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(54) **SYSTEMS, APPARATUS, METHODS AND PROCEDURES FOR THE NONINVASIVE TREATMENT OF TISSUE USING MICROWAVE ENERGY**

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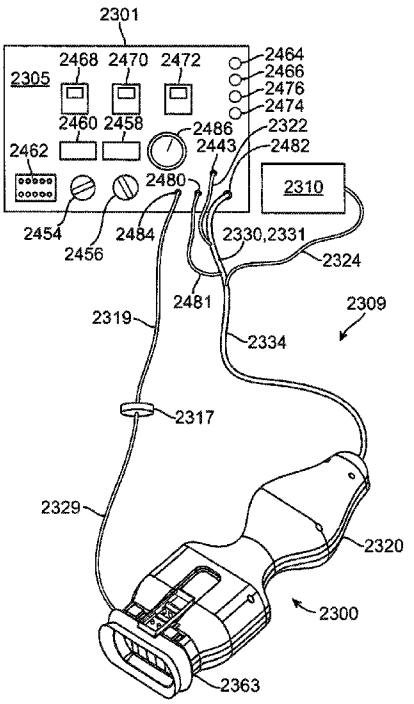
(57) **ABSTRACT**

The present invention is directed to systems, apparatus, methods and procedures for the noninvasive treatment of tissue, including treatment using microwave energy. In one embodiment of the invention a medical device and associated apparatus and procedures are used to treat dermatological conditions using, for example, microwave energy.



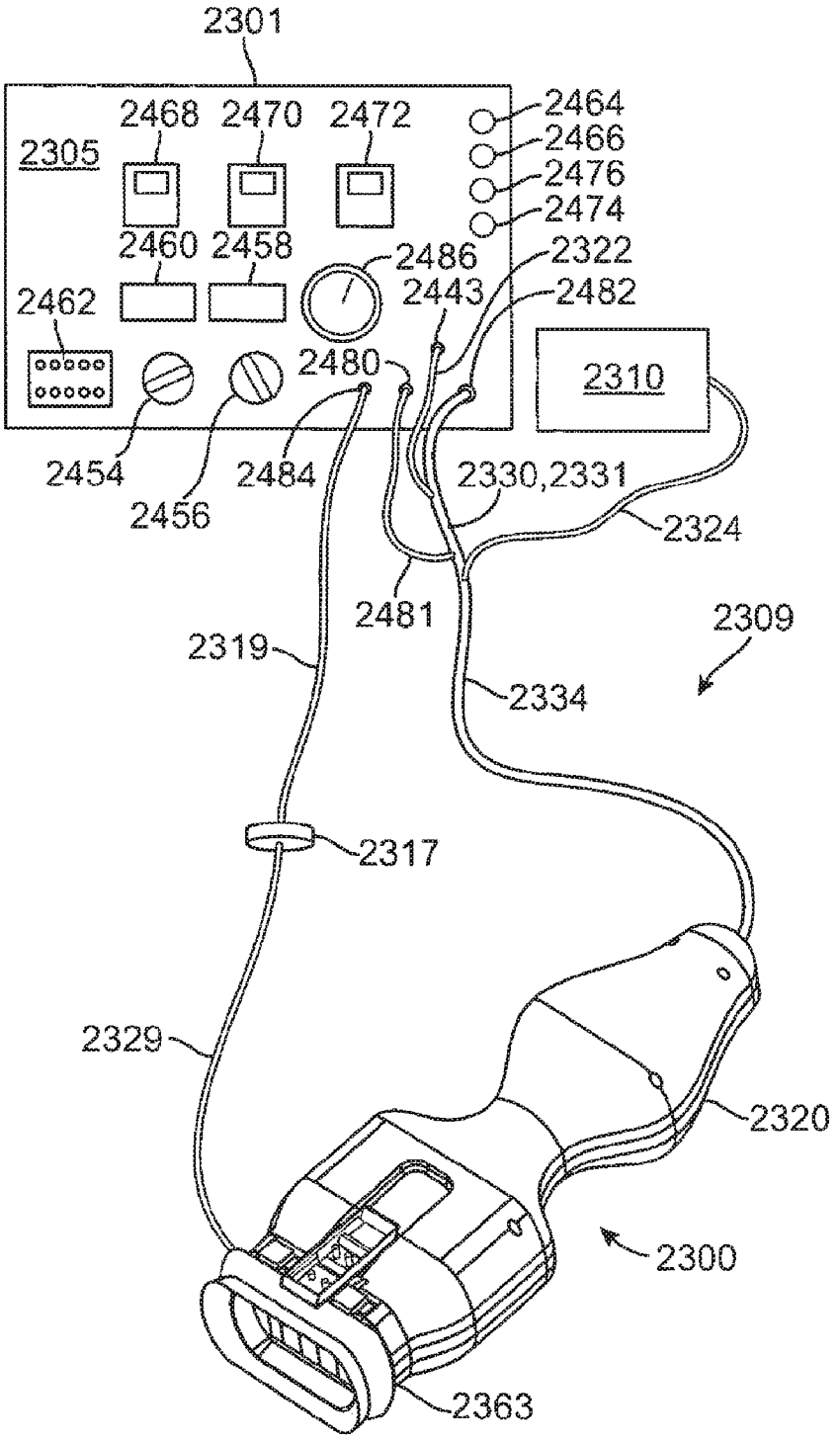

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FIG. 1

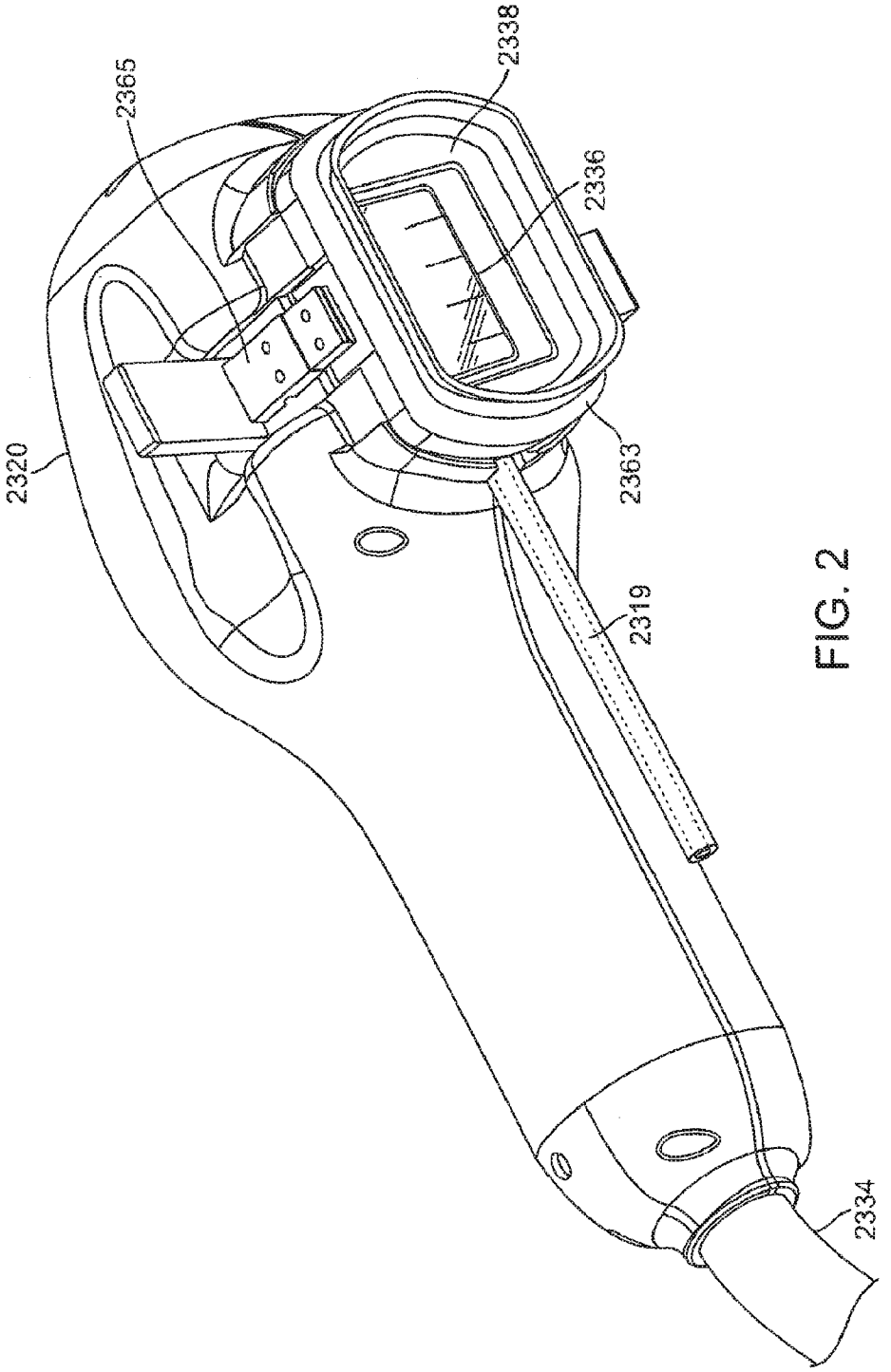

FIG. 2

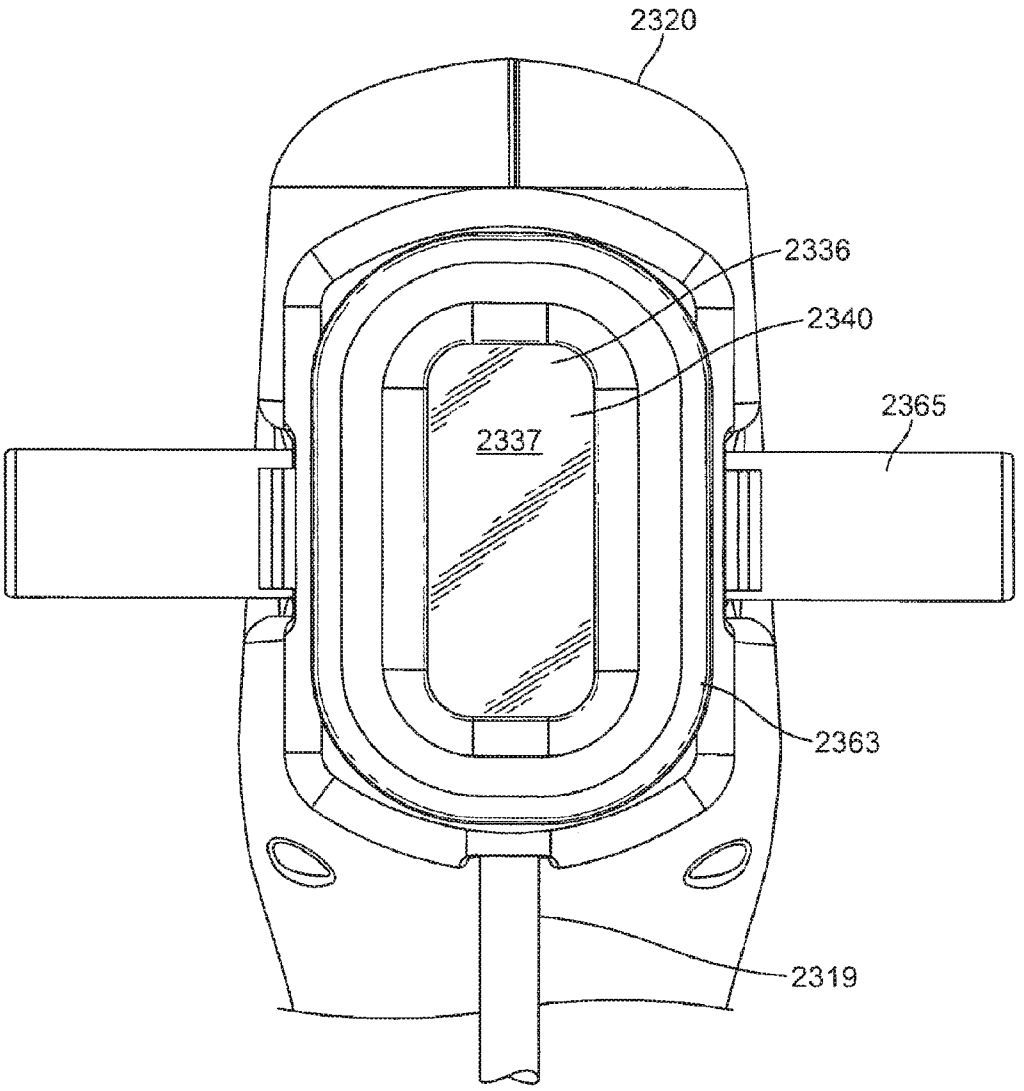

FIG. 3

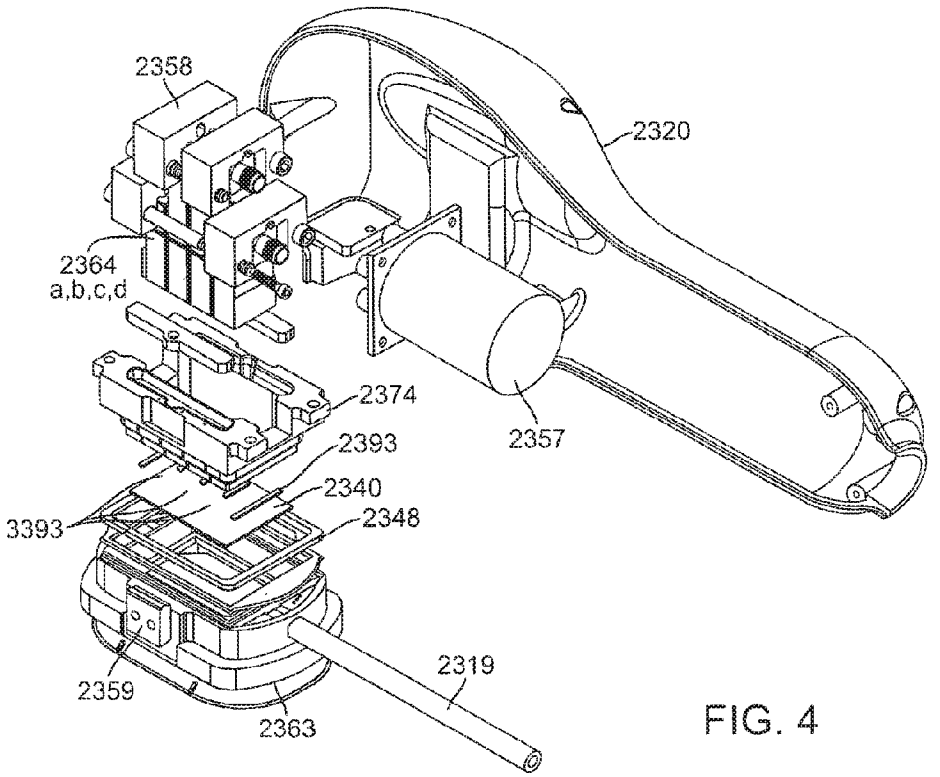
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FIG. 4

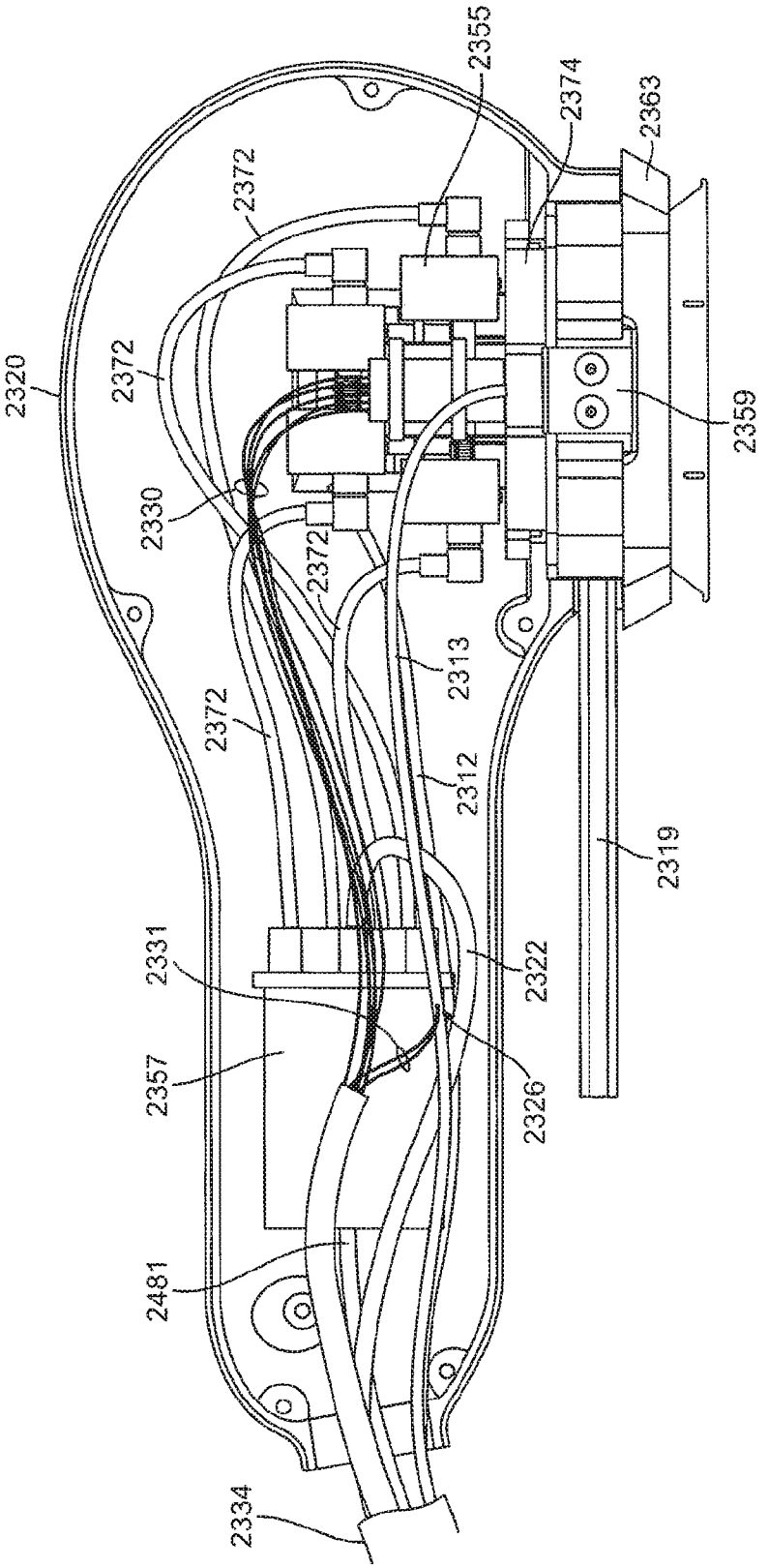
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FIG. 5

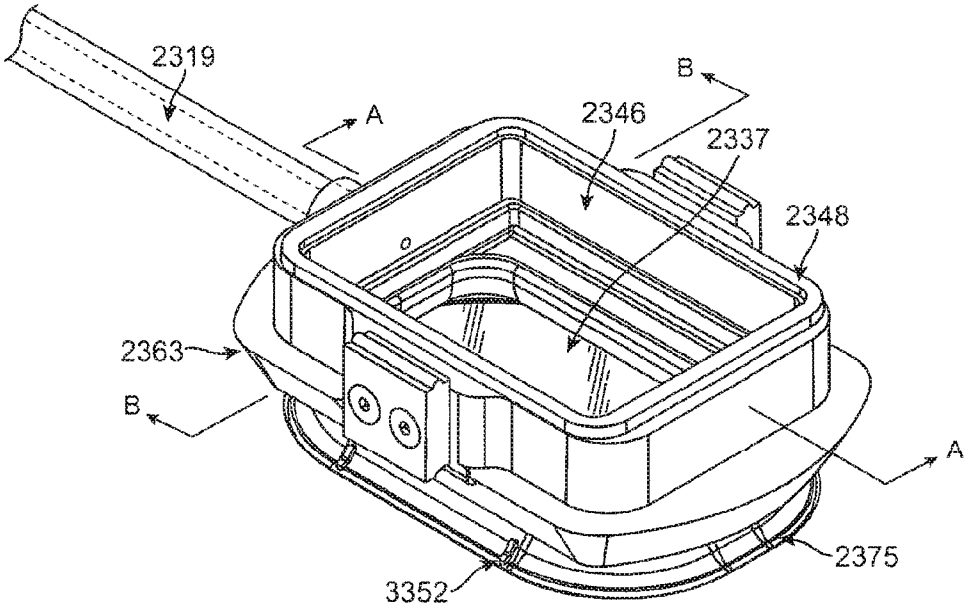

FIG. 6

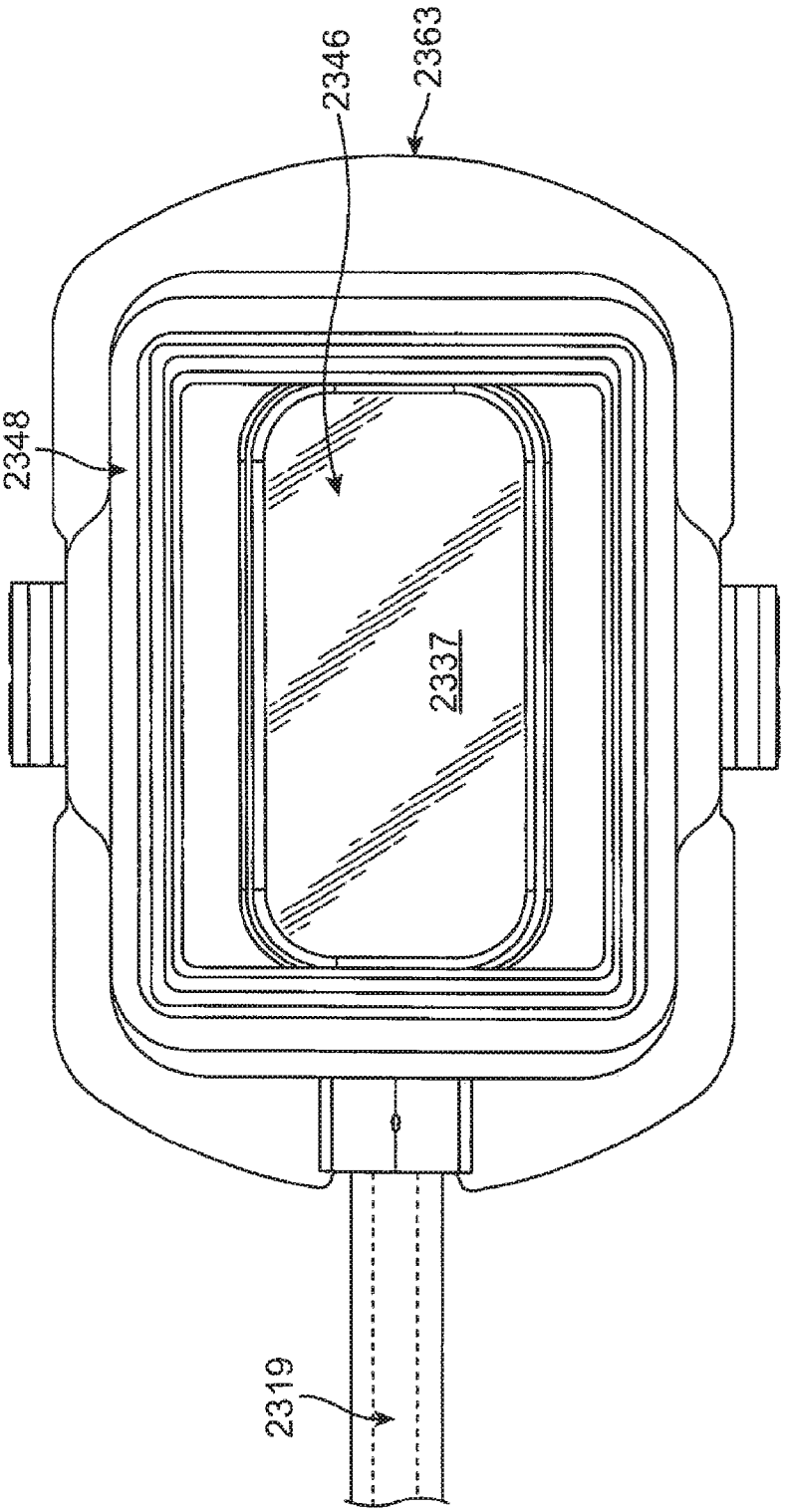

FIG. 7

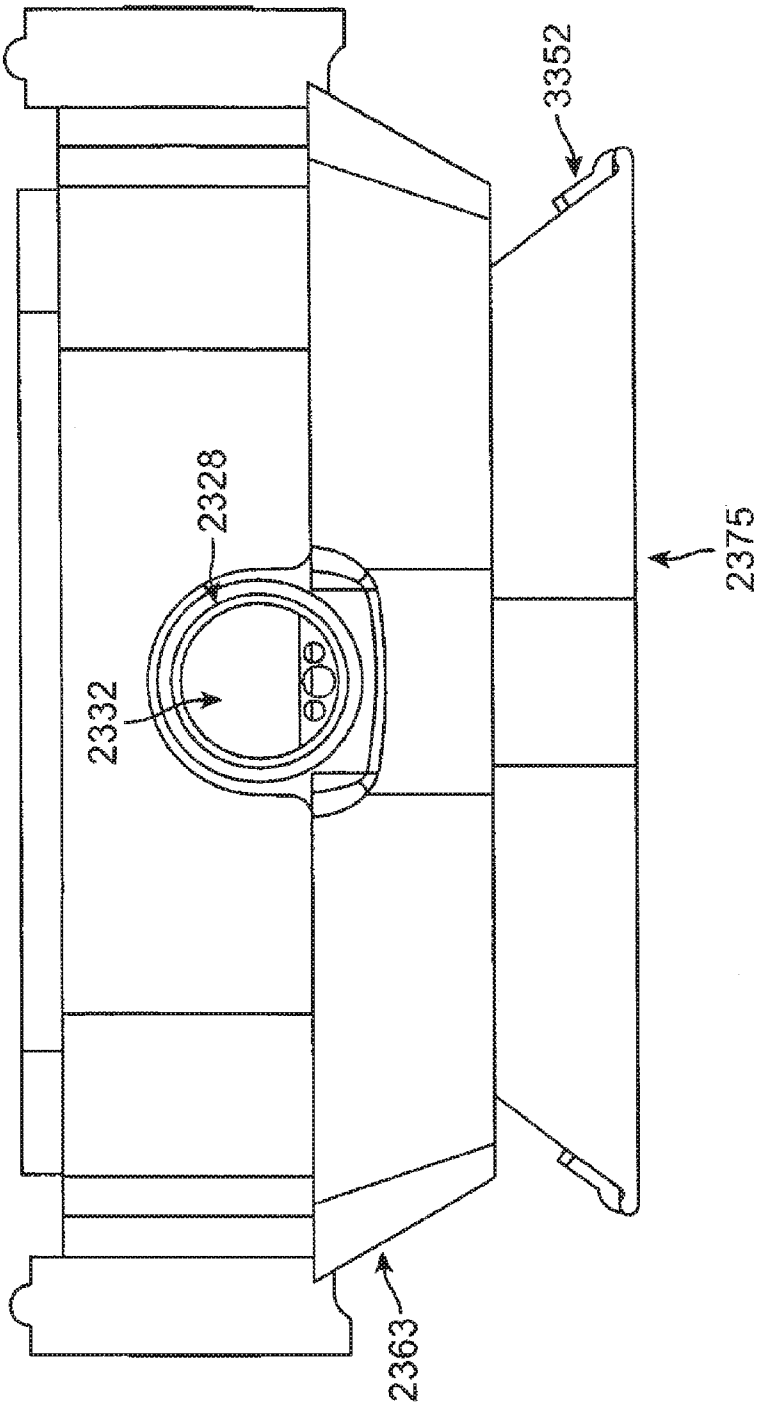

FIG. 8

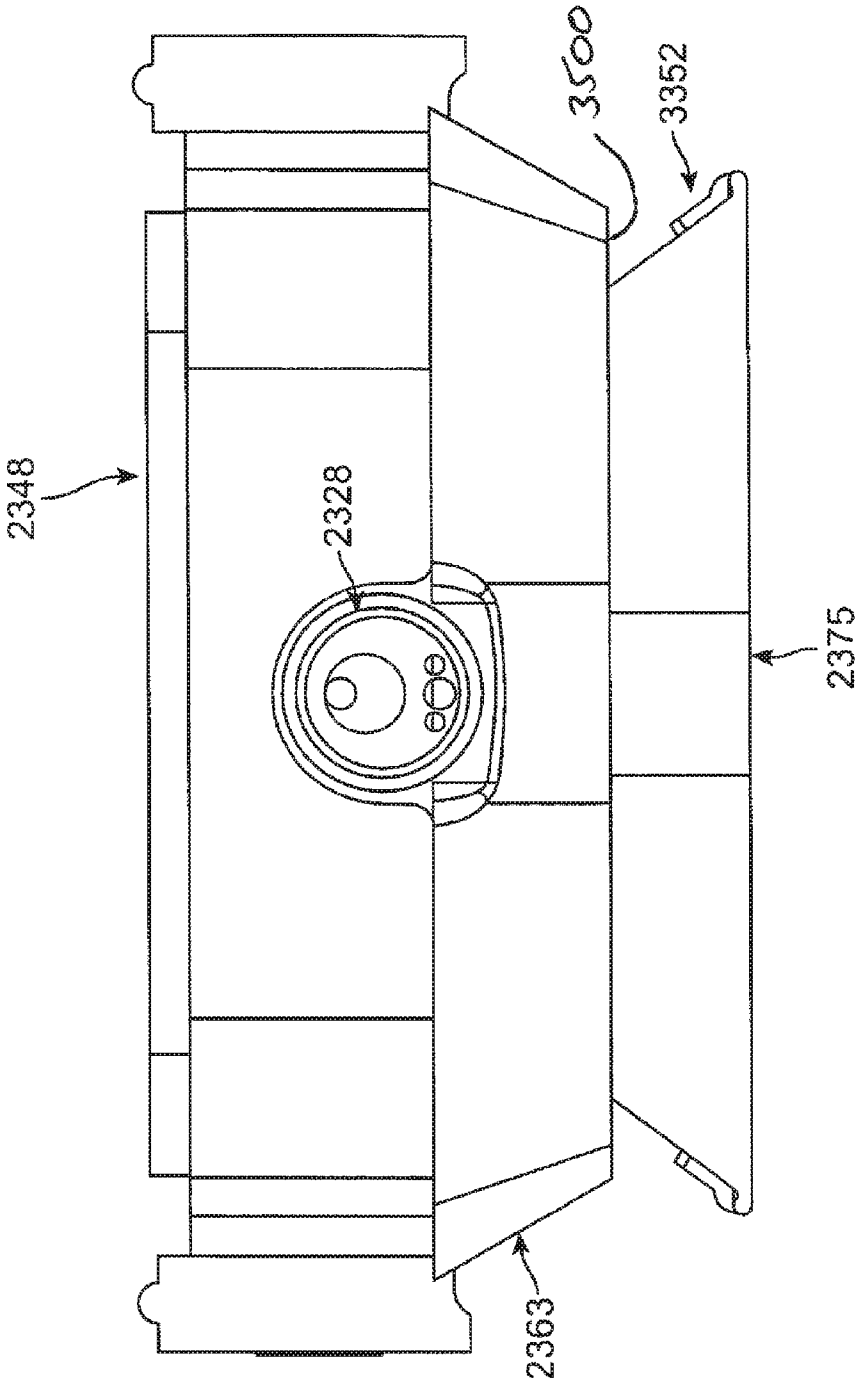

FIG. 9

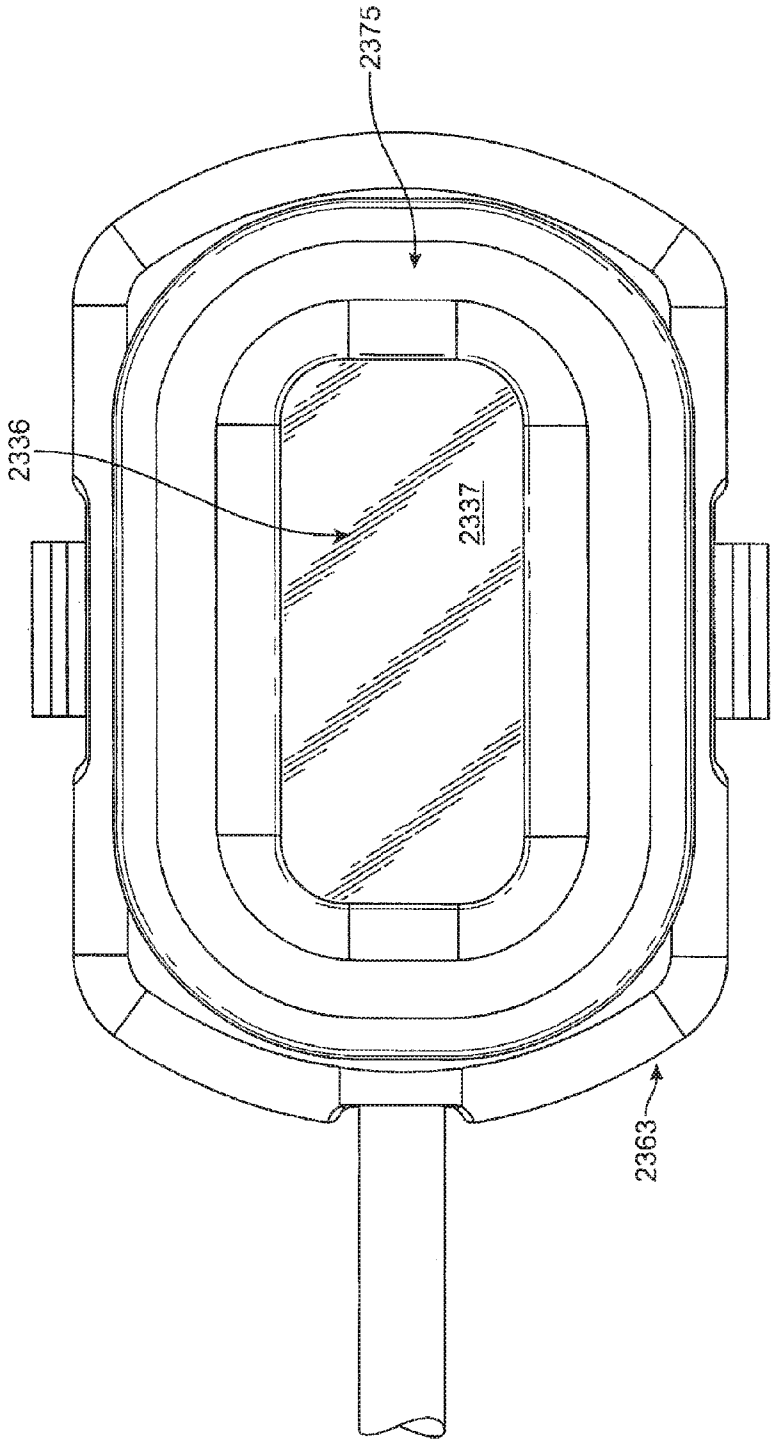

FIG. 10

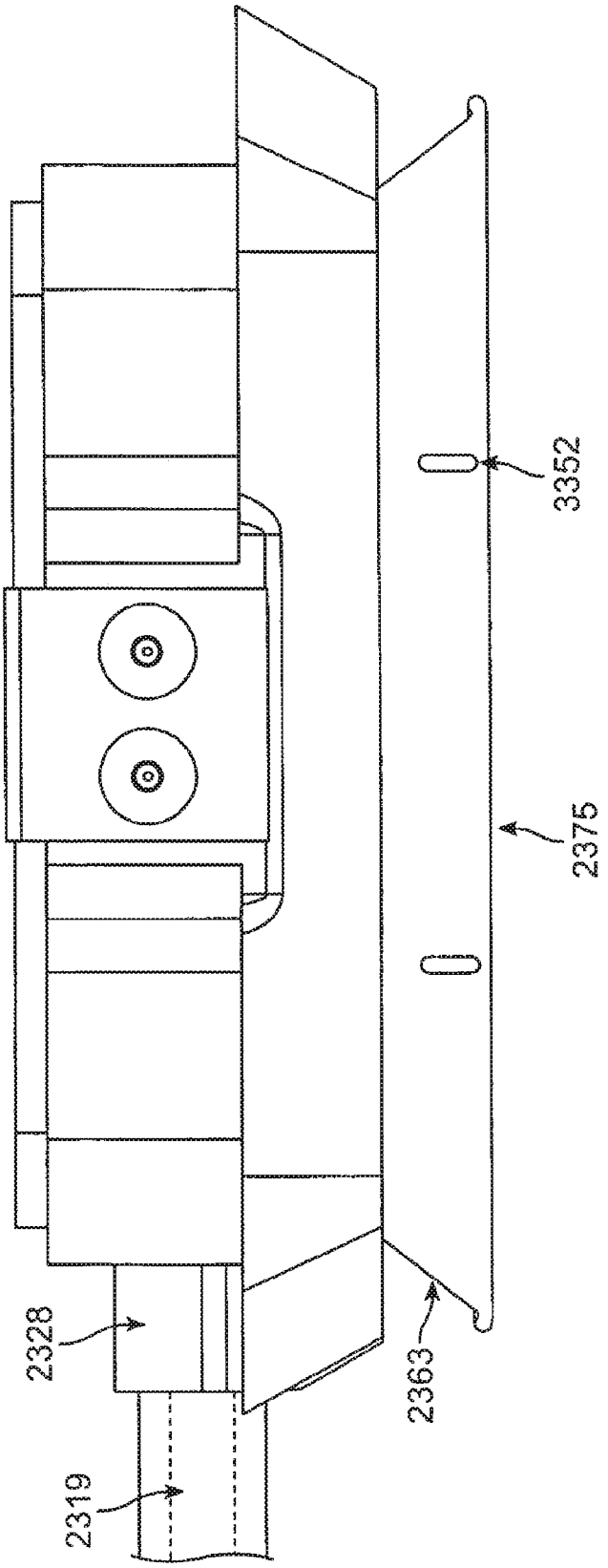

FIG. 11

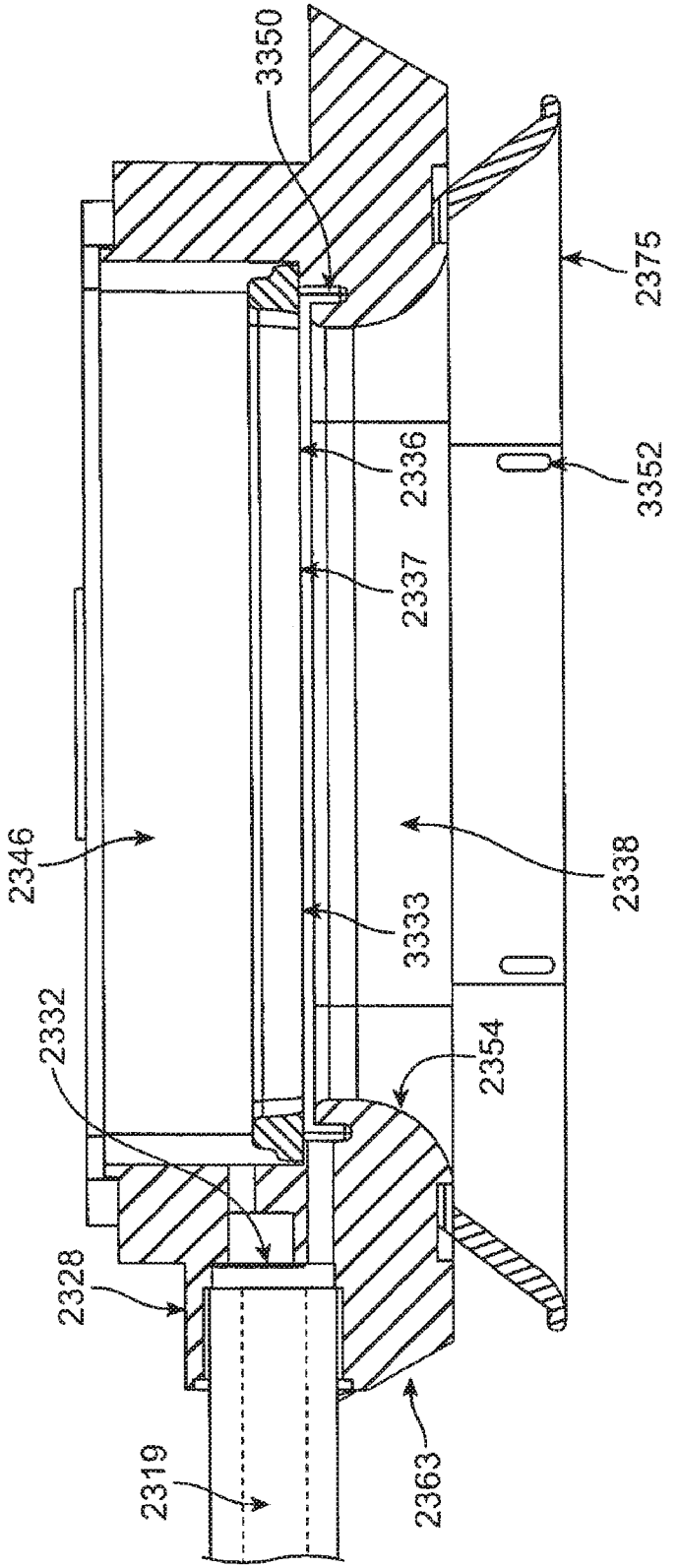
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FIG. 12

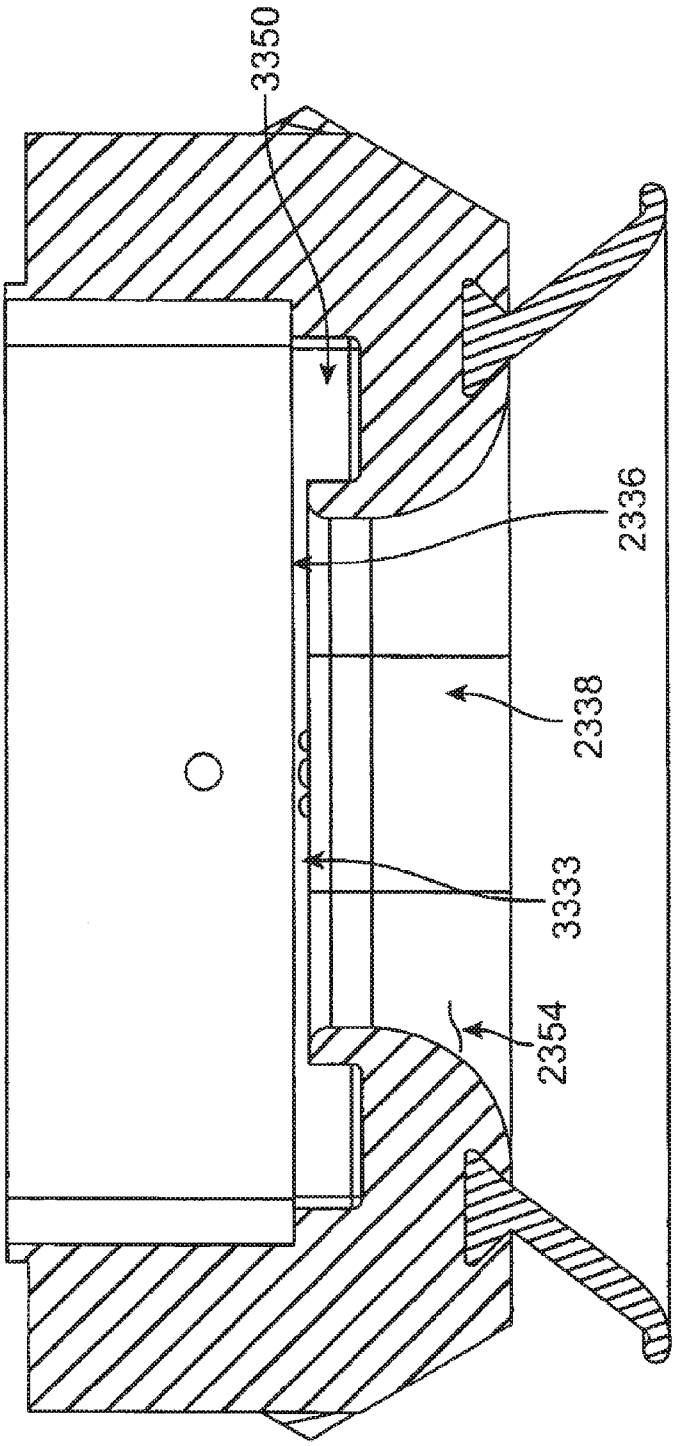

FIG. 13

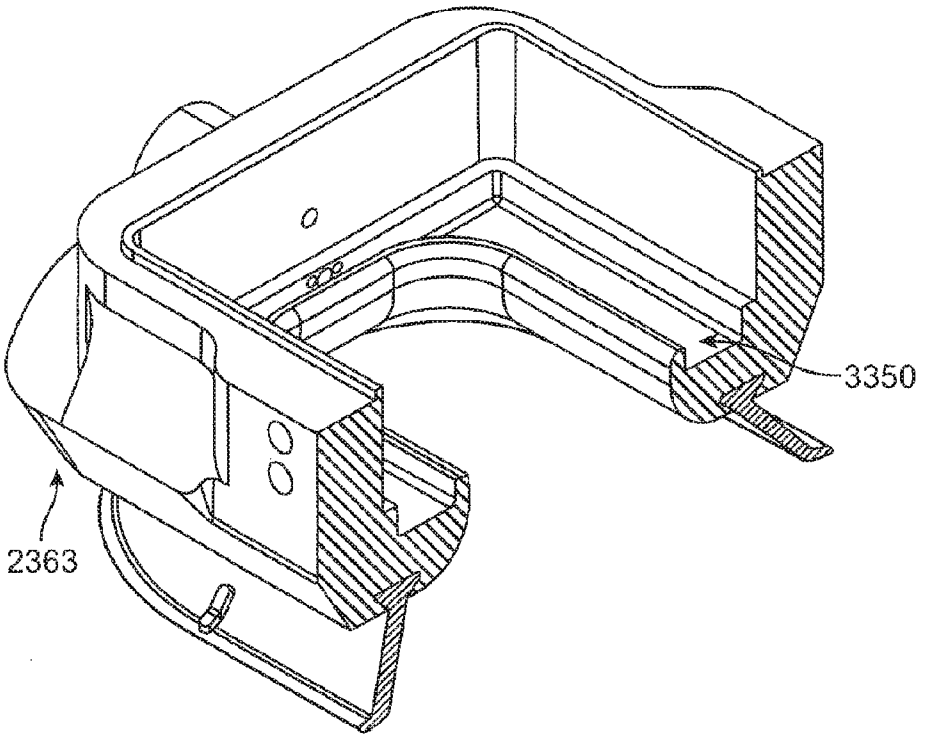

FIG. 14

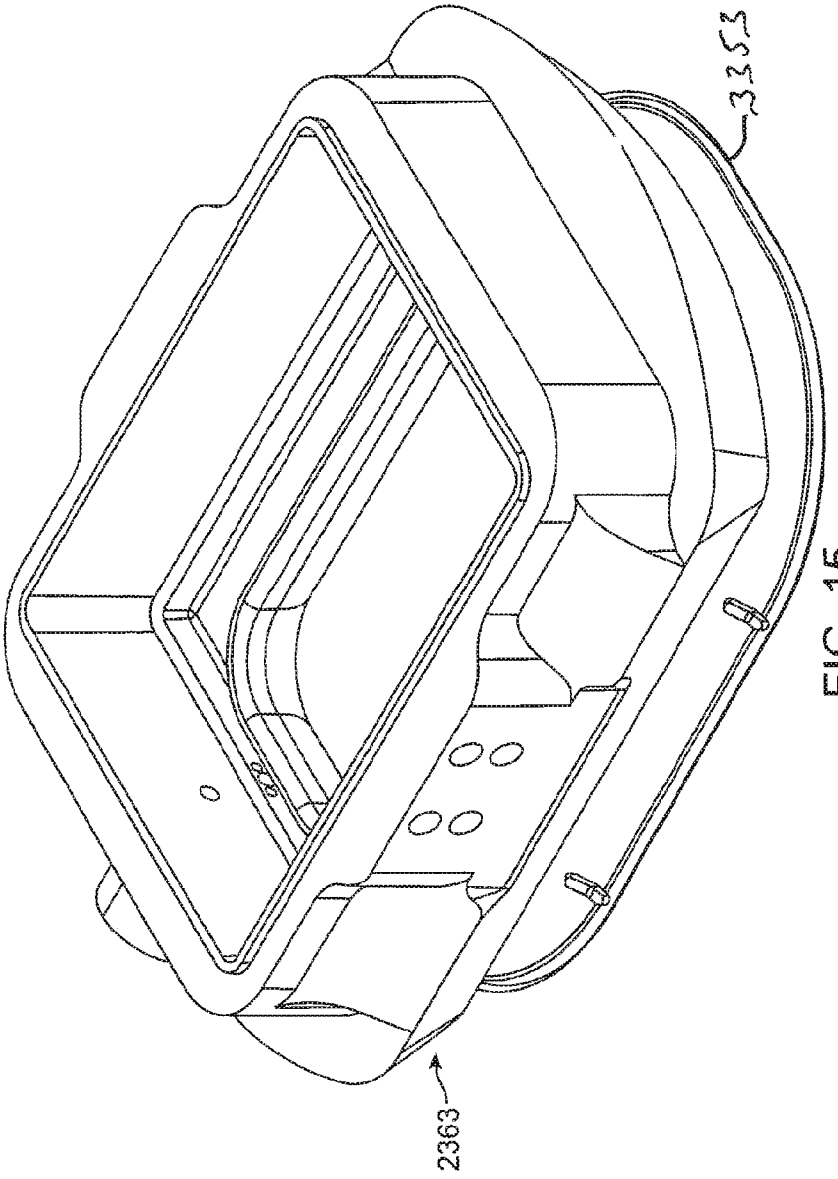

FIG. 15

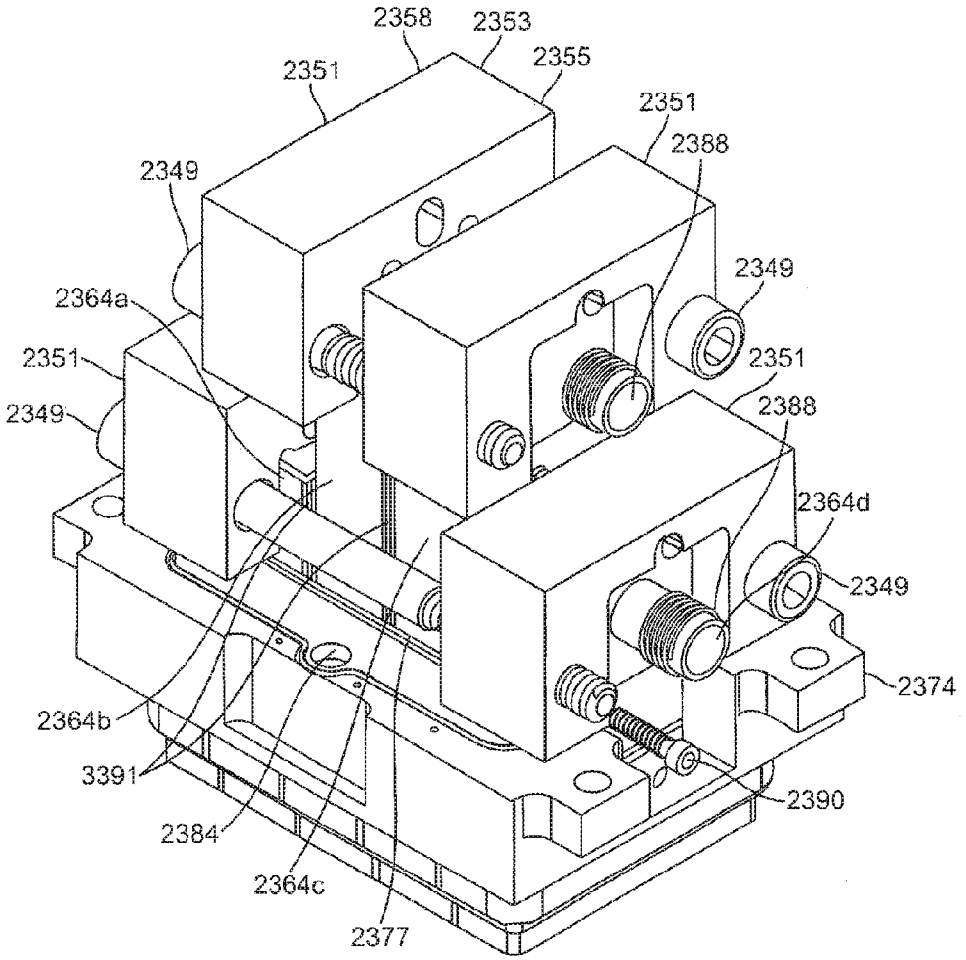
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FIG. 16

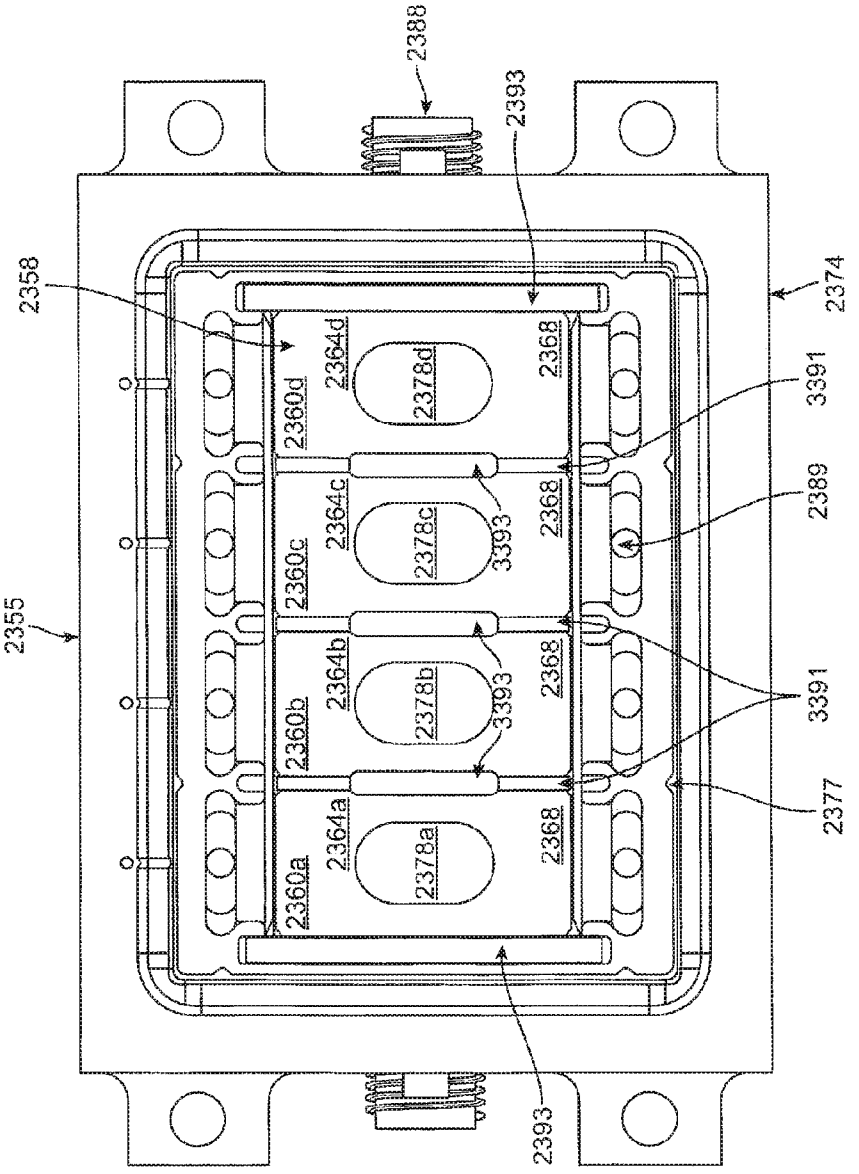
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FIG. 17

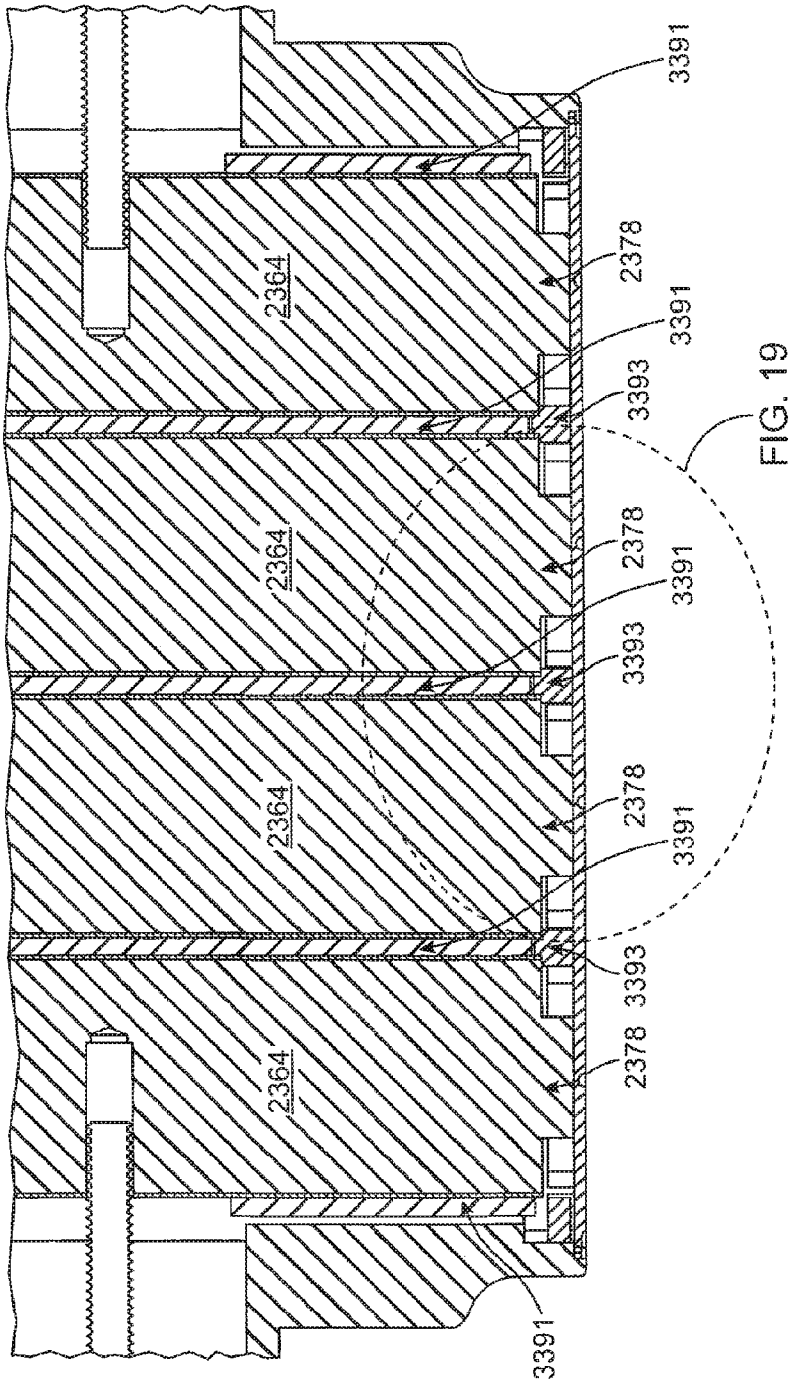
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FIG. 18

FIG. 19

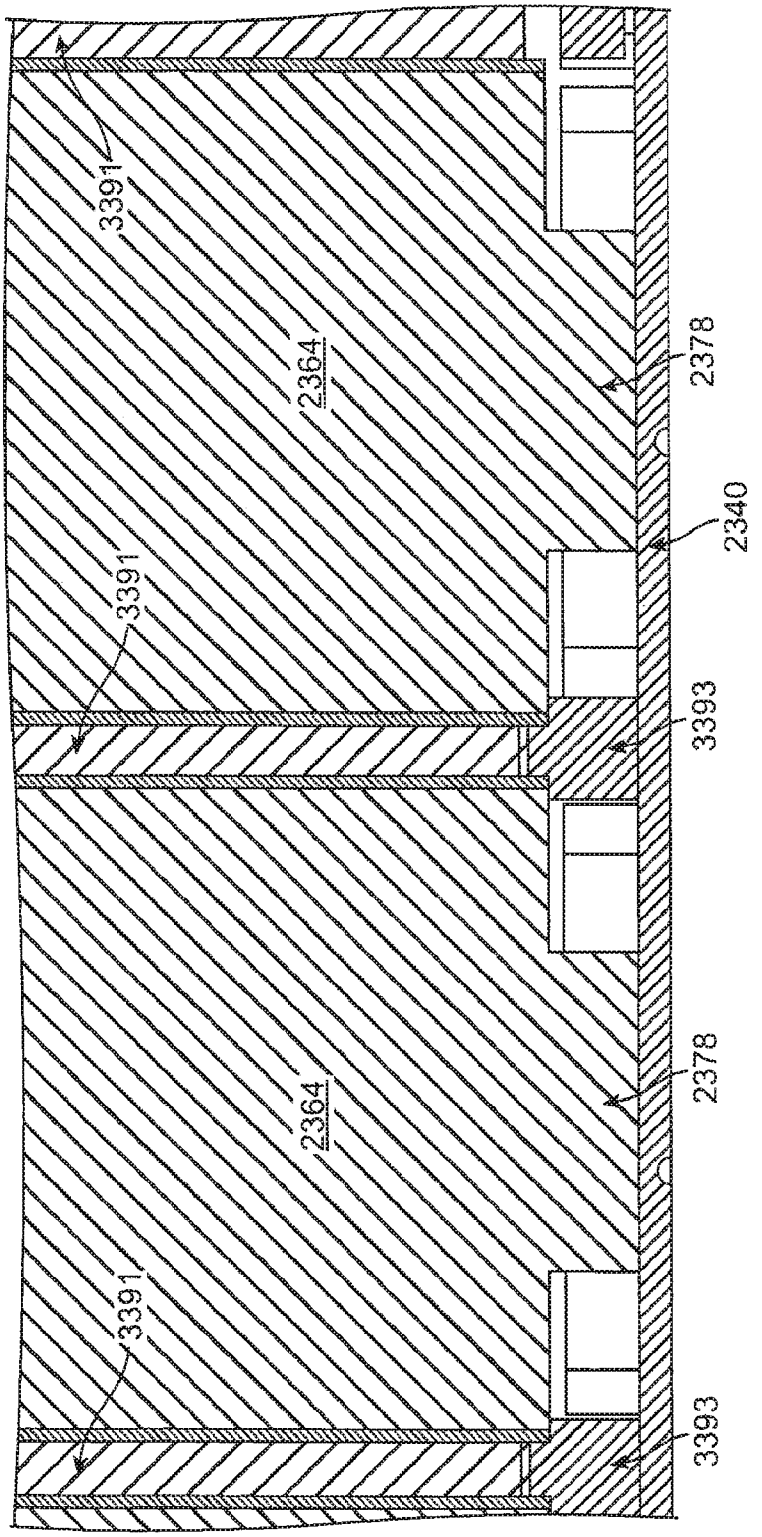

FIG. 19

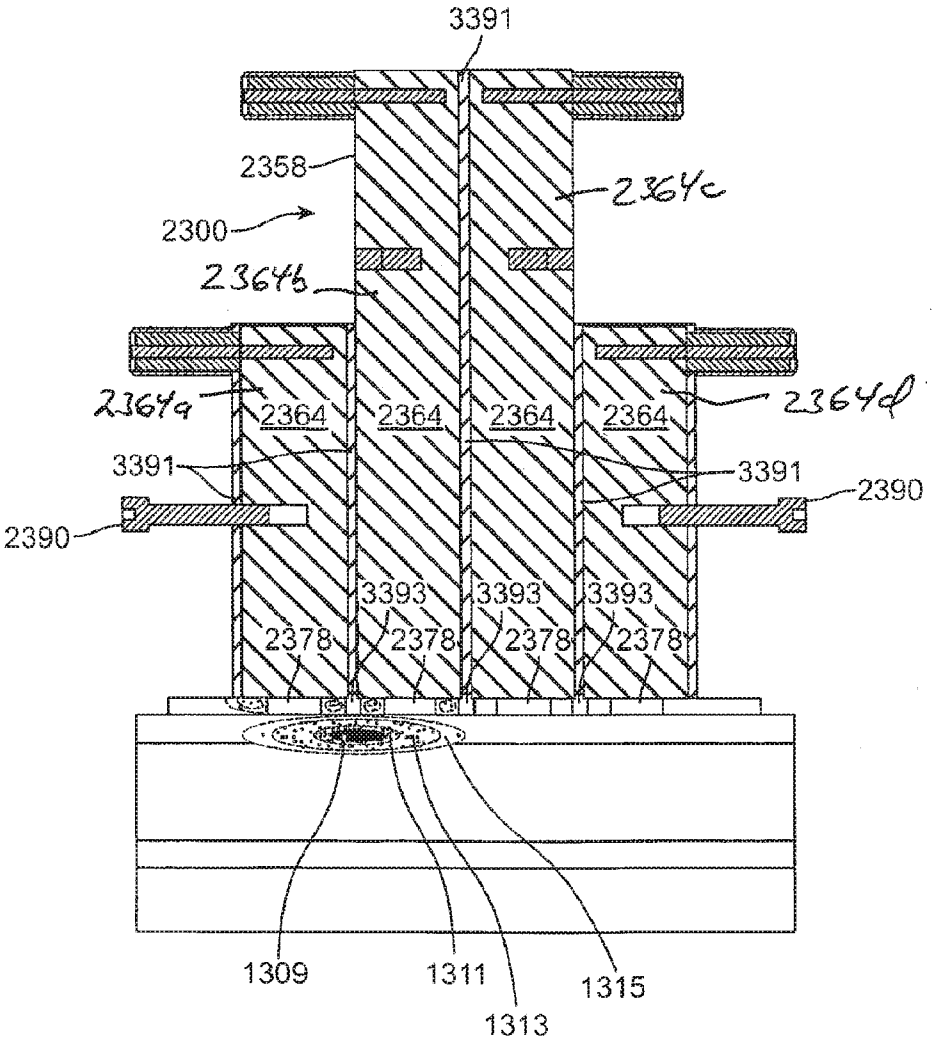
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FIG. 20

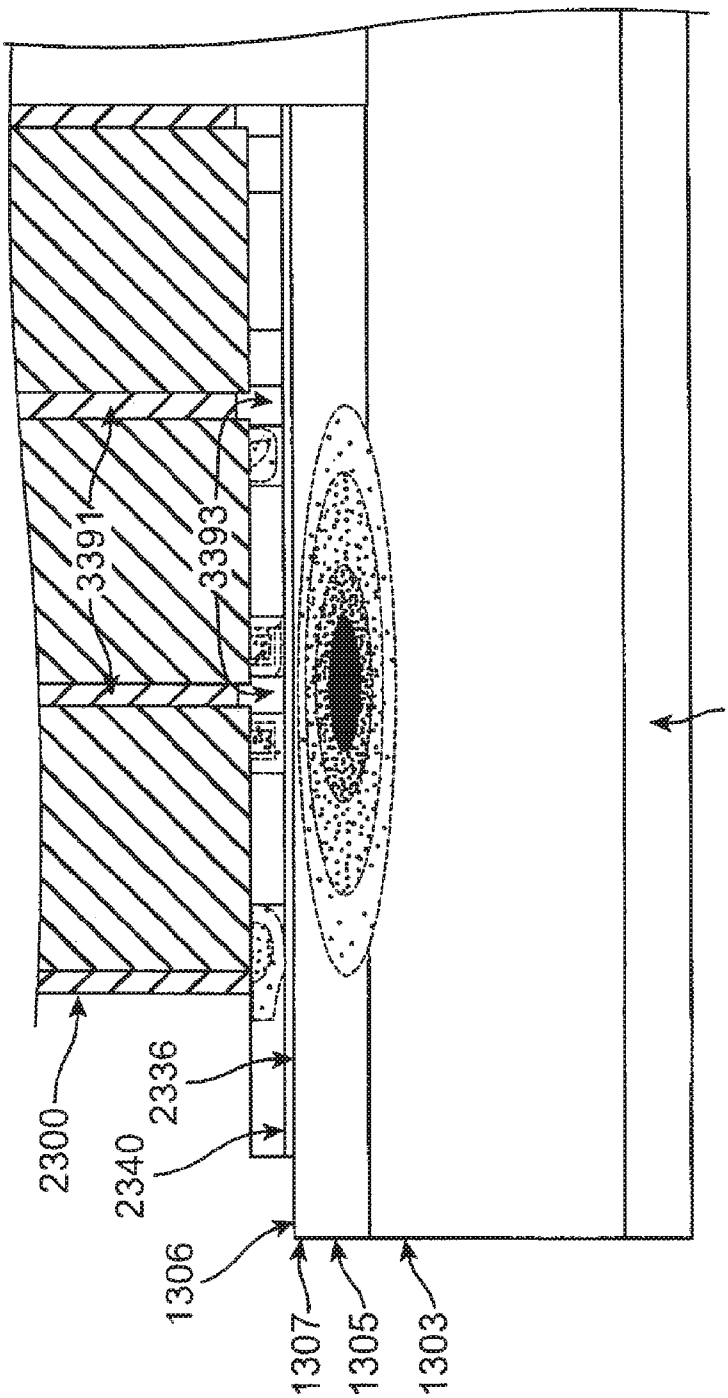


FIG. 21

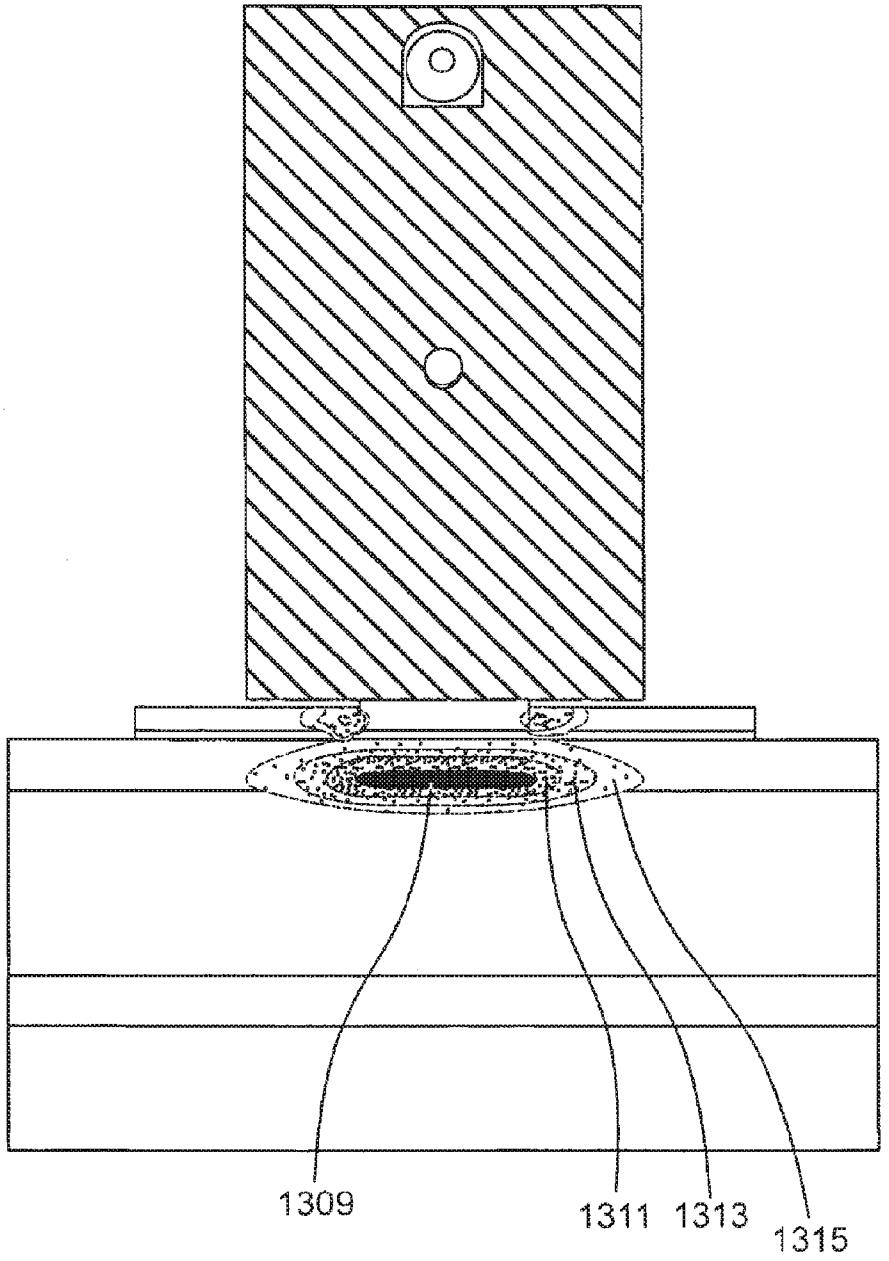


FIG. 22

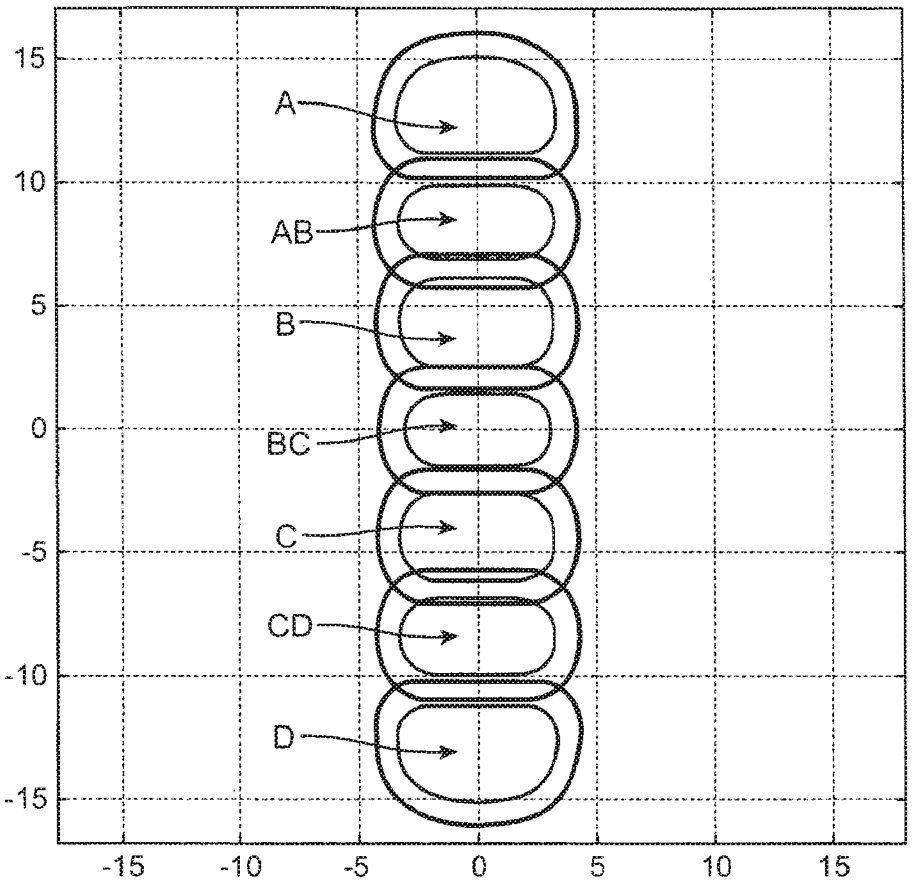
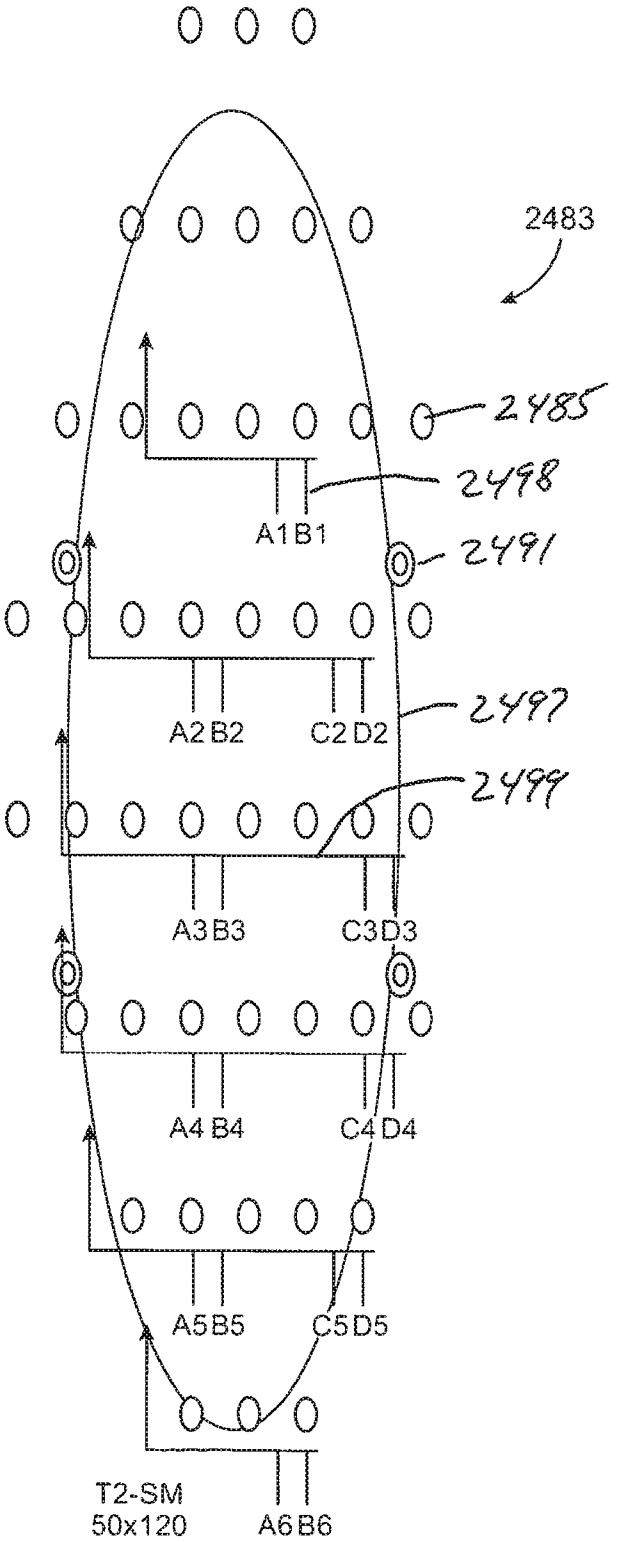


FIG. 23


2483
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A1 B1
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A2 B2
C2 D2
2499
A3 B3
C3 D3
A4 B4
C4 D4
A5 B5
C5 D5
T2-SM
50x120
A6 B6

FIG. 24

SYSTEMS, APPARATUS, METHODS AND PROCEDURES FOR THE NONINVASIVE TREATMENT OF TISSUE USING MICROWAVE ENERGY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. application Ser. No. 12/988,165, filed Oct. 15, 2010, now U.S. Pat. No. 9,241,763, which application is the national stage of International Application No. PCT/US2009/002403, filed Apr. 17, 2009.

[0002] Said International Application No. PCT/US2009/002403 claims the benefit of U.S. Provisional Application No. 61/208,315, filed Feb. 23, 2009, and also claims the benefit of PCT Application No. PCT/US2008/013650, filed Dec. 12, 2008. Further, said International Application No. PCT/US2009/002403, also claims the benefit of U.S. Provisional Patent Application No. 61/196,948, filed Oct. 22, 2008.

[0003] Said International Application No. PCT/US2009/002403 also is a continuation-in-part of co-pending U.S. application Ser. No. 12/107,025, filed Apr. 21, 2008, which claims the benefit of each of U.S. Provisional Application No. 60/912,899, filed Apr. 19, 2007, and U.S. Provisional Application No. 61/013,274, filed Dec. 12, 2007, and U.S. Provisional Application No. 61/045,937, filed Apr. 17, 2008. All of the above priority applications are expressly incorporated by reference in their entirety.

[0004] Co-pending U.S. application Ser. No. 12/107,025 also claims priority to each of PCT Application No. PCT/US2008/060935, filed Apr. 18, 2008, and PCT Application No. PCT/US2008/060929, filed Apr. 18, 2008, and PCT Application No. PCT/US2008/060940, filed Apr.18, 2008, and PCT Application No. PCT/US2008/060922, filed Apr. 18, 2008. All of the above priority applications are expressly incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0005] The present application relates to methods, apparatuses and systems for non-invasive delivery of energy, including microwave therapy. In particular, the present application relates to methods, apparatuses and systems for non-invasively delivering energy, such as, for example, microwave energy, to the epidermal, dermal and sub-dermal tissue of a patient to achieve various therapeutic and/or aesthetic results.

DESCRIPTION OF THE RELATED ART

[0006] It is known that energy-based therapies can be applied to tissue throughout the body to achieve numerous therapeutic and/or aesthetic results. There remains a continual need to improve on the effectiveness of these energy-based therapies and provide enhanced therapeutic results with minimal adverse side effects or discomfort.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The invention will be understood from the following detailed description of preferred embodiments, taken in conjunction with the accompanying drawings, wherein:

[0008] FIG. **1** is an illustration of a system including a generator, applicator and disposable according to an embodiment of the invention.

[0009] FIG. **2** is a perspective view of a medical treatment device, including an applicator and disposable, according to an embodiment of the invention.

[0010] FIG. **3** is an end on view of the distal end of a medical treatment device, including an applicator and the disposable according to an embodiment of the invention.

[0011] FIG. **4** is an exploded perspective view of a medical treatment device according to an embodiment of the invention.

[0012] FIG. **5** is a view of a medical treatment device according to an embodiment of the invention including a cutaway view of applicator according to an embodiment of the invention.

[0013] FIG. **6** is a perspective view of a disposable according to an embodiment of the invention.

[0014] FIG. **7** is a view of a proximal side of a disposable according to an embodiment of the invention.

[0015] FIG. **8** is a side view of one end of a disposable according to an embodiment of the invention.

[0016] FIG. **9** is a side view of one end of a disposable according to an embodiment of the invention.

[0017] FIG. **10** is a view of a distal side of a disposable according to an embodiment of the invention.

[0018] FIG. **11** is a side view of a disposable according to an embodiment of the invention.

[0019] FIG. **12** is a cutaway side view of a disposable according to an embodiment of the invention.

[0020] FIG. **13** is a cutaway side view of a disposable according to an embodiment of the invention.

[0021] FIG. **14** is a cutaway perspective view of a disposable according to an embodiment of the invention.

[0022] FIG. **15** is a top perspective view of a proximal end of a disposable according to an embodiment of the invention.

[0023] FIG. **16** is a perspective view of an antenna array according to an embodiment of the invention.

[0024] FIG. **17** is an end view of a portion of an antenna array according to an embodiment of the invention.

[0025] FIG. **18** is a cutaway side view of a portion antenna array according to an embodiment of the invention.

[0026] FIG. **19** is a cutaway side view of a portion antenna array according to an embodiment of the invention.

[0027] FIG. **20** is a simplified cutaway view of a medical treatment device with tissue engaged according to an embodiment of the invention.

[0028] FIG. **21** is a simplified cutaway view of a medical treatment device with tissue engaged according to an embodiment of the invention.

[0029] FIG. **22** is a simplified cutaway view of a medical treatment device with tissue engaged according to an embodiment of the invention.

[0030] FIG. **23** is a graphical illustration of a pattern of lesions in tissue according to an embodiment of the invention.

[0031] FIG. **24** illustrates a treatment template according to an embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0032] Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structures. While the preferred embodiment has been described, the details may be changed without departing from the invention which is defined by the claims.

[0033] FIG. **1** is an illustration of a system **2309** including a generator **2301**, applicator **2320** (which may also be referred to as re-usable) and disposable **2363** according to an embodiment of the invention. According to an embodiment of the invention applicator **2320** and disposable **2363** may comprise a medical treatment device **2300**. According to an embodiment of the invention generator **2301** may operate in the ISM band of 5.775 to 5.825 GHz. According to an embodiment of the invention generator **2301** may have a Frequency centered at approximately 5.8 GHz. According to an embodiment of the invention generator **2301** includes circuitry for setting and controlling output power; measuring forward and reverse power and setting alarms. According to an embodiment of the invention generator **2301** may have a power output of between approximately 40 Watts and approximately 100 Watts. According to an embodiment of the invention generator **2301** may have a power output of between approximately 40 Watts and approximately 100 Watts where said output is measured into a 50 ohm load. According to an embodiment of the invention generator **2301** may have a power output of approximately 55 Watts measured into a 50 ohm load. According to an embodiment of the invention disposable **2363** and applicator **2320** may be formed into two separable units. According to an embodiment of the invention disposable **2363** and applicator **2320** may be formed into a single unit. According to an embodiment of the invention when combined disposable **2363** and applicator **2320** may form a medical treatment device **2300**. According to an embodiment of the invention generator **2301** may be a microwave generator. According to an embodiment of the invention in system **2309** applicator **2320** may be connected to generator **2301** by applicator cable **2334**. According to an embodiment of the invention in system **2309** applicator cable **2334** may include coolant conduit **2324**, energy cable **2322**, coolant thermocouple wires **2331**, cooling plate thermocouple wires **2330** and antenna switch signal **2481**. According to an embodiment of the invention in system **2309** coolant conduit **2324** may be connected to a coolant source **2310** (which may be, for example, a Nanotherm industrial recirculation chiller with 8 pounds per square inch pump output pressure available from ThermoTek, Inc.). According to an embodiment of the invention in system **2309** energy cable **2322** may be connected to generator **2301** by microwave output connector **2443**. According to an embodiment of the invention in system **2309** antenna switch signal **2481** may be connected to generator **2301** by antenna switch connector **2480**. According to an embodiment of the invention in system **2309** disposable **2363** may be connected to generator **2301** by vacuum tubing **2319** which may include generator bio-barrier **2317**, which may be, for example, a hydrophobic filter. According to an embodiment of the invention in system **2309** vacuum tubing **2319** may be connected to generator **2301** by vacuum port connector **2484**. According to an embodiment of the invention in system **2309** front panel **2305** of generator **2301** may include power control knob **2454**, vacuum control knob **2456**, antenna select switch **2462** (which may include both display elements and selection switches), vacuum meter **2486**, antenna temperature display **2458**, coolant temperature display **2460**, pre-cool timer **2468** (which may include both display elements and time set elements), energy timer **2470** (which may include both display elements and time set elements), post-cool timer **2472** (which may include both display elements and time set elements), start button **2464**, stop button **2466**, ready indicator **2476** and fault indicator **2474**. According to an embodiment of the invention an error signal is sent to generator **2301** if a measured signal is outside of the specification for the requested power set by the power control knob **2454** on front panel **2305**. According to an embodiment of the invention vacuum tube **2319** may include a flexible vacuum hose **2329** and a generator bio-barrier **2317**. According to an embodiment of the invention flexible vacuum hose **2329** is adapted to collect fluids, such as, for example sweat or blood, which may escape disposable **2363** so that such fluids do not reach generator **2301**. According to an embodiment of the invention generator bio-barrier **2317** may include a hydrophobic filter to keep fluids out of vacuum port connector **2484** of generator **2301**. According to an embodiment of the invention generator bio-barrier **2317** may include a hydrophobic filter, such as, for example, a Millex FH Filter made of 0.45 micrometer hydrophobic PTFE which is available from Milipore. According to an embodiment of the invention generator bio-barrier **2317** may be positioned in vacuum tube **2319** between flexible vacuum hose **2329** and vacuum port connector **2484**. According to an embodiment of the invention applicator cable **2334** may connect generator **2301** to applicator **2320**. According to an embodiment of the invention cooling plate thermocouple wires **2330** and coolant thermocouple wires **2331** may be connected to generator **2301** by temperature connector **2482**. According to an embodiment of the invention coolant conduit **2324** may convey cooling fluid from a coolant source **2310** to applicator **2320**. According to an embodiment of the invention applicator cable **2334** may convey microwave switch selection data to applicator **2320** and temperature data from thermocouples in applicator **2320** to generator **2301**. According to an embodiment of the invention applicator cable **2334** may comprise one or more separate cables and connectors. According to an embodiment of the invention a generator connector may be designed and adapted to connect applicator cable **2334** to generator **2301**, including connections for cooling conduit **2324**, antenna switch signal **2481**, energy cable **2322**, cooling plate thermocouple wires **2330** and coolant thermocouple wires **2331**.

[0034] FIG. **2** is a perspective view of a medical treatment device **2300** including an applicator **2320** and disposable **2363** according to an embodiment of the invention. According to an embodiment of the invention applicator **2320** may be attached to disposable **2363** by latching mechanism **2365**. According to an embodiment of the invention applicator **2320** may include applicator cable **2334**. According to an embodiment of the invention disposable **2363** may include vacuum tubing **2319**, tissue chamber **2338** and tissue interface surface **2336**.

[0035] FIG. **3** is an end on view of a distal end of a medical treatment device **2300** including an applicator **2320** and disposable **2363** according to an embodiment of the invention. According to an embodiment of the invention disposable **2363** may include tissue bio-barrier **2337**. According to an embodiment of the invention applicator **2320** may include cooling plate **2340**, which may be, for example, positioned behind tissue bio-barrier **2337**. According to an embodiment of the invention tissue bio-barrier **2337** may form a portion of tissue interface surface **2336**. According to an embodiment of the invention latching mechanism **2365** may be used to facilitate the connection of disposable **2363** to applicator **2320**.

[0036] FIG. **4** is a perspective view of a medical treatment device **2300** including an exploded perspective view of an applicator **2320** and a view of disposable **2363** according to the present invention. According to an embodiment of the

invention applicator **2320** may include a cooling plate **2340**, separation ribs **2393**, intermediate scattering elements **3393**, antenna cradle **2374**, waveguide assembly **2358** and antenna switch **2357**. According to an embodiment of the invention waveguide assembly **2358** may include antennas **2364**(*a-d*). According to an embodiment of the invention disposable **2363** may include vacuum tubing **2319**, latching elements **2359** and vacuum seal **2348**.

[0037] FIG. **5** is a view of a medical treatment device **2300** according to an embodiment of the present invention including a cutaway view of applicator **2320** and disposable **2363**. According to an embodiment of the invention applicator **2320** may include antenna array **2355**, antenna switch **2357** and applicator cable **2334**. According to an embodiment of the invention applicator cable **2334** may include cooling plate thermocouple wires **2330**, coolant thermocouple wires **2331**, coolant supply tubing **2312**, coolant return tubing **2313**, antenna switch signal **2481**, energy cable **2322**. According to an embodiment of the invention cooling plate thermocouple wires **2330** may include one or more thermocouple wires which may be attached to an or more thermocouples positioned opposite an output of antenna array **2355**. According to an embodiment of the invention coolant thermocouple wires **2331** may include one or more thermocouple wires attached to an or more cooling path thermocouples **2326** which may be positioned to measure coolant fluid, such as, for example, in coolant return tubing **2313**. According to an embodiment of the invention one or more cooling path thermocouples **2326** may be positioned to measure the temperature of cooling fluid **2361** after it passes through coolant chamber **2360**. According to an embodiment of the invention one or more cooling path thermocouples **2326** may be located in coolant return tubing **2313**. According to an embodiment of the invention cooling path thermocouples **2326** may function to provide feedback to generator **2301** indicative of the temperature of cooling fluid **2361** after cooling fluid **2361** passes through coolant chamber **2360**. According to an embodiment of the invention disposable **2363** may include latching element **2359**. According to an embodiment of the invention applicator cable **2334** may include interconnect cables **2372** to transmit signals to antenna array **2355**. According to an embodiment of the invention antenna array **2355** may include antenna cradle **2374**.

[0038] FIG. **6** is a perspective view of disposable **2363** according to an embodiment of the invention. FIG. **7** is a view of the proximal side of disposable **2363** according to an embodiment of the invention. FIG. **8** is a side view of one end of disposable **2363** according to an embodiment of the invention. FIG. **9** is a side view of one end of disposable **2363** according to an embodiment of the invention. FIG. **10** is a view of the distal side of disposable **2363** according to an embodiment of the invention. FIG. **11** is a side view of disposable **2363** according to an embodiment of the invention. FIG. **12** is a cutaway side view of disposable **2363** according to an embodiment of the invention. FIG. **13** is a cutaway side view of disposable **2363** according to an embodiment of the invention. FIG. **14** is a cutaway perspective view of disposable **2363** according to an embodiment of the invention. FIG. **15** is a top perspective view of a proximal end of disposable **2363** according to an embodiment of the invention.

[0039] According to an embodiment of the invention disposable **2363** may include tissue interface surface **2336**, tissue chamber **2338** and alignment features **3352**. According to an embodiment of the invention tissue interface surface **2336** may form a back wall of tissue chamber **2338**. According to an embodiment of the invention tissue interface surface **2336** may include tissue bio-barrier **2337** and vacuum passage **3333**. According to an embodiment of the invention vacuum passage **3333** may also be referred to as a lip or rim. According to an embodiment of the invention disposable **2363** may include alignment features **3352** and vacuum tubing **2319**. According to an embodiment of the invention disposable **2363** may include compliant member **2375**. According to an embodiment of the invention chamber walls **2354** may include a compliant member **2375**. According to an embodiment of the invention compliant member **2375** may be formed from a compliant material, such as, for example, rubber, coated urethane foam (with a compliant plastic or rubber seal coating), silicone, polyurethane or heat sealed open cell foam. According to an embodiment of the invention compliant member **2375** may be positioned around the outer edge of tissue chamber **2338** to facilitate the acquisition of tissue. According to an embodiment of the invention compliant member **2375** may be positioned around the outer edge of chamber opening **2339** to facilitate the acquisition of tissue. According to an embodiment of the invention compliant member **2375** may facilitate the engagement of tissue which is not flat, such as, for example tissue in the axilla. According to an embodiment of the invention compliant member **2375** may facilitate the engagement of tissue which is not flat, such as, for example tissue in the outer regions of the axilla. According to an embodiment of the invention compliant member **2375** may provide improved sealing characteristics between the skin and tissue chamber **2338**, particularly where the skin is not flat. According to an embodiment of the invention compliant member **2375** may speed the acquisition of tissue in tissue chamber **2338**, particularly where the skin is not flat. According to an embodiment of the invention compliant member **2375** may have a height of between approximately 0.15 inches and approximately 0.40 inches above chamber opening **2339** when compliant member **2375** is not compressed. According to an embodiment of the invention compliant member **2375** may have a height of approximately 0.25 inches above chamber opening **2339** when compliant member **2375** is not compressed. According to an embodiment of the invention alignment features **3352** may be positioned at a distance which facilitate appropriate placement of applicator **2320** during treatment. According to an embodiment of the invention alignment features **3352** may be positioned approximately 30.7 millimeters apart. According to an embodiment of the invention alignment features **3352** may be further positioned and may be designed to assist a physician in positioning applicator **2320** prior to the application of energy. According to an embodiment of the invention alignment features **3352** on disposable **2363** assist the user in properly positioning the applicator prior to treatment and in moving the applicator to the next treatment region during a procedure. According to an embodiment of the invention alignment features **3352** on disposable **2363**, when used with marks or landmarks in a treatment region facilitate the creation of a continuous lesion. According to an embodiment of the invention alignment features **3352** may be used to align medical treatment device **2300** before suction is applied. According to an embodiment of the invention an outer edge of compliant member **2375** may assist a user in aligning medical treatment device **2300**.

[0040] According to an embodiment of the invention compliant member **2375**, which may also be referred to as a skirt

or flexible skirt, may be manufactured from silicone. According to an embodiment of the invention compliant member **2375** may extend approximately 0.25" from rigid surface **3500**. According to an embodiment of the invention a counter sink or dovetail notch **2356** may be positioned in rigid disposable surface **3500** around the outer edge of chamber opening **2339** to assist in alignment of compliant member **2375**. According to an embodiment of the invention the compliant member **2375** may have a durometer density rating (softness) of approximately A60 which may help compliant member **2375** to maintain its shape better while being easier to mold. According to an embodiment of the invention colorant may be used in compliant member **2375** to contrast with skin viewed through compliant member **2375**, making it easier for user, such as a physician to distinguish between skin and a distal surface of compliant member **2375**. According to an embodiment of the invention colorant may be used in compliant member **2375** to make it easier for user, such as a physician to distinguish between skin and an outer edge of compliant member **2375**. According to an embodiment of the invention colorant may be used in compliant member **2375** to help a user distinguish an edge of compliant member **2375** from surrounding skin and assist in aligning of medical treatment device **2300**. According to an embodiment of the invention the angle of compliant member **2375** relative to rigid surface **3500** may be approximately 53 degrees when compliant member **2375** is not compressed.

[0041] According to an embodiment of the invention disposable **2363** includes applicator chamber **2346**. According to an embodiment of the invention disposable **2363** may include an applicator chamber **2346** which may be formed, at least in part, by tissue bio-barrier **2337**. According to an embodiment of the invention disposable **2363** may include applicator bio-barrier **2332** (which may be, for example, a polyethylene film, available from Fisher Scientific), and vacuum passage **3333**. According to an embodiment of the invention a counter bore may positioned between applicator bio-barrier **2332** and applicator chamber **2346**.

[0042] According to an embodiment of the invention vacuum passage **3333** connects vacuum channel **3350** to tissue chamber **2338**. According to an embodiment of the invention vacuum channel **3350** may also be referred to as a reservoir or vacuum reservoir. According to an embodiment of the invention vacuum connector **2328** is connected to vacuum passage **3333** through vacuum channel **3350**. According to an embodiment of the invention vacuum channel **3350** may connect vacuum passages **3333** connect vacuum connector **2328** in tissue chamber **2338**. According to an embodiment of the invention vacuum passages **3333** form a direct path to tissue interface surface **2336**. According to an embodiment of the invention vacuum passages **3333** and vacuum channel **3350** may be adapted to restrict the movement of fluids from tissue chamber **2338** to applicator bio-barrier **2332**. According to an embodiment of the invention vacuum connector **2328** may be positioned on the same side of disposable **2363** as applicator bio-barrier **2332**. According to an embodiment of the invention applicator bio-barrier **2332** may be designed to prevent fluids from tissue chamber **2338** from reaching applicator chamber **2346**, particularly when there is back pressure caused by, for example, a vacuum created in tissue chamber **2338** as tissue is pulled away from tissue interface surface **2336**. According to an embodiment of the invention vacuum pressure may be used to support tissue acquisition in tissue chamber **2338**. According to an embodiment of the invention vacuum pressure may be used to pull tissue into tissue chamber **2338**. According to an embodiment of the invention vacuum pressure may be used to maintain tissue in tissue chamber **2338**. According to an embodiment of the invention vacuum channel **2350** may surround tissue interface surface **2336**. According to an embodiment of the invention applicator bio-barrier **2332** may be positioned between vacuum passages **3333** and applicator chamber **2346**. According to an embodiment of the invention applicator bio-barrier **2332** may be a membrane which may be adapted to be permeable to air but substantially impermeable to biological fluids such as, for example, blood and sweat. According to an embodiment of the invention applicator bio-barrier **2332** may be a hydrophobic membrane filter. According to an embodiment of the invention applicator bio-barrier **2332** may be made of polyethylene film, nylon or other suitable materials. According to an embodiment of the invention applicator bio-barrier **2332** may include pores having sizes sufficient to pass enough air to substantially equalize the vacuum pressure in applicator chamber **2346** and in tissue chamber **2338** without passing biological fluids from tissue chamber **2338** to applicator chamber **2346**. According to an embodiment of the invention applicator bio-barrier **2332** may include pores having sizes of approximately 0.45 micrometers. According to an embodiment of the invention when the vacuum is turned on, and before pressure is equalized, applicator bio-barrier **2332** may induce a minimal pressure drop between vacuum passages **3333** and the applicator chamber **2346**. According to an embodiment of the invention applicator chamber **2346** and tissue chamber **2338** may be separated, at least in part, by tissue bio-barrier **2337**. According to an embodiment of the invention tissue chamber **2338** may include tissue interface surface **2336** and chamber wall **2354**.

[0043] According to an embodiment of the invention tissue chamber opening **2339** has dimensions which facilitate the acquisition of tissue. According to an embodiment of the invention tissue chamber **2339** may be sized to facilitate tissue acquisition while being large enough to prevent interference with energy radiated from waveguide antennas **2364** in antenna array **2355** when applicator **2320** is attached to disposable **2363**. According to an embodiment of the invention a vacuum circuit **3341** may include vacuum passages **3333**, vacuum channel **3350** and may encircle tissue chamber **3338**. According to an embodiment of the invention vacuum channel **3350** may be positioned around tissue chamber **2338**. According to an embodiment of the invention vacuum passage **3333** may be positioned around a proximal end of tissue chamber **2338**. According to an embodiment of the invention vacuum passage **3333** may be positioned around a proximal end of tissue chamber **2338** between tissue bio-barrier **2337** and a proximal end of chamber wall **2354**. According to an embodiment of the invention an opening to vacuum passage **3333** may be approximately 0.020 inches in height. According to an embodiment of the invention an opening to vacuum passage **3333** may be approximately 0.010 inches in height when disposable **2363** is attached to applicator **2320** and tissue bio-barrier **2337** is stretched into tissue chamber **2338** by a distal end of applicator **2320**. According to an embodiment of the invention vacuum passage **3333** may have an opening height which is too small for tissue to invade when a vacuum is applied.

[0044] According to an embodiment of the invention disposable **2363** may be manufactured from a clear or substantially clear material to assist a user, such as a physician in

viewing tissue engagement. According to an embodiment of the invention the disposable **2363** may have an outer angle to allow a user to see alignment features **3352** on compliant member **2375** to assist a user in aligning medical treatment device **2300**. According to an embodiment of the invention an angle around the outside of disposable **2363** provides a user with a direct view of alignment features **3352**. According to an embodiment of the invention tissue chamber **2338** may have dimensions of approximately 1.54 inches by approximately 0.7 inches. According to an embodiment of the invention the 4 corners of tissue chamber **2338** may have a radius of 0.1875 inches. According to an embodiment of the invention antenna array **2335** may include four antennas and may have dimensions of approximately 1.34 inches by approximately 0.628 inches. According to an embodiment of the invention the dimensions of the waveguide array **2335** and tissue chamber **2338** may be optimized to minimizing stray fields forming at the edges of waveguide array **2335** as well as optimizing the effective cooling area of tissue interface surface **2336**. According to an embodiment of the invention tissue chamber **2338** may be optimized to facilitate tissue acquisition without adversely impacting cooling or energy transmission.

[0045] FIG. **16** is a perspective view of antenna array **2355** according to an embodiment of the invention. According to an embodiment of the invention antenna array **2355** may include antenna cradle **2374**. According to an embodiment of the invention antenna cradle **2374** may include reservoir inlet **2384** and antenna chamber **2377**. According to an embodiment of the invention waveguide assembly **2358** may include one or more spacer **3391** (which may be, for example, copper shims) positioned between waveguide antennas **2364**. According to an embodiment of the invention spacer **3391** may be positioned between waveguide antenna **2364***a* and waveguide antenna **2364***b*. According to an embodiment of the invention spacer **3391** may be positioned between waveguide antenna **2364***b* and waveguide antenna **2364***c*. According to an embodiment of the invention spacer **3391** may be positioned between waveguide antenna **2364***c* and waveguide antenna **2364***d*. According to an embodiment of the invention microwave energy may be supplied to each waveguide antenna through feed connectors **2388**. According to an embodiment of the invention waveguide assembly **2358** may be held together by a waveguide assembly frame **2353**. According to an embodiment of the invention waveguide assembly frame **2353** may include feed brackets **2351** and assembly bolts **2349**. According to an embodiment of the invention antenna array **2355** may include antenna cradle **2374** and least one waveguide antenna **2364**. According to an embodiment of the invention antenna array **2355** may include one or more spacer **3391**. According to an embodiment of the invention antenna array **2355** may include four waveguide antennas **2364***a*, **2364***b*, **2364***c* and **2364***d*. According to an embodiment of the invention the heights of waveguide antennas **2364** in antenna array **2355** may be staggered to facilitate access to feed connectors **2388**. According to an embodiment of the invention one or more waveguide antenna **2364** in antenna array **2355** may include tuning element **2390**.

[0046] FIG. **17** is an end view of a portion of antenna array **2355** according to an embodiment of the invention. FIG. **18** is a cutaway side view of a portion antenna array **2355** according to an embodiment of the invention. FIG. **19** is a cutaway side view of a portion antenna array **2355** according to an embodiment of the invention. According to an embodiment of the invention antenna array **2355** includes coolant chambers **2360** (for example coolant chambers **2360***a*, **2360***b*, **2360***c* and **2360***d*), intermediate scattering elements **3393**, separation ribs **2393** and scattering elements **2378** (for example scattering elements **2378***a*, **2378***b*, **2378***c* and **2378***d*). According to an embodiment of the invention scattering elements **2378** may also be referred to as central scattering elements. According to an embodiment of the invention coolant chambers **2360***a*-**2360***d* may be located beneath waveguide antenna **2364***a*-**2364***d*. According to an embodiment of the invention coolant chambers **2360** may include separation ribs **2393** on either side of antenna array **2355** and intermediate scattering elements **3393** between antennas **2364**. According to an embodiment of the invention an intermediate scattering element **3393** may be positioned between waveguide antenna **2364***a* and waveguide antenna **2364***b*. According to an embodiment of the invention an intermediate scattering element **3393** may be positioned between waveguide antenna **2364***b* and waveguide antenna **2364***c*. According to an embodiment of the invention an intermediate scattering element **3393** may be positioned between waveguide antenna **2364***c* and waveguide antenna **2364***d*. According to an embodiment of the invention cooling fluid flowing through coolant chambers **2360** may have a flow rate of between approximately 200 milliliters per minute and approximately 450 milliliters per minute and preferably approximately 430 milliliters per minute. According to an embodiment of the invention coolant chambers **2360** may be designed to ensure that the flow rate through each coolant chamber **2360** is substantially the same. According to an embodiment of the invention coolant the flow rate of cooling fluid through coolant chamber **2360***a* is the same as the flow rate of cooling fluid through coolant chamber **2360***b*. According to an embodiment of the invention coolant the flow rate of cooling fluid through coolant chamber **2360***a* is the same as the flow rate of cooling fluid through coolant chambers **2360***b*, **2360***c* and **2360***d*. According to an embodiment of the invention cooling fluid flowing through coolant chamber **2360** may have a temperature of between approximately 8 degrees centigrade and approximately 22 degrees centigrade and preferably approximately 15 degrees centigrade. According to an embodiment of the invention coolant chambers **2360** may be positioned between an aperture of waveguide antenna **2364** cooling plate **2340**. According to an embodiment of the invention scattering elements **2378** may extend into at least a portion of coolant chambers **2360**. According to an embodiment of the invention scattering elements **2378** may extend through coolant chambers **2360**. According to an embodiment of the invention scattering elements **2378** and intermediate scattering elements **3393** may extend through coolant chambers **2360** to contact a proximal surface of cooling plate **2340**. According to an embodiment of the invention elements of coolant chamber **2360** may be smoothed or rounded to promote laminar fluid flow through coolant chambers **2360**. According to an embodiment of the invention elements of coolant chambers **2360** may be smoothed to reduce the generation of air bubbles in coolant chamber **2360**. According to an embodiment of the invention scattering elements **2378** which extend into coolant chambers **2360** may be rounded to promote laminar flow and prevent the buildup of bubbles in coolant chamber **2360**. According to an embodiment of the invention scattering elements **2378** may be formed in the shape of ovals or racetracks. According to an embodiment of the invention square edges or sharp corners in coolant chamber **2360** may result in undesirable flow characteristics,

including the generation of air bubbles, as cooling fluid moves through coolant chamber **2360**. According to an embodiment of the invention intermediate scattering elements **3393** may be positioned between separate individual coolant chambers **2360**. According to an embodiment of the invention intermediate scattering elements **3393** may be positioned such that they facilitate equalized cooling across cooling plate **2340**. According to an embodiment of the invention intermediate scattering elements **3393** may be sized such that they have a width which is equal to or less than the separation distance between apertures of waveguide antennas **2364**. According to an embodiment of the invention intermediate scattering elements **3393** may be sized and positioned such that they are not positioned an aperture of waveguide antenna **2364**. According to an embodiment of the invention intermediate scattering elements **3393** may be sized and positioned such that they modify a microwave field as it travels through coolant chamber **2360**. According to an embodiment of the invention intermediate scattering elements **3393** may be sized and positioned such that they modify a microwave field radiated from waveguide antenna **2364**. According to an embodiment of the invention intermediate scattering elements **3393** may be sized and positioned such that they spread out a microwave field as it travels through coolant chamber **2360**. According to an embodiment of the invention intermediate scattering elements **3393** may cause disruption or perturbation of microwave energy radiated from waveguide antenna **2364**. According to an embodiment of the invention intermediate scattering elements **3393** may be made of materials which will not rust or degrade in cooling fluid. According to an embodiment of the invention intermediate scattering elements **3393** may be made of materials which improve the SAR pattern in tissue. According to an embodiment of the invention intermediate scattering elements **3393** may be made of materials, such as dielectric materials, which are used to form scattering elements **2378**. According to an embodiment of the invention FIGS. **17** through **19** may also include waveguide assembly **2358**, feed connectors **2388**, antenna chamber **2377**, spacers **3391**, cradle channels **2389** and antenna cradle **2374**.

[0047] According to an embodiment of the invention intermediate scattering elements **3393** may be positioned between waveguide antennas **2364**. According to an embodiment of the invention the size and shape of the intermediate scattering elements **3393** may be designed to optimize the size and shape of lesions developed in the skin between waveguide antennas **2364**. According to an embodiment of the invention intermediate scattering elements **3393** may make lesions created in tissue between waveguide antennas **2364** larger and more spread out. According to an embodiment of the invention intermediate scattering elements **3393** may make lesions created in tissue between waveguide antennas **2364** narrower. According to an embodiment of the invention intermediate scattering elements **3393** may have an optimal length which is shorter than the length of scattering elements **2378**. According to an embodiment of the invention scattering elements **2378** may be approximately 7 millimeters in length. According to an embodiment of the invention intermediate scattering elements **3393** may have an optimal length which is approximately 6.8 millimeters. According to an embodiment of the invention intermediate scattering elements **3393** may be manufactured from, for example, alumina. According to an embodiment of the invention intermediate scattering elements **3393** may be manufactured from, for example, a material which is approximately 96% alumina. According to an embodiment of the invention intermediate scattering elements **3393** may be manufactured from, for example, silicone. According to an embodiment of the invention the intermediate scattering elements **3393** may be manufactured from a material having the same dielectric constant as scattering elements **2378**. According to an embodiment of the invention the intermediate scattering elements **3393** may be manufactured from a material having approximately the same dielectric constant as scattering elements **2378**. According to an embodiment of the invention intermediate scattering elements **3393** may be manufactured from a material having a dielectric constant of approximately 10. According to an embodiment of the invention intermediate scattering elements **3393** may be manufactured from a material having a dielectric constant of approximately 3. According to an embodiment of the invention increasing the dielectric constant of intermediate scattering element **3393** may reduce the size of a lesion created in skin between waveguide antennas **2364**. According to an embodiment of the invention intermediate scattering elements **3393** may be inserted into tongue and groove slots between wave antennas **2364**. According to an embodiment of the invention thermocouples may be positioned beneath one or more of intermediate scattering elements **3393**. According to an embodiment of the invention thermocouples may be positioned each of intermediate scattering elements **3393**.

[0048] FIGS. **20**, **21** and **22** are simplified cutaway views of a medical treatment device **2300** with tissue engaged according to an embodiment of the invention. According to an embodiment of the invention skin **1307** is engaged in treatment device **2300**. According to an embodiment of the invention dermis **1305** and hypodermis **1303** are engaged in medical treatment device **2300**. According to an embodiment of the invention skin surface **1306** is engaged in medical treatment device **2300** such that skin surface **1306** is in thermal contact with at least a portion of cooling plate **2340**. According to an embodiment of the invention skin surface **1306** is engaged in medical treatment device **2300** such that skin surface **1306** is in contact with at least a portion of tissue interface **2336**. According to an embodiment of the invention a vacuum pressure may be used to elevate dermis **1305** and hypodermis **1303**, separating dermis **1305** and hypodermis **1303** from muscle **1301**. According to an embodiment of the invention vacuum pressure may be used to elevate dermis **1305** and hypodermis **1303**, separating dermis **1305** and hypodermis **1303** from muscle **1301** to, for example, protect muscle **1301** by limiting or eliminating the electromagnetic energy which reaches muscle **1301**. According to an embodiment of the invention waveguide assembly **2358** may include one or more waveguide antennas **2364**. According to an embodiment of the invention electromagnetic energy, such as, for example, microwave energy may be radiated into dermis **1305** by medical treatment device **2300**. According to an embodiment of the invention medical treatment device **2300** may include coolant chamber **2360** and cooling plate **2340**. According to an embodiment of the invention a peak which may be, for example, a peak SAR, peak power loss density or peak temperature, is generated in first tissue region **1309**. According to an embodiment of the invention first tissue region **1309** may represent a lesion created by energy, such as, for example, microwave energy radiated from medical treatment device **2300**. According to an embodiment of the invention first tissue region **1309** may represent a lesion created by

microwave energy radiated from one or more of waveguide antennas **2364**. According to an embodiment of the invention first tissue region **1309** may be initiated in skin **1307** between first waveguide antenna **2364** and a second waveguide antenna **2364**. According to an embodiment of the invention first tissue region **1309** may be initiated in skin **1307** between first waveguide antenna **2364***a* and a second waveguide antenna **2364***b*. According to an embodiment of the invention first tissue region **1309** may be initiated in skin **1307** underlying intermediate scattering element **3393**. According to an embodiment of the invention a reduced magnitude which may be, for example, a reduced SAR, reduced power loss density or reduced temperature, is generated in second tissue region **1311** with further reduced magnitudes in third tissue region **1313** and fourth tissue region **1315**. As illustrated in FIGS. **20** through **22**, dermis **1305** is separated from hypodermis **1303** by interface **1308**. As illustrated in FIGS. **20** through **22** interface **1308** may be idealized as a substantially straight line for the purposes of simplified illustration however in actual tissue, interface **1308** may be a non-linear, non-continuous, rough interface which may also include many tissue structures and groups of tissue structures which cross and interrupt tissue interface **1308**. According to an embodiment of the invention electromagnetic radiation may be radiated at a frequency of, for example, between 5 and 6.5 GHz. According to an embodiment of the invention electromagnetic radiation may be radiated at a frequency of, for example, approximately 5.8 GHz. According to an embodiment of the invention scattering element **2378** may be located in coolant chamber **2360** and intermediate scattering elements **3393** may be located between coolant chambers **2360**. According to an embodiment of the invention scattering element **2378** and intermediate scattering elements **3393** may be used to, for example, spread and flatten first tissue region **1309**. According to an embodiment of the invention scattering element **2378** and intermediate scattering elements **3393** may be used to, for example, spread and flatten a region, such as first tissue region **1309**, of peak SAR in tissue. According to an embodiment of the invention scattering element **2378** and intermediate scattering elements **3393** may be used to, for example, spread and flatten a region, such as first tissue region **1309**, of peak power loss density in tissue. According to an embodiment of the invention scattering element **2378** and intermediate scattering elements **3393** may be used to, for example, spread and flatten a region, such as first tissue region **1309**, of peak temperature in tissue. According to an embodiment of the invention scattering element **2378** and scattering elements **3393** may be used to, for example, spread and flatten lesions formed in first tissue region **1309**. According to an embodiment of the invention the creation of lesions, such as for example, a lesion in tissue region **1309** may be used to treat the skin of patients. According to an embodiment of the invention the creation of lesions, such as for example, a lesion in tissue region **1309** may be used to damage or destroy structures, such as, for example, sweat glands in the skin of a patient.

[0049] FIG. **23** is a graphical illustration of a pattern of lesions in tissue according to an embodiment of the invention. According to an embodiment of the invention lesions may be created in a predetermined order, such as, for example A-B-C-D where: A represents a lesion initiated directly under waveguide antenna **2364***a;* B represents a lesion initiated directly under waveguide antenna **2364***b;* C represents a lesion initiated directly under waveguide antenna **2364***c;* D represents a lesion initiated directly under waveguide antenna **2364***d.* According to an embodiment of the invention lesions may be created in a predetermined order such as, for example, A-AB-B-BC-C-CD-D where: A represents a lesion initiated directly under waveguide antenna **2364***a;* AB represents a lesion initiated under the intersection between waveguide antenna **2364***a* and waveguide antenna **2364***b;* B represents a lesion initiated directly under waveguide antenna **2364***b;* BC represents a lesion initiated under the intersection between waveguide antenna **2364***b* and waveguide antenna **2364***c;* C represents a lesion initiated directly under waveguide antenna **2364***c;* CD represents a lesion initiated under the intersection between waveguide antenna **2364***c* and waveguide antenna **2364***d;* and D represents a lesion initiated directly under waveguide antenna **2364***d.* According to an embodiment of the invention a lesion AB may be created between waveguide antenna **2364***a* and waveguide antenna **2364***b,* by driving waveguide antenna **2364***a* and waveguide antenna **2364***b* simultaneously in phase and with a balanced output from each antenna. According to an embodiment of the invention a lesion BC may be created between waveguide antenna **2364***b* and waveguide antenna **2364***c,* by driving waveguide antenna **2364***b* and waveguide antenna **2364***c* simultaneously in phase and with a balanced output from each waveguide antenna. According to an embodiment of the invention a lesion CD may be created between waveguide antenna **2364***c* and waveguide antenna **2364***d,* by driving waveguide antenna **2364***c* and waveguide antenna **2364***d* simultaneously in phase and with a balanced output from each waveguide antenna.

[0050] FIG. **24** is a treatment template **2483** according to an embodiment of the invention. According to an embodiment of the invention treatment template **2483** may include axilla outline **2497**, anesthesia injection sites **2485**, landmark alignment marks **2497**, device alignment points **2498** and device alignment lines **2499**. According to an embodiment of the invention axilla outline **2497** may be matched to the hair bearing area of a patient to select an appropriate treatment template **2483**. According to an embodiment of the invention anesthesia injection sites **2485** may be used to identify appropriate points in the axilla for the injection of anesthesia. According to an embodiment of the invention landmark alignment marks may be used to align treatment template **2483** to landmarks, such as, for example, tattoos or moles on the axilla. According to an embodiment of the invention device alignment points **2498** may be used in conjunction with alignment features **3352** to properly align medical treatment device **2300**. According to an embodiment of the invention device alignment lines **2499** may be used in conjunction with an outer edge of compliant member **2375** to properly align medical treatment device **2300**. According to an embodiment of the invention treatment template **2384** provides guidance and placement information for medical treatment device **2300** in matrix format.

[0051] According to an embodiment of the invention, a medical device disposable may include: a tissue chamber may have a tissue opening at a distal end and a rigid surface surrounding the tissue opening; an applicator chamber; a flexible bio-barrier at a proximal end of the tissue chamber the flexible bio-barrier separating the tissue chamber and the applicator chamber, a portion of the flexible bio-barrier forming a tissue contacting surface; a compliant member surrounding the tissue opening, the compliant member may have

a proximal opening adjacent the tissue opening and a distal opening, wherein the distal opening may be larger than the proximal opening.

[0052] According to an embodiment of the invention the medical device disposable compliant member may be positioned at an angle of approximately fifty-three degrees with respect to the rigid surface. According to an embodiment of the invention the compliant member may include a wall connecting the proximal opening and the distal opening and the wall may be angled approximately fifty-three degrees with respect to the rigid surface. According to an embodiment of the invention the compliant member may further include an outer rim positioned around the distal opening. According to an embodiment of the invention: the outer rim may extend a distance of approximately 0.033 inches from the distal opening; the compliant member may have a height of approximately 0.25 inches; the tissue opening may have a long axis and a short axis, the tissue opening long axis may be approximately 1.875 inches and the tissue opening short axis may be approximately 1.055 inches; the distal opening in the compliant member may have a long axis and a short axis, the distal opening long axis may be approximately 2.429 inches and the distal opening short axis may be approximately 1.609 inches; the tissue contact surface may have a long axis and a short axis, the long axis may be approximately 1.54 inches and the short axis may be approximately 0.700 inches. According to an embodiment of the invention the wall may be substantially straight. According to an embodiment of the invention the compliant member may include one or more alignment marks, at least one of the alignment marks may be positioned on a long side of the compliant member. According to an embodiment of the invention the alignment marks may be positioned on a wall of the skirt and may extend from approximately the rim toward the tissue opening. According to an embodiment of the invention the alignment marks may move with respect to an applicator positioned in the applicator chamber when the medical device disposable is pressed against tissue with sufficient pressure to compress the compliant member. According to an embodiment of the invention the wall may have a thickness of approximately 0.050 inches. According to an embodiment of the invention the tissue chamber may include a chamber wall extending from the tissue opening to approximately the tissue contact surface, the wall may also include a substantially smooth, radiused surface. According to an embodiment of the invention the radiused surface may have a radius of approximately three-sixteenths of an inch. According to an embodiment of the invention the compliant member may have durometer density rating of approximately A60.

[0053] According to an embodiment of the invention, a medical device disposable may include: a tissue chamber including a tissue contact surface at a proximal end of the tissue chamber and a tissue opening at a distal end of the tissue chamber; an applicator chamber; a flexible bio-barrier at a proximal end of the tissue chamber the flexible bio-barrier separating the tissue chamber and the applicator chamber, the flexible bio-barrier forming at least a portion of the tissue contact surface; a vacuum port; a vacuum circuit connecting the tissue chamber, the applicator chamber and the vacuum port, the vacuum circuit including a vacuum passage.

[0054] According to an embodiment of the invention the vacuum circuit may include: a vacuum passage positioned around the tissue contact surface; a vacuum channel positioned around the vacuum passage, the vacuum channel positioned between the vacuum passage and the vacuum port; an applicator bio-barrier positioned between the vacuum port and the applicator chamber, the applicator bio-barrier being substantially permeable to air and substantially impermeable to fluids. According to an embodiment of the invention the vacuum passage may completely surround the tissue interface surface. According to an embodiment of the invention the vacuum passage may substantially surrounds the tissue interface surface. According to an embodiment of the invention the vacuum passage may be positioned in a wall of the tissue chamber adjacent the tissue contact surface. According to an embodiment of the invention vacuum port may be connected to a vacuum tube. According to an embodiment of the invention the vacuum tube may include a generator bio-barrier. According to an embodiment of the invention the generator bio-barrier may be substantially permeable to air and being substantially impermeable to fluids. According to an embodiment of the invention the vacuum channel may include a well region adapted to collect fluids from the tissue chamber. According to an embodiment of the invention a compliant member may surround the tissue opening, the compliant member may have a proximal opening adjacent the tissue opening and a distal opening, wherein the distal opening may be larger than the proximal opening. According to an embodiment of the invention the vacuum passage may be an opening between a wall of the tissue chamber and the tissue bio-barrier. According to an embodiment of the invention the vacuum passage may be approximately 0.020" inches wide. According to an embodiment of the invention the vacuum passage may be greater than approximately 0.010" inches when the medical device disposable may be attached to an applicator. According to an embodiment of the invention the tissue surface may have an area greater than an outer area of an antenna array in an applicator affixed to the medical device disposable. According to an embodiment of the invention the tissue surface may have an area greater than an aperture area of an antenna array in an applicator affixed to the medical device disposable.

[0055] According to an embodiment of the invention a method of creating a lesion in skin is described, the method including the steps of: positioning an apparatus including a plurality of antennas adjacent a skin surface; supplying energy to a first antenna at a first power level for a first time period; supplying energy to a second antenna at a second power level for a second time period; supplying energy simultaneously to both the first antenna and the second antenna for a third time period, wherein, during the third time period the energy may be supplied to the first antenna at a third power level and the energy may be supplied to the second antenna at a fourth power level. According to an embodiment of the invention the energy supplied to the first antenna may be in phase with the energy supplied to the second antenna. According to an embodiment of the invention the energy supplied to the first antenna may be phase shifted from the energy supplied to the second antenna. According to an embodiment of the invention the energy supplied to the first antenna may be phase shifted approximately one hundred eighty degrees from the energy supplied to the second antenna. According to an embodiment of the invention the energy supplied to the first antenna may be phase shifted between one and one hundred eighty degrees from the energy supplied to the second antenna. According to an embodiment of the invention the energy output from the first antenna may be substantially in phase with energy output from the second

antenna. According to an embodiment of the invention the energy supplied to the first antenna may be phase shifted from the energy supplied to the second antenna, the phase shift being sufficient to cause energy output from the first antenna to be in phase with energy output from the second antenna. According to an embodiment of the invention the energy supplied to the first and second antennas may be microwave energy having a frequency of approximately 5.8 GHz. According to an embodiment of the invention the first and second antennas may be microwave antennas. According to an embodiment of the invention the first and second antennas may be waveguide antennas. According to an embodiment of the invention the first and the second power levels may be substantially equal. According to an embodiment of the invention the first power level may be greater than the second power level. According to an embodiment of the invention the power emitted by the first antenna may be substantially equal to power emitted by the second antenna.

[0056] According to an embodiment of the invention a medical device applicator may include: an antenna array including at least two antenna apertures; at least one intermediate scattering element positioned outside the apertures wherein the at least one intermediate scattering element may be further positioned between the apertures. According to an embodiment of the invention each of the apertures may be substantially rectangular in shape, the apertures including a long axis and a short axis. According to an embodiment of the invention each of the intermediate scattering elements may include a long axis and a short axis wherein the long axis of the at least one intermediate scattering element may be substantially parallel to the long axis of the aperture. According to an embodiment of the invention the medical device applicator may include a cooling plate and the intermediate scattering element may be positioned between the antenna apertures and the cooling plate. According to an embodiment of the invention the medical device applicator may further include one or more coolant chambers positioned between the cooling plate and the antenna aperture. According to an embodiment of the invention the medical device applicator may include at least two central scattering elements positioned under the aperture wherein the at least one intermediate scattering element may be positioned between the central scattering elements. According to an embodiment of the invention the central scattering elements may be positioned substantially in a center of one of the antenna apertures. According to an embodiment of the invention the long axis of the intermediate scattering element may be shorter than the longest dimension of the central scattering element. According to an embodiment of the invention the intermediate scattering element may be manufactured from a material which may have the same dielectric constant as the central scattering element. According to an embodiment of the invention the intermediate scattering element may be made from alumina. According to an embodiment of the invention the intermediate scattering element may be made from a material which may be more than 90 percent alumina. According to an embodiment of the invention the intermediate scattering element may be made from a material which may be approximately 96 percent alumina. According to an embodiment of the invention the intermediate scattering element may be made from, for example silicone. According to an embodiment of the invention one or more temperature measurement devices may be positioned on the cooling plate under the intermediate scattering element. According to an embodiment of the invention the one or more temperature measurement device may be one or more thermocouples.

[0057] According to an embodiment of the invention a medical device applicator may include at least a first and a second waveguide antenna and at least a first electrically conductive shim positioned between the waveguide antennas. According to an embodiment of the invention each of the waveguide antennas may include: a dielectric core having four sides; metal plating on three sides of the dielectric core, the fourth side of the dielectric core forming an antenna aperture. According to an embodiment of the invention the electrically conductive shim may be copper. According to an embodiment of the invention the electrically conductive shim may be approximately 0.025 inches thick. According to an embodiment of the invention the electrically conductive shim may be positioned between the first and second waveguide antennas such that an edge of the electrically conductive shim may be adjacent the antenna apertures. According to an embodiment of the invention an intermediate scattering element may be positioned under the conductive shim. According to an embodiment of the invention central scattering elements may be positioned under the antenna apertures. According to an embodiment of the invention the medical device applicator may include a cooling plate. According to an embodiment of the invention the intermediate scattering element and the central scattering element may be positioned between the antenna apertures and the cooling plate. According to an embodiment of the invention the medical device applicator may include a coolant chamber positioned between the antenna apertures and the cooling plate. According to an embodiment of the invention the medical device applicator may include temperature sensors positioned on the cooling plate.

What is claimed is:

1. A system for creating a lesion in skin, said system comprising:

an apparatus including a plurality of waveguide antennas, including at least a first, second, third and fourth waveguide antenna;

a control system, wherein said control system:

supplies energy to said first waveguide antenna at a first power level for a first time period;

supplies energy to said second waveguide antenna at a second power level for a second time period; and

supplies energy simultaneously to both said first waveguide antenna and said second waveguide antenna for a third time period, wherein, during said third time period said energy is supplied to said first waveguide antenna at a third power level and said energy is supplied to said second waveguide antenna at a fourth power level.

2. The system of claim **1** wherein said energy supplied to said first waveguide antenna is in phase with said energy supplied to said second waveguide antenna.

3. The system of claim **2** wherein said energy supplied to said first waveguide antenna is phase shifted from said energy applied to said second waveguide antenna.

4. The system of claim **3** wherein said energy supplied to said first waveguide antenna is phase shifted approximately 180 degrees from said energy applied to said second waveguide antenna.

5. The system of claim **4** wherein said energy supplied to said first waveguide antenna is phase shifted between

approximately 1 degree and 180 degrees from said energy applied to said second waveguide antenna.

6. The system of claim **5** wherein energy output from said first waveguide antenna is substantially in phase with energy output from said second waveguide antenna.

7. The system of claim **3** wherein said energy supplied to said first waveguide antenna is phase shifted from said energy applied to said second waveguide antenna, said phase shift being sufficient to cause energy output from said first waveguide antenna to be in phase with energy output from said second waveguide antenna.

8. The system of claim **1** wherein said energy supplied to said first and second waveguide antennas is microwave energy.

9. The system of claim **7** wherein said first and second power levels are substantially equal.

10. The system of claim **9** wherein said first power level is greater than said second power level.

11. The system of claim I wherein energy output from said first waveguide antenna is substantially equal to energy output from said second waveguide antenna.

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