system disease, e.g. deep vein thrombosis. The present method is not limited to the application of the treatment to major muscle. Muscles other than major muscles may be treated as well.

[0058] The applicator of magnetic treatment may be placed proximate to the patient's body. As used here, proximate to includes both contactless and in actual contact with the skin of the patient. The muscles may be selectively treated and the magnetic flux density may be adjusted following the patient's feeling or needs. The treatment time may be shortened due to selective treatment of the correct muscles. Additionally, due to the high value of magnetic flux density, the muscle may be treated more effectively. Further, the treatment may be non-invasive or even preferably contactless due to the high value of magnetic flux density. The patient may be treated without removing clothing, reducing patient discomfort. Additionally, following the high efficiency of the muscle contraction the collagen and/or elastin fibers above the muscle structure may be remodeled, hence the visual appearance may be enhanced.

[0059] The position of the patient may correspond to treated biological structure and/or body region. The patient may be treated in seated position. Alternatively, the patient may be treated in lying position, e.g. in supine position. Treatment in lateral recumbent position may be also applicable. Patient may be in prone position as well.

[0060] In the preferred application the treatment method may be applied to body regions prone to cellulite and/or prone to adipose accumulation, such as thighs, saddlebags, buttocks, abdomen, region of love handles, region of bra fat or arm. The adipose accumulation may be influenced by number and/or volume of adipose cells.

[0061] The magnetic treatment of the biological structure may have various applications for enhancing visual appearance of the contour of a body region. High density magnetic field reaching such values which may be used for: adipose tissue reduction, wherein the adipose tissue reduction may be achieved by reduction of number and/or volume of

adipose cells; muscle toning, wherein the muscle appearance enhancement may be achieved by adipose tissue reduction with no muscle bulking; muscle shaping, wherein the muscle appearance enhancement may be achieved by adipose tissue reduction and/or muscle bulking; body contouring, wherein the silhouette appearance enhancement may be achieved by adipose tissue reduction with no muscle bulking; body shaping, wherein the silhouette appearance enhancement may be achieved by adipose tissue reduction and/or muscle bulking; skin tightening, wherein the skin appearance enhancement may be achieved by obtaining smoother and younger appearance, including wrinkles reduction; cellulite treatment, wherein the appearance enhancement may be achieved by adipose tissue reduction, muscle contraction and/or elastic fibers neogenesis; circumferential reduction, wherein the reduction may be achieved by adipose tissue reduction and/or the muscle bulking; breast enhancement, wherein the appearance enhancement effect may be achieved by elevation or shape modification; lip enhancement, wherein the lip appearance enhancement may be achieved by obtaining fuller and firmer appearance. The body region may be reduced in overall size. Further aesthetic effects may be achieved, e.g. connective tissue improvement, fat disruption, muscle volumization, muscle forming, muscle toning, muscle remodeling, contouring, sculpting or body sculpting.

[0062] In the methods described, the magnetic stimulation device may or may not include a magnetic core. The magnetic stimulation device may be cooled by fluid, e.g. by air. Total power consumption of the magnetic stimulation device may be below 1.3 kW. A magnetic stimulation device as described in the U.S. patent application Ser. No. 14/789,156 or U.S. patent application Ser. No. 14/789,658, incorporated herein by reference, may be used.

[0063] The applicator for magnetic treatment may be placed proximate to the patient's body. The magnetic flux density may be applied into the target biological structure. Electric current may be induced and treat the neuromuscular plate and/or the nerve innervating the at least one muscle fiber. The treatment may cause at least a partial muscle contraction.

[0064] Furthermore, the present invention discloses the advanced approaches in aesthetic applications, e.g. for cellulite treatment and/or body shaping. Combined methods of treatment by electromagnetic field and treatment by magnetic field are used. The electromagnetic field may include treatment by radiofrequency, infrared or optical waves. The magnetic treatment may be provided by permanent magnets, electromagnetic devices generating a static magnetic field or time-varying magnetic devices. In the preferred application the treatment by a pulsed magnetic field and radiofrequency treatment may be combined. However the application is not limited by the recited combination so the combined method may include magnetic treatment and any treatment by electromagnetic field, e.g. light treatment, IR treatment or treatment by radiofrequency waves, e.g. microwaves, short waves or long waves. The magnetic treatment may also be provided with thermal treatment, e.g. heating and/or cooling.

[0065] A device described in U.S. patent application Ser. No. 14/278,756 incorporated herein by reference may be used for application of the present methods. The device may exclude the balun transformer, or the balun transformer may be included in transmatch. The possible methods of treatment by combined methods are described below.

[0066] Magnetic treatment in combination with radiofrequency treatment may be applied by two independent treatment devices, e.g. one device for treating the biological structure by radiofrequency waves and second device for treating the biological structure by magnetic field. Both devices may have a separate applicator for treating the biological structure, or one applicator may be used by at least two devices, i.e. the applicator may be modular for a plurality of devices.

[0067] The device may include at least one HF frequency generator for providing energy for radiofrequency treatment and for providing energy for magnetic treatment. In an alternative embodiment, the device may include at least one HF frequency generator for providing energy for radiofrequency treatment and at least one other independent frequency generator for providing energy for magnetic treatment. The device may include plurality of applicators for providing separate radiofrequency or magnetic treatments to the patient.

[0068] In alternative embodiment the applicator may provide a combination of radiofrequency and magnetic treatment. In one embodiment, the applicator may include at least one radiofrequency electrode for providing radiofrequency treatment and at least one magnetic field generating device, e.g. a coil, for providing magnetic treatment. In another embodiment, the applicator may include at least one electrode for providing radiofrequency treatment and at least one magnetic field generating device providing magnetic treatment, wherein the at least one RF source provides energy for both at least one electrode and at least one magnetic field generating device.

[0069] In still another embodiment the at least one RF source may provide the energy for the at least one magnetic field generating device providing magnetic treatment wherein the at least one magnetic field generating device may be used as the at least one electrode. The essence is the far different stimulation frequencies which are used for RF treatment and magnetic treatment. The magnetic field generating device in the high frequency field is similar to the electrode. This enables the magnetic field generating device to be the electrode for radiofrequency treatment. In the preferred embodiment a flat coil may be used as the electrode.

[0070] The frequencies for the radiofrequency treatment may be in the range of ones of MHz to hundreds of GHz, more preferably in the range of 13 MHz to 3 GHz, most preferably around 13.56 or 40.68 or 27.12 MHz or 2.45 GHz. The term "around" should be interpreted as in the range of 5% of the recited value. The impulse frequencies for the magnetic treatment may be in the range of hundreds of Hz to hundreds of kHz, more preferably in the range of ones of kHz to tens of kHz, most preferably up to 10 kHz. However the repetition rate of the magnetic impulses may reach up to 700 Hz, more preferably up to 500 Hz, most preferably in the range of 1 to 300 Hz, e.g. at least 1, 5, 20, 30, 50, 100, 140 or 180 Hz. The magnetic flux density of the magnetic treatment may be at least 0.1, 0.8, 1, 1.5, 2, 2.4 or up to 7 Tesla on the coil surface. The treatment/successive treatments may last several seconds, e.g. at least 5, 10, 30, 60, 120 or 240 seconds, or longer, e.g. at least 20, 30, 45, 60 minutes. The impulse duration may be in the range of tens to hundreds of μ s. The magnetic stimulation device may emit no radiation.

[0071] Cellulite is an effect of skin change resulting in orange peel appearance. The cause of the cellulite is orientation of collagen fibers in so called “fibrous” septae. The fibrous septae contract and harden over time creating a dimple effect. Additionally, blood and lymphatic vessels lack circulation due to the contraction and hardening of the septae. The lymph flow may be blocked resulting in swelling. Another cause of cellulite may be adipose cells protruding to dermis. Cellulite may be treated by the recited methods.

[0072] One application of time-varying magnetic field for enhancing the visual appearance of body region may be treatment of a muscle by magnetic flux density for reducing the cellulite. The magnetic flux density may be delivered through the skin to the neuromuscular plate and/or nerve innervating at least one muscle fiber. The electric current may be induced in the target biological structure causing at least partial muscle contraction. The at least partial muscle contraction may cause the movement of the skin and all the biological structures subtending epidermis. Additionally, the at least partial muscle contraction may improve blood circulation by itself, or via the movement of the muscle in the vicinity including fibrous septae. Additionally, blood and/or lymph circulation may be improved in the layers subtending epidermis since the muscle contraction may move the fibrous septae. Also local and/or adipose tissue metabolism may be improved.

[0073] The lymph flow may be improved by at least partial muscle contraction which may provide effect similar to manual massage. The improved lymph flow may improve local metabolism and/or immune system. The improved lymph flow may contribute to purer lymph due to faster delivery of the lymph to the lymph nodes where the lymph may be cleared.

[0074] The present method may provide a massage effect via the treatment which may be caused by the at least partial muscle contraction. Therefore the massage effect may be achieved by contactless methods instead of manual massage techniques or soft tissue techniques. The massage effect may improve lymph circulation.

[0075] In another aspect, improvement of functionality and/or the appearance of the muscle may be achieved with results similar to body exercise. The results may be achieved by application of high magnetic flux density to the body region and inducing at least partial muscle contraction. Higher values of magnetic flux density applied may result in a stronger muscle contraction. The patient may feel firmer and tighter.

[0076] With the present method muscle contractions induced by the applied magnetic flux density may help to tone the muscle providing a more attractive appearance. As the muscle structure is treated by time-varying magnetic field the entire limb may be moved due to the high power of the magnetic treatment. Nevertheless, the method is not limited to the applications to the limbs and the method is able to treat any muscle, e.g. gluteus maximus or any muscle/deep muscle to induce body contouring and/or body shaping effect and fat burn. Additionally, shortened and/or flabby muscles may be stretched. The physical fitness of the patient may be improved as well.

[0077] The magnetic field may treat various body regions, e.g. thighs, buttocks, hips, abdomen or arms. The muscles

may be shaped to enhance visual appearance of the treated body region. The body part may obtain enhanced visual appearance of its contour.

[0078] The magnetic field may treat at least one muscle of lower limb, particularly the parts which are prone to cellulite such as thighs or saddlebags. The time-varying magnetic field may induce at least partial muscle contraction in different muscle and/or muscle group. Following the position and/or orientation of the magnetic field generating device the anterior, posterior and/or medial compartment of the thigh may be treated. The anterior compartment includes sartorius muscle, rectus femoris muscle, vastus lateralis muscle, vastus intermedius muscle, vastus medialis muscle. Posterior compartment includes biceps femoris muscle, semitendinosus muscle and semimembranosus muscle. Medial compartment includes pectineus muscle, external obturator muscle, gracilis muscle, adductor longus muscle, adductor brevis muscle and adductor magnus muscle.

[0079] The treatment may cause circumferential reduction of thighs. Further the muscle may obtain enhanced visual appearance, thigh may be well-shaped. Thigh contour may be enhanced as well.

[0080] The at least one surrounding body region may be treated as well, e.g. buttocks.

[0081] In one application, the treatment may induce the same effect as muscle exercising of buttocks. During the treatment of buttocks the magnetic field may be targeted to treat of muscles shaping the buttocks, e.g. tensor fasciae latae muscle or at least one of gluteal muscles: maximus, medius or minimus. In one preferred application all three gluteal muscles may be treated. Further other muscles may be treated, e.g. abdominal muscles, spinal muscles and/or thoracic muscles. By the complex treatment and muscle contraction in the body region the treated muscles may be strengthened, toned, the cellulite may be reduced and dimples may be removed. Buttocks and even the patient's figure may be enhanced in visual shape appearance and may become more attractive. Buttocks become well-shaped, round, firm, well-trained, toned, smoother, tight and lifted. The complex treatment may reduce hips, make perfect round and lifted buttocks, increasing the self-confidence of the patient

[0082] The treatment may be more efficient than standard workout in fitness since the fitness machines strengthen only the isolated muscles. The results may be achieved in very short-time periods with minimal time of treatment. Without being limited, it is believed that the exercising of the gluteus medius may reduce the volume of the buttocks; exercising of the gluteus maximus may shape and/or lift the buttocks; exercising of the gluteus minimus may lift the buttocks.

[0083] In the preferred application the magnetic treatment may be combined with other treatment methods using different approaches, e.g. conventional non-invasive treatments. The combined treatment may be applied to the surroundings tissues around buttocks to reduce the cellulite around the buttocks and enhance the shape of the enhanced appearance of the buttocks. The surrounding tissues may be represented by e.g. abdomen, love handles, thighs or saddle bags.

[0084] The magnetic field may treat at least one muscle responsible for silhouette of the body. The time-varying magnetic field may induce at least partial muscle contraction in different muscle and/or muscle group responsible for silhouette in the region of abdomen, love handles and/or bra

fat. Following the position and/or orientation of the magnetic field generating device rectus abdominis muscle may be treated. Alternatively latissimus dorsi muscle, abdominal internal oblique muscle, abdominal external oblique muscle, transverse abdominal muscle and/or *pyramidalis* muscle may be treated by the time-varying magnetic field.

[0085] The treatment may cause circumferential reduction in the region of belly, hips and/or love handles. Alternatively the treatment may tighten at least one of these body parts. Further the muscles may obtain enhanced visual appearance, belly may be well-shaped. Repetitive application may even reach in a six-pack look. The at least one surrounding body region may be treated as well, e.g. buttocks.

[0086] The magnetic field may treat at least one muscle of upper limb, particularly the parts which may be prone to cellulite such as arm. The time-varying magnetic field may induce at least partial muscle contraction. Following the position and/or orientation of the magnetic field generating device the at least partial muscle contraction may occur in biceps brachii muscle, brachialis muscle, coracobrachialis muscle and/or triceps brachii muscle.

[0087] The treatment may cause circumferential reduction of the arm. Further the muscle may obtain enhanced visual appearance, arm may be well-shaped. Arm contour may be enhanced as well.

[0088] The at least partial muscle contraction may be more efficient for adipose tissue metabolism as the value of magnetic flux density increases since the muscle contraction may be stronger. The higher magnetic flux density may treat the higher number of muscle fibers contraction and the more adipose tissue may be reduced. Therefore the visual appearance of regions prone to cellulite may be enhanced.

[0089] Treatment by time-varying magnetic field may induce lipolysis. Adipose tissue may be reduced by decreasing the number and/or volume of adipose cells. Promoted adipose cell metabolism may increase as the value of magnetic flux density increases. The treatment may release free fatty acids (FFA) from at least one adipose cell. The increased concentration of FFA may influence a homeostasis of the adipose cell. A disruption of the homeostasis may cause a dysfunction of the adipose cell. The dysfunction may be followed by stress for endoplasmic reticulum (ER stress). ER stress may cause additional lipolysis and/or apoptosis of the at least one adipose cell.

[0090] Furthermore, ER stress may cause increase of intracellular calcium ions (Ca^{2+}) which may promote an apoptotic process and may continue into controlled cell death of the adipose cell. The apoptosis may be induced by Ca-dependent effectors, e.g. calpain or caspase-12. Endogenous ligands or pharmacological agents, such as vitamin D, may induce prolonged cytosolic calcium increase. Vitamin D may influence release of Ca^{2+} from endoplasmic reticulum. Hence the effect of treatment may be enhanced by application of vitamin D and/or Ca^{2+} prior, during and/or after the treatment. The most significant effect may be achieved by application of both, Ca^{2+} and vitamin D, prior the treatment to provide all factors influencing adipose cell apoptosis.

[0091] Alternatively, increased level of Ca^{2+} may induce autophagy within adipose cell as well. Autophagy is self-eating process of cellular organelles to produce energy and it may proceed into cell death. Autophagy may be induced by ER stress or it may be induced via Ca^{2+} signaling.

[0092] FIG. 6 illustrates pathways which may induce apoptosis of the at least one adipose cell. FFA may accumulate in the at least one adipose cell (20). The magnetic field may induce lipolysis (21), i.e. a release of FFA from adipose tissue. Accumulated FFA may reach a threshold when adipose cell is unable to utilize FFA. A dysfunction of the adipose cell may occur. The adipose cell may react on the dysfunction by ER stress (22). ER stress may induce lipolysis hence additional release of FFA may occur (20). ER stress may cause apoptosis of the adipose cell (23). Furthermore, the ER stress may release Ca^{2+} (24) which may contribute the apoptosis (23).

[0093] The effect of the treatment by magnetic field for adipose tissue reduction may be influenced by various biological processes and/or pathways as recited above. The processes and/or pathways may be synergic hence the adipose tissue reduction may be accelerated and/or more efficient.

[0094] The method may cause the circumferential reduction i.e. a reduction of the size of the treated body region. The method may be mostly indicated for the regions with cellulite, particularly for thighs, buttocks, saddlebags, love handles, abdomen, hips and/or arms. However, the indication is not limited to the mentioned regions and the method may be used for treatment of any other body region.

[0095] Furthermore, the method may reduce BMI of the patient.

[0096] The target structure may be treated by combined methods which may be used for remodeling the adipose tissue, body shaping and/or contouring, muscle toning, skin tightening, skin rejuvenation, wrinkle removing, reducing stretchmarks, breast lifting, lip enhancement or treatment of cellulite in general by application of electromagnetic radiation to target structure to selectively heat the target tissue to remove and/or remodel adipose tissue from the target tissue. The second approach is to transmit a magnetic treatment to the target structure, inducing at least partial muscle contraction within the target structure to remodel the adipose tissue by natural adipose tissue catabolism. Adipose tissue catabolism may be caused by apoptosis or necrosis of the adipocytes. The muscle contraction caused by induced eddy current is the same as a natural contraction. The adipose tissue may be reduced in natural way. Additionally, the muscle may be shredded in a natural way. Therefore the effect resulting in body shaping and/or contouring may be significantly improved.

[0097] The combination of the recited method may improve currently used applications in various aspects and the effect of the treatments may be significantly enhanced. The application of a radiofrequency electromagnetic field may be combined with application of a magnetic field applied before, simultaneously or after the radiofrequency treatment. The application of a magnetic field may induce many benefits for radiofrequency treatment, such as applications inducing at least partial muscle contraction, myorelaxation effect or analgesic effect. The perfusion or metabolism may be improved as well.

[0098] The at least partial muscle contraction may induce enhanced effects on adipose tissue reduction by catabolism of the adipose tissue and burning energy from adipose tissue. The total adipose tissue reduction effect may be enhanced by radiofrequency treatment.

[0099] Additionally, the at least partial muscle contraction may improve a blood flow and/or perfusion in the treated

body region. The improved blood flow may be caused by activation of muscle pump and/or by the muscle necessity of more oxygen due to the at least partial contraction. Due to increased blood flow and/or local perfusion, the risk of overheated muscle may be limited or even eliminated. Further the homogeneity of the thermal field induced by thermal effect of radiofrequency treatment may be significantly enhanced and/or the temperatures may be well-balanced/compensated in the target body region. Still another benefit may be prevention of creation any hot spot caused by steep thermal gradient.

[0100] Due to improved blood flow, perfusion and/or lymph flow the metabolism may be improved. Additionally, the effect of radiofrequency treatment may be enhanced by improved metabolism, e.g. cellulite treatment, body shaping and/or contouring, skin tightening or skin rejuvenation. Further benefit may be reducing or eliminating the risk of panniculitis or local skin inflammation since any clustering of the treated adipocytes may be prevented by the improved metabolism. The improved blood and/or lymph flow may contribute the removing of the adipocytes. The removing of the adipocytes may be promoted by higher number of cells phagocytosing the adipocytes as well. Synergic effects of magnetic and RF treatment may significantly improve metabolism. Therefore the possibility of adverse event occurrence may be limited and treatment results induced by the present invention may be reached in shorter time period.

[0101] Further the at least partial muscle contraction may improve the movement of lymphatic vessel and the lymph flow may be improved.

[0102] In the preferred application the RF and/or magnetic field may be modulated. In the most preferred application both treatments are modulated. The magnetic treatment may be modulated in the magnetic flux density domain, repetition rate domain, or impulse duration domain, to provide different treatment effects and to prevent adaptation of the target biological structure. The radiofrequency treatment may be modulated in the frequency domain, intensity domain and/or time domain to reach the most complexity and/or efficiency of the target treated biological structure. The modulation in the time domain may be changing the active and passive periods of stimulation, e.g. the radiofrequency treatment may include period with no stimulation, i.e. the radiofrequency treatment may be not continual but the treatment may be provided in pulses. The periods of no stimulation may vary and may be adjusted by the operator. Due to modulation during the treatment, different target biological structures may be treated in the different depth.

[0103] The application may be contact or in the preferred application the treatment may be applied contactless. Contactless application may avoid all biocompatibility factors which may occur during contact treatment. In the most preferred application the treatment may be provided by self-operated device. Hence the continual surveillance and/or control by the operator may not be essential for correct and/or safe operation of the treatment device. Self-operated treatment may be provided by a hand-held applicator or the applicator may be fixed to stand-alone device. The self-operated treatment may be also enabled using various types of sensors in communication with the device for monitoring the treatment and/or the patient. The at least one sensor may be e.g. reactive sensor, electrochemical sensor, biosensor, biochemical sensor, temperature sensor, sorption sensor, pH sensor, voltage sensor, sensor for measuring distance of

applicator from the patient surface and/or from the treated area, position sensor, motion detector, photo sensor, camera, sound detector, current sensor, sensor for measuring of specific human/animal tissue and/or any suitable sensors measuring biological parameters and/or combination thereof such as sensor for measuring dermal tensile forces, sensor for measuring the activity of the muscle, muscle contraction forces, tissue impedance or skin elasticity.

[0104] Further the homogeneity of the treatment may be improved by several approaches. A first approach may be represented by a moveable applicator providing the dynamic treatment to a large target area. The dynamic treatment may improve the homogeneity of applied treatment energy and additionally due to large area the effect is uniform and/or well balanced. Static positioning of the applicator may be used as well. Another approach of improving homogeneity may be represented by using a bolus. The bolus may provide improved transmittance of the electromagnetic energy to the treated biological structures. Additionally, the bolus may prevent occurrence of hot spots within the treated area; the bolus may provide constant temperature to the target treated surface area; or the bolus may increase the homogeneity of the radiofrequency waves application by providing a homogenous medium for electromagnetic waves propagation not being influenced by the interface of the target treated area and an air. The bolus may profile the electromagnetic field to enhance the effect of the treatment. In still another approach an air gap may be between the applicator and the patient.

[0105] The treatment by magnetic and/or electromagnetic field may be in continuous or discrete mode. In one application the magnetic treatment may be applied in continual mode with no pauses and the electromagnetic treatment may be applied in pulsed mode to provide improved adipose tissue reduction caused by natural process and by the increased temperature. In another application the electromagnetic treatment may be applied continuously with no pauses and the magnetic treatment may be applied in pulsed mode to provide improved thermal reduction of adipose tissue and by improved metabolism due to improved blood flow. Both modes may be combined in various treatment sequences.

[0106] In the preferred application the treatment may be started at the moment when the target biological structure reaches the predetermined temperature. The temperature in the target tissue may be up to 80° C., more preferably in the range of 37 to 60° C., even more preferably in the range of 40 to 45° C. The temperature may be adjusted based on the intended use, e.g. adipose tissue reduction, collagen production or muscle contraction. In an alternative application the intended use may be coagulation and/or ablation. The temperature in the target biological structure may be measured by invasive method, e.g. using an invasive probe; or by contact method, e.g. using thermocouple sensor; or by contactless method, e.g. using infrared sensor or camera. The temperature of the target biological structure may be determined by a mathematic method. The sensor for measuring the temperature in the target biological structure may be attached to the applicator.

[0107] A benefit of the application of magnetic treatment and electromagnetic treatment may be causing an analgesic effect of the application and providing a possibility of treating a patient with higher sensitivity for thermal effects induced by electromagnetic treatment, i.e. patients with any

predisposition inducing increased thermal sensitivity. The analgesic effect may be induced by magnetic treatment by suitable repetition rates and it may be induced immediately during the magnetic treatment. The analgesic effect may last up to several hours after magnetic treatment. The magnetic flux density of the magnetic treatment may preferably reach at least motor-threshold intensity inducing at least partial muscle contraction therefore the homogeneity of the thermal field may be significantly enhanced.

[0108] Another benefit of application the magnetic treatment may be causing a myorelaxation effect. The magnetic treatment may be applied on spastic muscle structures to relieve the hypertonus of the muscle and improving the blood and/or lymph flow. Therefore relieving the hypertoned muscle may contribute to the analgesic effect and contribute to the acceptability of the treatment by the patient.

[0109] The blood and/or lymph flow may be limited in the spastic muscles and the metabolism may be limited as well, meaning that the risk of clustering the treated target structures may be higher and possible adverse events may occur. The recited risks may be eliminated by the used of magnetic treatment.

[0110] In one aspect of the invention, the treatment by magnetic field may be applied to the target structure before the radiofrequency treatment to prepare the target structure for following treatment by radiofrequency field. The effect of magnetic treatment may be to induce at least partial muscle contraction or to treat a muscle structure to increase a muscular tonus of the target structure. Both effects may provide a massage effect for the structure within the proximity of the target structure hence the blood and/or lymph circulation may be improved to promote local metabolism. The temperature may be locally increased by the improved blood flow and the target structure may accept the following radiofrequency treatment at significantly higher quality. Additionally, the collagen and/or elastin fibers may be remodeled or restored and/or its neogenesis may be improved to provide a younger, smoother, firmer and enhanced skin appearance.

[0111] Additionally, previous application may improve acceptability of the electromagnetic field by increasing the temperature of the skin and the transmittance of the electromagnetic field may be improved due to less value of skin impedance. Further the radiofrequency may penetrate deeper target structures relative to treatment without a preceding magnetic treatment of the target structure and/or area.

[0112] Another benefit may be releasing the adipose tissue in the muscle by muscle contraction and/or by temperature increase causing better liquidity of adipose tissue. Still another benefit of the at least partial muscle contraction may be mechanical breaking large adipose tissue bulks into smaller bulks which may be easier metabolized and/or the smaller adipose tissue bulks may be removed faster by the lymphatic and/or blood flow. Due to improved metabolism and/or circulation the cellulite may be treated in a short time and the visual effect on skin appearance may be significantly enhanced.

[0113] In another aspect of the invention, the treatment by magnetic field may be applied to the target structure simultaneously with the radiofrequency treatment to improve effects of the electromagnetic treatment inducing heat in the target structure.

[0114] The simultaneous application of magnetic treatment and radiofrequency treatment may be in two modes: a first mode may generate the magnetic impulses while radiofrequency treatment is active or another mode may generate radiofrequency treatment while the magnetic treatment is not in an active stimulation period, i.e. the period of magnetic treatment and radiofrequency treatment alternates. Both modes amplify the resulting effect of the treatment. Therefore the results may be achieved in significantly shorter time than the same results achieved by separate applications of the radio frequency and magnetic treatments.

[0115] The simultaneous method of magnetic treatment and radiofrequency treatment of the target tissue may increase the peak magnetic component of the entire treatment resulting in improved heating of the target structure including containing higher water volume, e.g. skin. Due to increased temperature of skin, the production and/or remodeling of collagen and/or elastin fibers may be improved and the skin may be provided with a younger, smoother, firmer and enhanced appearance. The effect of overheating the muscle may be reduced by the improved blood flow.

[0116] In still another aspect of the invention, the treatment by magnetic field may be applied to the target structure after the treatment by electromagnetic field to enhance and/or contribute to the effects of radiofrequency treatment by influencing the target structure by magnetic field.

[0117] The magnetic field may treat the target structure to cause at least partial muscle contraction proximate to the target structure to improve blood flow and provide homogeneous temperature distribution at high quality after creating a temperature distribution at lower quality by radiofrequency treatment.

[0118] All of the methods may be provided by the above recited technical solutions. The above mentioned methods may be used separately or in any combination.

[0119] The method may cause the circumferential reduction i.e. a reduction of the size of the treated body region. The method may be mostly indicated for the regions with cellulite, especially for buttocks, saddlebags, love handles, abdomen, hips, thighs or arms. However, the indication is not limited to the mentioned regions and the method may be used for treatment of any other body region.

[0120] The at least one applicator may include at least one magnetic field generating device. The plurality of magnetic field generating devices may be positioned in isolated locations of the at least one applicator. Alternatively, the magnetic field generating devices may be positioned next to each other, in an array or matrix, in a pattern or in randomized locations of the at least applicator.

[0121] The magnetic field generating devices may be positioned and/or moved in the at least one applicator in one plane; in at least two mutually tilted planes defined by a convex or concave angle, or perpendicular to each other; or in at least two parallel planes with the at least one magnetic field generating device in each parallel plane. The movement of the at least one magnetic field generating device may be translational and/or rotational, constant or accelerated. The movement may follow a predetermined, random or pre-defined trajectory, such as a pattern, array or matrix. The movement of the at least one applicator may be handled in similar manner as the movement of the at least one magnetic field generating device. The angles of the planes and/or the movement of the at least one magnetic field generating device may be adjusted by an operator following the

patient's needs. The positioning may be provided by mechanical holder, enabling tilting, distancing and positioning magnetic field generating device in various planes. In an alternative embodiment the patient may be positioned in the intersection of the magnetic fields generated by the plurality of magnetic field generating devices. In the preferred application the at least one applicator may be movable and the movement may be circular.

[0122] The plurality of magnetic field generating devices may be positioned within one applicator having form of mechanical holder. The shape of the applicator having form of mechanical holder may be adjustable, e.g. the applicator may include at least one moveable part. In a preferred embodiment the applicator having form of mechanical holder may provide spatial arrangement of the energy delivery elements in one axis, two axes or three axes and/or provide tilting and/or rotation. The applicator having form of mechanical holder may provide fixation of the at least one magnetic field generating device in one position. The moveable parts may be connected by sliding mechanism and/or by a joint mechanism. An exemplary embodiment of such an applicator may be found in U.S. Pat. No. 9,468,774, incorporated herein by reference. The applicator may be adjustable following the body region and/or biological structure.

[0123] The static position of the at least one applicator may be provided by a positioning member. The positioning member may be e.g. an arm or an adjustable flexible belt. The positioning member may include a buckle for adjusting the length of the belt. The applicator may be placed within predefined locations of the belt. Alternatively the applicator may be shaped to be moveable along the positioning member, e.g. the shape of the applicator may be preferably concave, e.g. V-shaped or U-shaped. The positioning member may be inserted itself into the concavity of the applicator. The position of the applicator may be adjusted by limited movement along the positioning member because the positioning member may be used as guiding member. However, the applicator may not be fixed to a particular static position. The position of the applicator may be dynamically adjusted during the treatment following the patient's needs. The position of the applicator may be adjusted manually by the operator, or automatically by the treatment device. In one exemplary embodiment a plurality of applicators may be used for treating larger body regions, e.g. buttocks, abdomen or thigh.

[0124] The present methods may also induce muscle contraction to reduce effect of skin laxity. Skin laxity may be caused by e.g. aging process or increasing number and/or volume of adipose cells which pulls down the skin by gravity, rapid weight loss or skin stretching during the pregnancy. The muscles may be treated by the induced electric current to contract. Repetitive contractions may cause the muscles to obtain the tonus and flexibility. Therefore the skin appearance may be enhanced by treating the flabby muscles. The effect of skin tightening may be achieved. The method also may promote the collagen and elastin fibers in the layers subtending the epidermis hence the skin may obtain enhanced visual appearance. The method may be widely applied but not limited to application to the regions of neck, breasts, arms or abdomen. The method may provide the smoother and younger appearance of the skin to the patient.

[0125] Similar methods of the muscle structure treatment by time-varying magnetic field for inducing the at least

partial muscle contraction may be used for treatment of wrinkles as well. Wrinkles are results of extrinsic and intrinsic factors. Nowadays, wrinkles are considered to be negative effect of natural aging process which decreases the production of collagen and elastin fibers and weakens the skin which becomes thinner. As the muscle treatment by the magnetic flux density may induce at least partial muscle contraction, the collagen and elastin fibers neogenesis may be improved. Additionally, the muscles subtending the treated region may be toned and the skin may obtain a younger and enhanced visual appearance. Therefore, the effect of skin tightening may be achieved.

[0126] Wrinkles may be prevented or reduced by practicing facial exercises which may cause a massage effect to the facial tissues, improving blood and lymph circulation. Additionally, the facial muscles may be relaxed and toned after the exercise. A similar effect as facial exercise may be achieved by non-invasive and/or contactless method of treating the facial muscles by magnetic flux density. Further additional advantage of the present method may be the improvement of restoration of the collagen and elastin fibers, more effective toning and strengthening of the facial muscles.

[0127] The present methods may improve the neogenesis and remodeling of collagen fibers in the lips to reach a full, plump and firmer appearance. The magnetic flux density may be applied to the lips by an applicator. Therefore the lips may become fuller and firmer without any need of invasive method such as injection of the synthetic fillers, permanent makeup or the facial implants. The present method may promote the remodeling and/or neogenesis of collagen fibers in a natural way. Additionally, the collagen is natural substance of the human body which may provide the elasticity to the structure.

[0128] The present methods may be used for enhancing the visual appearance of breasts. Cooper's ligament may be treated, improved and/or firmed by the at least partial muscle contraction. The treatment may induce the elevation of the breast tissue. Additionally, the breast tissue may be treated to be modified in a shape, wherein the shape includes the size and/or the contour of the breast tissue. Therefore the visual appearance may be enhanced and breasts may be more attractive for the patient. The present method may be a non-invasive alternative for current aesthetic surgery method for the treatment of sagging breast tissue. The present method may provide a patient a method of breast visual appearance enhancement without surgery. Therefore the method lacks post-surgery complications such as scars, postoperative pain or long recovery period. Various treatment protocols may be used.

[0129] Following the recited methods the treatment may be but is not limited to continuous, pulsed, randomized or burst. The impulse may be but not limited to monophasic, polyphasic and/or biphasic.

[0130] In the preferred application of the present method the trains of pulses, called bursts are used.

[0131] Repetition rate and/or magnetic flux density may vary during the treatment protocol. Further the treatment may include several periods of different repetition rates, therefore the modulation may be in repetition rate domain. The treatment may include several periods of different magnetic flux densities, therefore the modulation may be in magnetic flux density domain. Alternatively the treatment may include different impulse durations, therefore the modu-

lation may be in impulse duration domain. In yet another approach the treatment may be modulated by any combinations thereof.

[0132] Various envelopes and/or waveforms, e.g. pulse, sinusoidal, rectangular, square, triangular, saw-tooth, trapezoidal, exponential etc. for the purpose of muscle treatment may also be used, and are not limited to recited shapes.

[0133] The values of magnetic flux density and repetition rate are cited in several preferred applications since the perception of the treatment is subjective. Nevertheless, the magnetic flux density and repetition rates are not limited by the recited values. A person skilled in the physical therapy is able to repeat and apply the treatment methods adjusting the magnetic flux density and/or repetition rate following the patient's sensitivity or needs.

[0134] The present method is not limited to be used independently. For enhancing the result the method may be used in combination with other conventional non-invasive and/or invasive aesthetic medicine method.

[0135] All the recited methods may be applied to a patient in a non-invasive and/or contactless way. Therefore the present methods provide an effective alternative approach of enhancing the visual appearance with no need of invasive treatment or surgery. Further, the visual results are appreciable after several treatments. Additionally, the results include not only the visual appearance enhancement but even the improvement of the muscle structures, hence the patient feels firmer and tighter. The muscle structures become toned with no need of any diet or spending time by exercising in fitness.

[0136] The patient may feel firmer and/or tighter. The skin may be also tighter. Additionally, adipose tissue reduction may occur. Furthermore, cellulite may be reduced as well.

[0137] Thus, novel systems and methods have been described. Various changes and substitutions may of course be made without departing from the spirit and scope of the invention. The invention, therefore, should not be limited, except by the following claims and their equivalents.

[0138] The following U.S. patent applications are incorporated herein by reference: Ser. Nos. 14/873,110; 14/926,365; 14/951,093; 15/073,318; 15/151,012; 15/396,073; 15/446,951 and 15/404,384.

1-69. (canceled)

70. A method for reducing adipose cells, cellulite, BMI and/or toning, shaping and/or strengthening a muscle of a patient using a time-varying magnetic field applied to a patient's body, wherein the time-varying magnetic field is generated by a device which includes a connection to an energy source, a switching device, an energy storage device and a magnetic field generating device, comprising:

- a. providing energy from the energy storage device to the magnetic field generating device; and
- b. generating the time-magnetic field by the magnetic field generating device with a magnetic flux density in a range of 0.1 to 7 T; and
- c. applying the time-varying magnetic field to the patient; wherein a voltage drop between two successive peak amplitudes output from the energy storage device, is not higher than 21%.

71. A method for reducing adipose cells, cellulite, BMI and/or toning, shaping and/or strengthening a muscle of a patient using a time-varying magnetic field applied to a patient's body, wherein the time-varying magnetic field is generated by a device which includes a connection to an

energy source, a switching device, an energy storage device and a magnetic field generating device which includes a conductor of a diameter less than 3 mm, comprising:

- a. providing energy from the energy storage device to the magnetic field generating device; and
- b. generating the time-magnetic field by the magnetic field generating device with a magnetic flux density in a range of 0.5 to 7 T; and
- c. applying the time-varying magnetic field to at least one of thighs, saddlebags, buttocks, abdomen, hips, love handles, torso and/or arms of the patient; and
- d. generating the time-varying magnetic field with a treatment duty cycle is higher than 10%.

72. A method for reducing adipose cells, cellulite, BMI and/or toning, shaping and/or strengthening a muscle of a patient using a time-varying magnetic field applied to a patient's body, wherein the time-varying magnetic field is generated by a device which includes a connection to an energy source, a switching device, an energy storage device and a magnetic field generating device, comprising:

- a. charging the energy storage device; and
- b. discharging energy from the energy storage device to the magnetic field generating device in order to generate a time-varying magnetic field with a magnetic flux density in a range of 0.1 to 7 T, an impulse duration in a range of 10 to 900 μ s and with a repetition rate in a range of 1 to 700 Hz; and
- c. generating the time-varying magnetic field with a treatment duty cycle is higher than 10%; and
- d. applying the time-varying magnetic field to at least one of thighs, saddlebags, buttocks, abdomen, hips, love handles, torso and/or arms of the patient.

73. The method of claim 72 wherein the energy storage device providing the energy to the magnetic field generating device is in a serial connection with the magnetic field generating device.

74. The method of claim 73 further including switching the switching device on to provide controlled shorting of the energy source in order to generate the time-varying magnetic field.

75. The method of claim 72 further comprising positioning the patient in seated or lying position.

76. The method of claim 72 wherein the magnetic field generating device includes a litz-wire.

77. The method of claim 72 wherein the device further includes a sensor measuring a physical quantity including a voltage, a current, a phase shift or a magnetic flux density.

78. The method of claim 77 further comprising determining an unintended event including a hardware error or a metal object within proximity of the device and providing a notification to an operator by human perceptible means.

79. The method of claim 77 further comprising disabling generating the time-varying magnetic field upon a value measured by the sensor.

80. The method of claim 77 further comprising providing at least one maximal treatment parameter, including the magnetic flux density the repetition rate and the impulse duration, to an operator in a human perceptible form based on at least another treatment parameter set by the operator.

81. The method of claim 72 wherein the device further includes a blower for directing a cooling media and wherein the blower is on circumference of the magnetic field generating device.

82. The method of claim **72** further comprising directing a cooling media in a direction parallel to the magnetic field generating device.

83. The method of claim **82** further comprising directing a cooling media over at least upper and lower side of the magnetic field generating device in order to dissipate heat generated by the magnetic field generating device.

84. The method of claim **72** further comprising applying radiofrequency waves generated by at least one radiofrequency electrode in order to heat adipose cells.

85. The method of claim **84** wherein the device further includes balun and transmatch.

86. A method for reducing adipose cells, cellulite, BMI and/or toning, shaping and/or strengthening a muscle of a patient using a device which generates a time-varying magnetic field applied to a patient's body, wherein the device includes a connection to an energy source, a switching device, an energy storage device, a magnetic field generating device and a sensor measuring a physical quantity including a voltage, a current, a phase shift or a magnetic flux density, comprising:

- a. charging the energy storage device; and
- b. discharging energy from the energy storage device to the magnetic field generating device in order to generate a time-varying magnetic field with a magnetic flux density in a range of 0.5 to 7 T and an impulse duration in a range of 10 to 900 μ s and a repetition rate in a range of 1 to 700 Hz; and
- c. applying the time-varying magnetic field to at least one of thighs, saddlebags, buttocks, abdomen, hips, love handles, torso and/or arms of the patient.

87. The method of claim **86** wherein the energy storage device providing the energy to the magnetic field generating device is in a serial connection with the magnetic field generating device.

88. The method of claim **87** further including switching the switching device on to provide controlled shorting of the energy source in order to generate the time-varying magnetic field.

89. The method of claim **86** further comprising positioning the patient in seated or lying position.

90. The method of claim **86** wherein the magnetic field generating device includes a conductor of a litz-wire.

91. The method of claim **90** wherein the magnetic field generating device includes a diameter less than 3 mm.

92. The method of claim **86** further comprising determining an unintended event including a hardware error or a metal object within proximity of the device and/or providing a notification to an operator by human perceptible means.

93. The method of claim **92** further comprising disabling generating the time-varying magnetic field upon a value measured by the sensor.

94. The method of claim **86** further comprising providing at least one maximal treatment parameter, including the magnetic flux density the repetition rate and the impulse duration, to an operator in a human perceptible form based on at least another treatment parameter set by the operator.

95. The method of claim **86** wherein the device further includes a blower for directing a cooling media and wherein the blower is on circumference of the magnetic field generating device.

96. The method of claim **95** further comprising directing a cooling media in a direction parallel to the magnetic field generating device.

97. The method of claim **86** further comprising applying radiofrequency waves generated by at least one radiofrequency electrode in order to heat adipose cells.

98. The method of claim **97** wherein the device further includes balun and/or transmatch.

99. The method of claim **98** further comprising directing the radiofrequency waves between at least two electrodes.

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