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Feine

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(54) **ENERGY HARVESTING INSERT FOR AN ULTRASONIC HANDPIECE WITH ELECTRICAL DEVICE**

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A61C 17/20 (2006.01)
A61C 1/00 (2006.01)
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USPC 433/188-119, 86, 29; 310/21, 26, 30; 318/118; 601/2; 606/169, 171, 177, 606/178; 604/22

See application file for complete search history.

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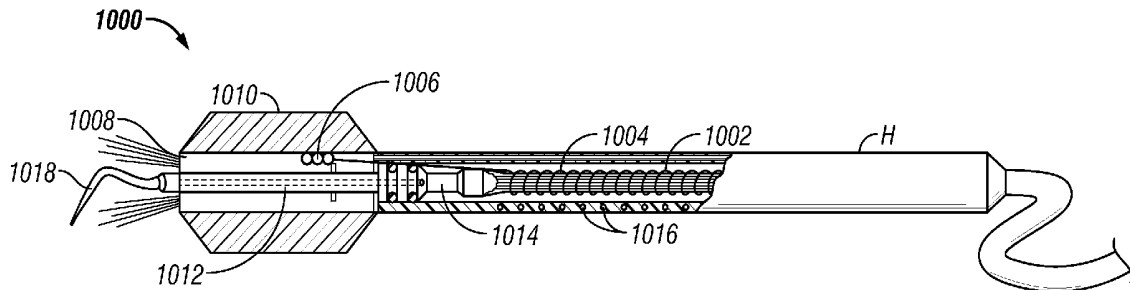
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(57) **ABSTRACT**

An apparatus and a handheld electrical tool system comprising an insert receivable in an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply, the insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil. A method of operating a handpiece and of retrofitting a handpiece is also disclosed.

27 Claims, 10 Drawing Sheets



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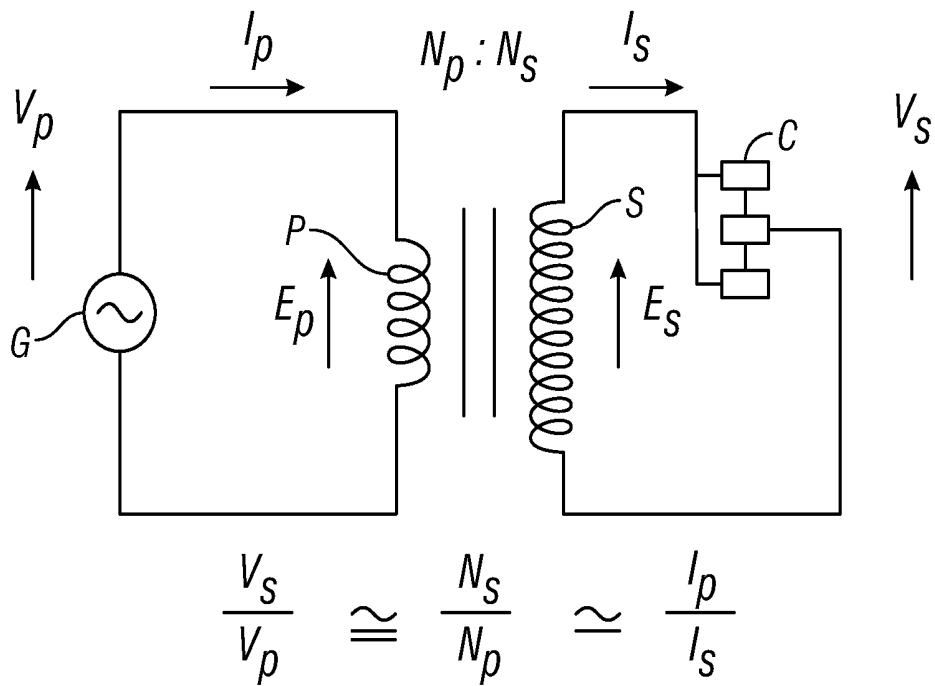


FIG. 1

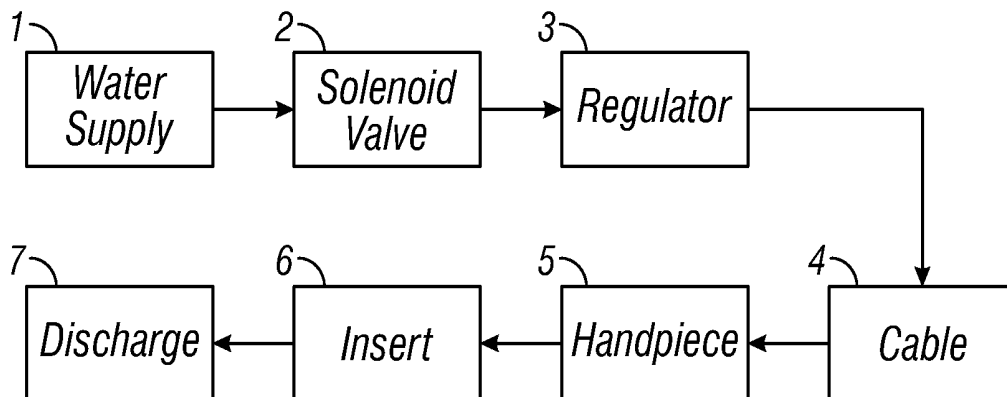


FIG. 2

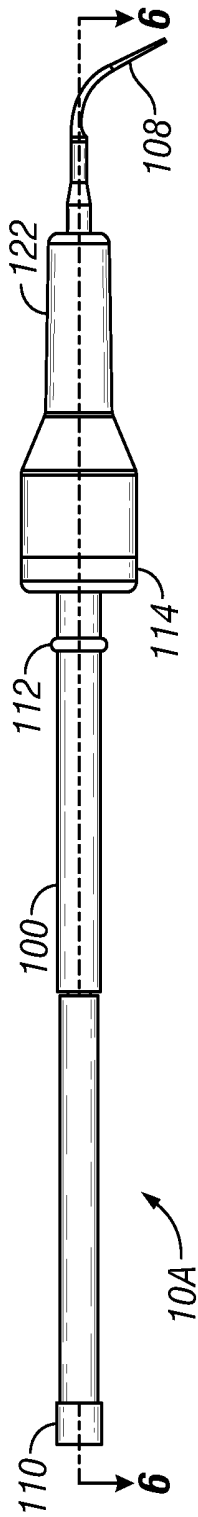


FIG. 5

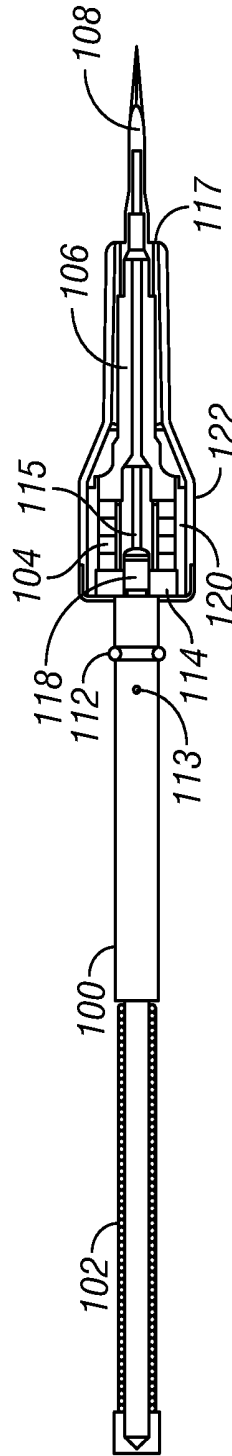


FIG. 6

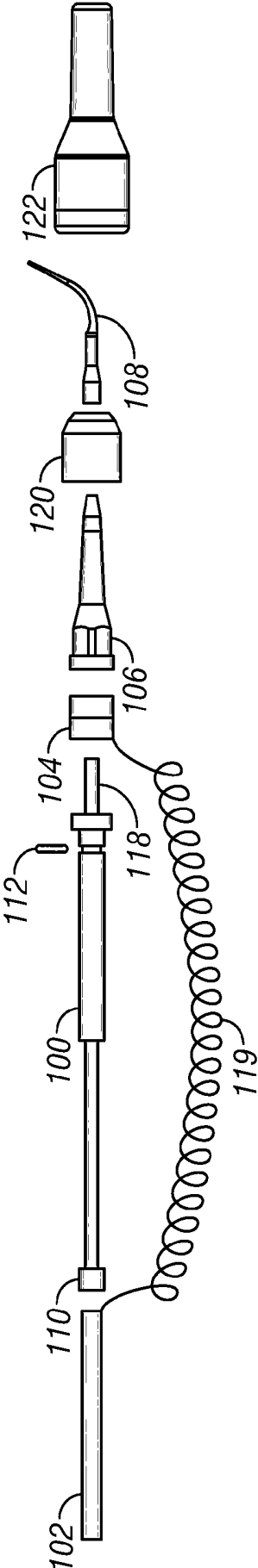


FIG. 7

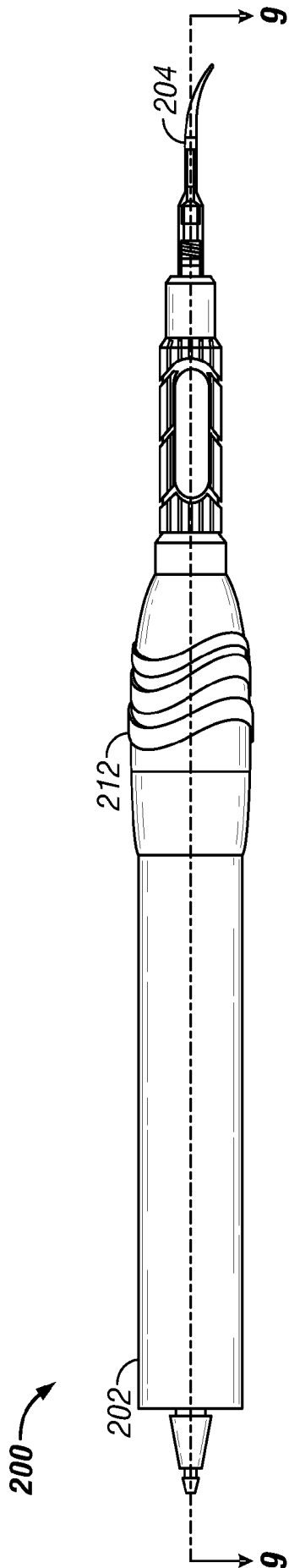


FIG. 8

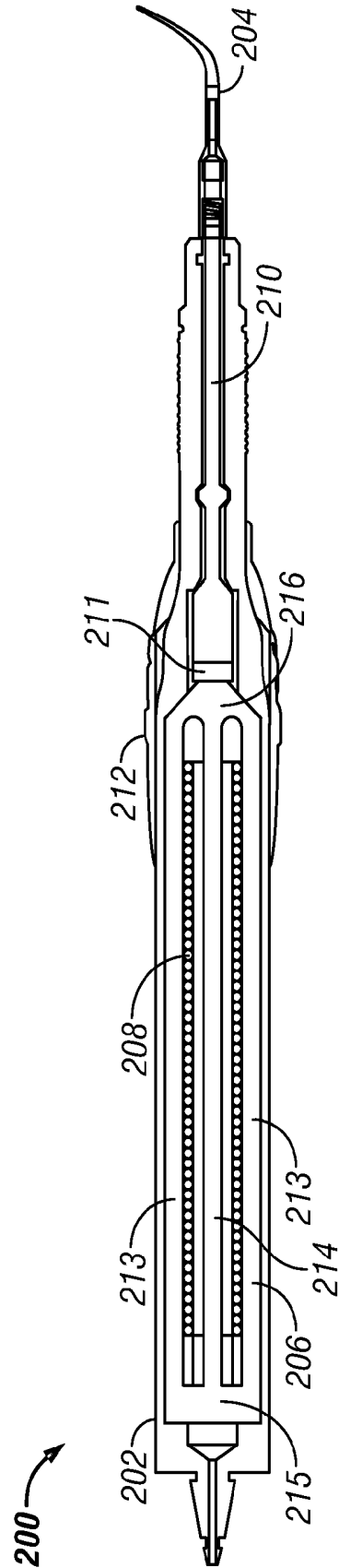


FIG. 9

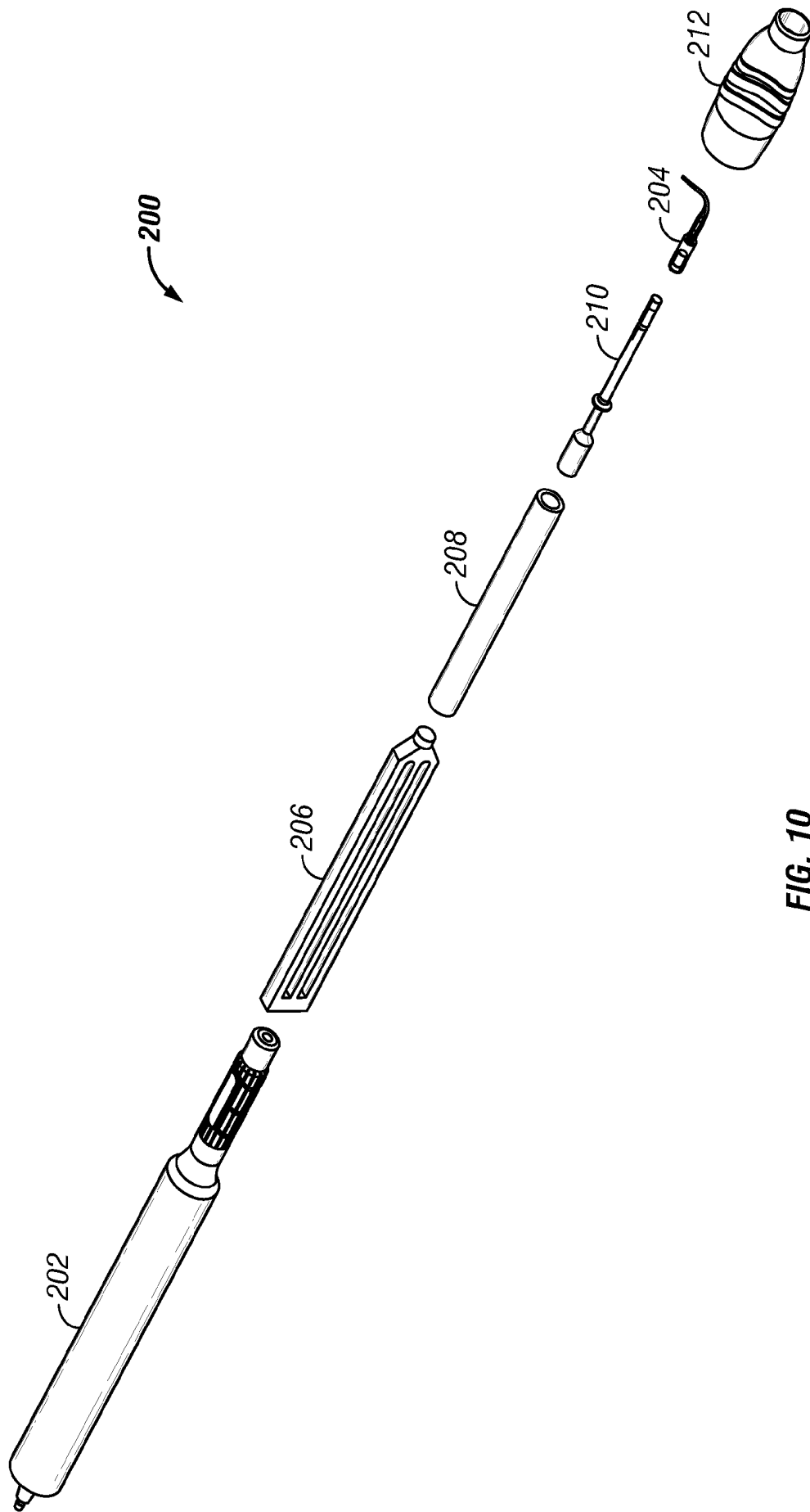


FIG. 10

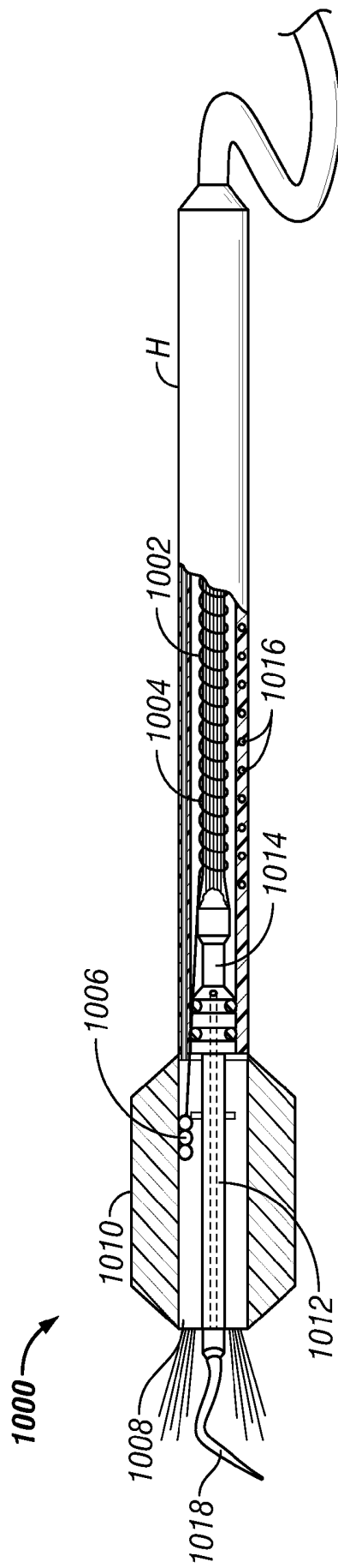


FIG. 11

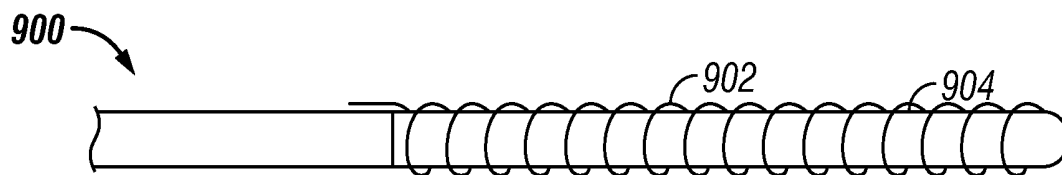


FIG. 12

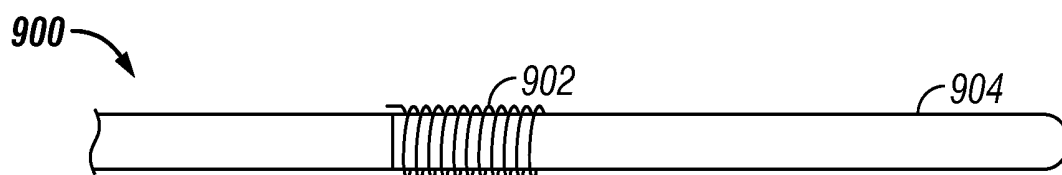


FIG. 13

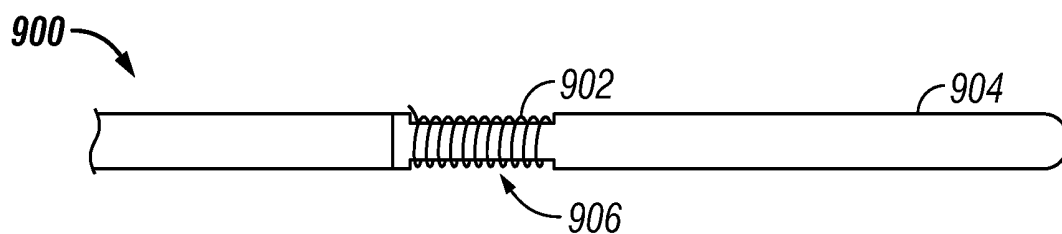


FIG. 14A

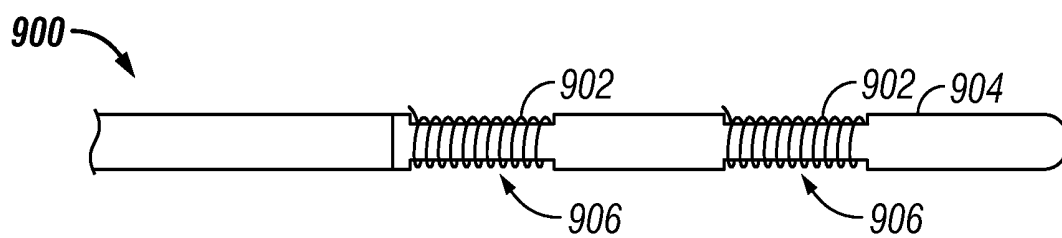


FIG. 14B

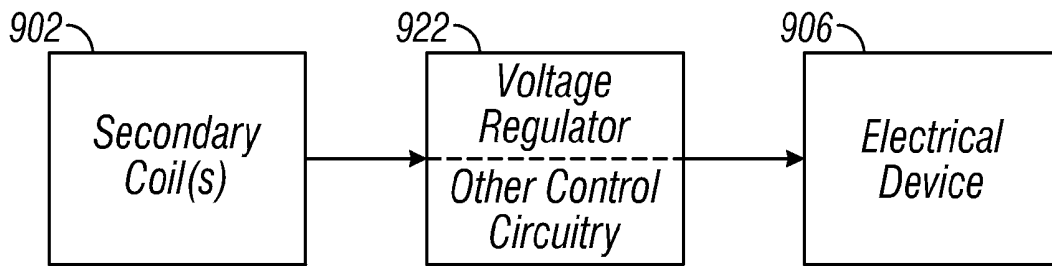


FIG. 15

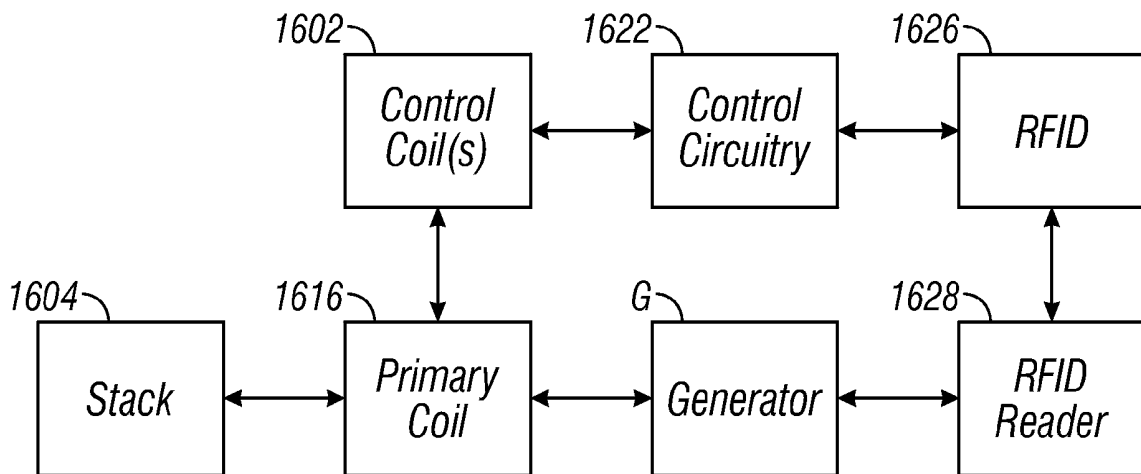


FIG. 16

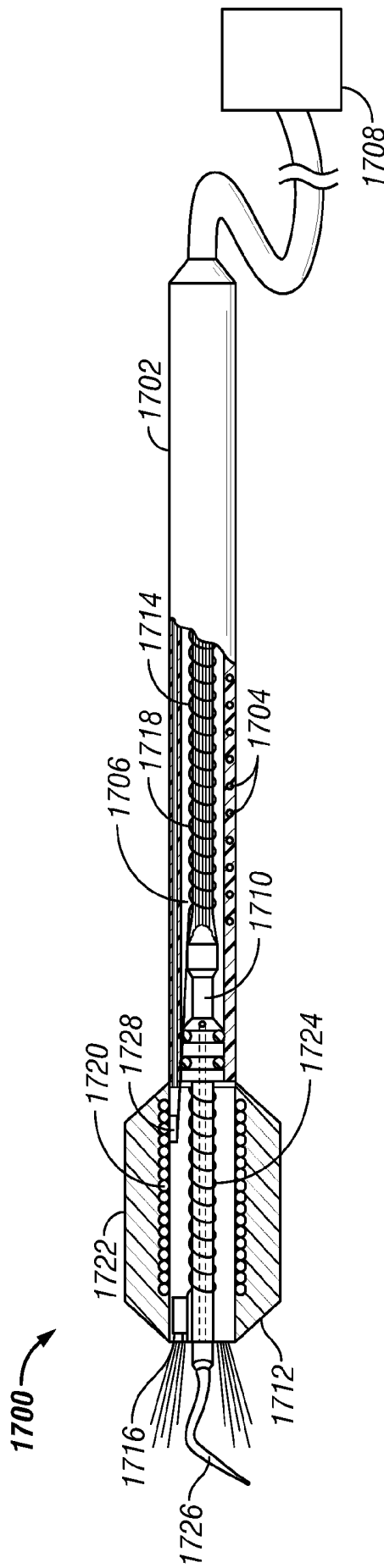


FIG. 17

ENERGY HARVESTING INSERT FOR AN ULTRASONIC HANDPIECE WITH ELECTRICAL DEVICE

BACKGROUND

Currently, piezo style replaceable tips are not compatible with magnetostrictive ultrasonic medical and dental equipment, e.g., scalers. Separate operating systems are used for the two different types of devices, each with its own generator or power supply, handpieces, inserts, etc. which are specific to the particular device not interchangeable or useful with other devices or types of devices. Sometimes, for example, it is desired to use lights with or integrated into the equipment, to provide illumination to the work area for the primary device, and various attempts have been made to transfer power or light from or through the handpiece to the light emitting device.

There is a need in general for improvements in ultrasonic medical and dental equipment, and specifically for more versatility, interchangeability and adaptability of ultrasonic medical and dental equipment.

SUMMARY OF THE INVENTION

Disclosed herein is an insert receivable in an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply, the insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil. Accordingly, the energy to power an electrical device disposed on, in, or coupled to the insert is provided by induction of the power supplied by the handpiece power supply, which results in an amount of available energy previously unknown in such devices without requiring a direct electrical connection between an external power source and the electrical device.

In an embodiment, a tip-based computer-controlled tool system comprises an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply; an insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil; the electrical device comprising an operating characteristic controller enabled to control a value of an operating characteristic of at least one other electrical device, and a microprocessor coupled to the operating characteristic controller, the microprocessor comprising an algorithm for determining a desired value of an operating characteristic for the at least one other electrical device and adjusting the operating characteristic delivered to the at least one other electrical device to the desired value via the operating characteristic controller, the operating characteristic comprising a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

In an embodiment, a method of operating an ultrasonic handpiece comprising a primary coil disposed about a well

and electrically connected to a primary current supply comprises disposing an insert into the well of the ultrasonic handpiece, the insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil being in electrical communication with at least one electrical device; supplying power to the primary coil via the primary current supply; and powering the at least one electrical device with the secondary coil via induction of the power from the primary coil into the secondary coil.

In an embodiment, a method of retrofitting a magnetostrictive ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a magnetostrictive primary current supply comprises inserting an insert into the well of the ultrasonic handpiece, the insert comprising: a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil.

The instant disclosure expands the functionality of a magnetostrictive generator and in one embodiment makes it compatible with piezo style tips. In an embodiment, the instant disclosure discloses conversion of a magnetostrictive generator into a piezo ultrasonic generator. Such an instrument may be especially advantageous where a clinician may need to use a portable unit, e.g., in moving from one location to another.

In other embodiments, an insert for a handpiece is provided which harvests energy by induction like a transformer to power a variety of handheld instruments, especially dental and medical tools, such as, for example, caries and/or cancer detectors, high speed rotary machines, low speed rotary machines, curing lights, localized prophylactic and medication dispensers, piezo scalers, and the like.

In an embodiment, electrical power to an electrical device, which may comprise a lighted element, is provided by utilizing the magnetic field flux generated in the handpiece of a magnetostrictive scaler. The magnetostrictive stack material is not only used to vibrate a connecting body and thusly a tip of a scaler, but is also utilized as a core in a coil or a plurality of coils of wire arranged as a secondary coil such that the secondary coil is inductively coupled to the primary coil, similar to the arrangement in a transformer, to generate electricity supplied to power at least one electrical device, which may include a light element.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an electrical diagram for the insert assembly according to an embodiment of the instant disclosure.

FIG. 2 is a block flow diagram for the water supply to the handpiece/insert assembly according to an embodiment of the instant disclosure.

FIG. 3 is a perspective view of a piezo insert assembled in a magnetostrictive handpiece according to an embodiment of the instant disclosure.

FIG. 4 is a cross sectional view of the assembly of FIG. 3 as seen along the lines 4-4.

FIG. 5 is a perspective view of an insert according to an embodiment of the instant disclosure.

FIG. 6 is a cross sectional view of the assembly of FIG. 5 as seen along the lines 6-6.

FIG. 7 is an exploded view of the insert of FIGS. 5-6.

FIG. 8 is a perspective view of a piezo insert assembled in a magnetostrictive handpiece according to another embodiment.

FIG. 9 is a cross sectional view of the assembly of FIG. 8 as seen along the lines 9-9.

FIG. 10 is a partially exploded view of the insert of FIGS. 8-9.

FIG. 11 is a partial cross-sectional perspective view of a handpiece, dental scaling insert, secondary circuit and lighting element according to an embodiment.

FIG. 12 is a schematic diagram of a portion of a magnetostrictive stack and full-length secondary coil according to an alternate embodiment of FIG. 11.

FIG. 13 is a schematic diagram of a portion of a magnetostrictive stack and partial-length secondary coil according to an alternate embodiment of FIG. 11.

FIG. 14 is a schematic diagram of a portion of a magnetostrictive stack and a profiled secondary coil according to an alternate embodiment of FIG. 11.

FIG. 15 is a schematic electrical diagram for an embodiment of the self-lighting magnetostrictive insert of FIG. 11.

FIG. 16 is a control schema for a tool- or tip-controlled insert according to another embodiment.

FIG. 17 is a partial cross-sectional perspective view of a handpiece, dental scaling insert, secondary circuit and tertiary circuit according to an embodiment.

DETAILED DESCRIPTION

At the outset, it should be noted that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developer's specific goals, such as compliance with system related and business related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time consuming but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure. In addition, the article or composition used/disclosed herein can also comprise some components other than those cited. In the summary and this detailed description, each numerical value should be read once as modified by the term "about" (unless already expressly so modified), and then read again as not so modified unless otherwise indicated in context. Also, in the summary and this detailed description, it should be understood that a physical range listed or described as being useful, suitable, or the like, is intended that any and every value within the range, including the end points, is to be considered as having been stated. For example, "a range of from 1 to 10" is to be read as indicating each and every possible number along the continuum between about 1 and about 10. Thus, even if specific data points within the range, or even no data points within the range, are explicitly identified or refer to only a few specific, it is to be understood that inventors appreciate and understand that any and all data points within the range are to be considered to have been specified, and that inventors possessed knowledge of the entire range and all points within the range.

As used in the specification and claims, "near" and "proximate to" is inclusive of "at."

The following definitions are provided in order to aid those skilled in the art in understanding the detailed description.

A magnetostrictive stack refers to an ultrasonic transducer, which typically comprise a plurality of elongated strips of magnetostrictive material, each strip having a proximal end and a distal end and are attached to its adjacent strip at the ends to form an integral substantially rigid column having a

central axis with fins extending radially relative to said axis; and an ultrasonic resonant vibrator including such a transducer.

A piezoelectric stack refers to a plurality of piezo crystals arranged with a middle crystal as a first electrode and the end crystals as a second electrode. Energizing of the crystals results in vibrations travel through a piezo horn attached to the piezo crystals to the point or tip of a piezo scaler or other dental device. In the following description, a piezo scaler is referred to for exemplary purposes and is not intended as a limitation unless indicated to the contrary.

For purposes herein an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply is also referred to herein as an ultrasonic handpiece, or simply as a handpiece. Likewise, a power supply to the handpiece refers to an external unit electrically connected to the handpiece which supplies the required power to the handpiece to operate the device consistent with its intended use. In addition, a power supply may further include the necessary hardware, connections, and controls to provide one or more fluids to the handpiece. Typical fluids include water or various aqueous solutions, compressed air or other gases, and the like.

For purposes herein an electrical device includes any device which requires electricity to operate consistent with its intended function. As used herein a detector refers to a device which senses or detects the intended parameter and which is able to evaluate and communicate this information to another entity separate from the detector. Accordingly, a temperature detector according to the instant disclosure refers to a device capable of determining the intended temperature and communicating the temperature via electronic communication to an external source, an internal controller, or the like. Direct electrical connection between the secondary coil and the electrical device indicates a direct wired link between the two.

As used herein, the terms primary coil and secondary coil are used consistent with their common use in the art wherein a primary coil refers to an electrical coil having power supplied to it by an external power supply. Likewise, a secondary coil refers to an electrical coil which is not in direct electrical contact with an external power supply, but instead receives power through induction by being inductively coupled with a primary coil.

As used herein, the turn ratio of the secondary coil relative to the primary coil is defined as the number of turns of the secondary coil divided by the number of turns on the primary. A turn ratio of greater than one increases the voltage induced by the secondary coil relative to the primary coil and a turn ratio of less than one decreases the voltage induced by the secondary coil relative to the primary coil.

For purposes herein, relative magnetic permeability, which is also referred to as relative permeability, and which may also be referred to simply as permeability is a variation upon 'straight' or absolute permeability, μ . Relative magnetic permeability is a measure of how the presence of a particular material affects the relationship between flux density and field strength. Relative magnetic permeability is defined in relation to the permeability of a vacuum, μ_0 , according to the following equation:

$$\mu_r = \mu / \mu_0 \quad \text{Equation MPE}$$

wherein $\mu_0 = 4\pi \times 10^{-7} \text{ V} \cdot \text{s} / (\text{A} \cdot \text{m}) \approx 1.2566370614 \dots \times 10^{-6} \text{ H} \cdot \text{m}^{-1}$ or $\text{N} \cdot \text{A}^{-2}$ or $\text{T} \cdot \text{m} / \text{A}$ or $\text{Wb} / (\text{A} \cdot \text{m})$.

For example, if you use a material for which $\mu_r = 3$ then you know that the flux density will be three times as great as it

would be if we just applied the same field strength to a vacuum. μ_r is a dimensionless ratio having no units associated with it.

As used herein a magnetostrictively inactive core refers to a material which is typically not utilized for producing magnetostrictive movement. While it to be understood that essentially any material may exhibit magnetostrictive oscillation if positioned in a strong-enough oscillating magnetic field, a magnetostrictively inactive metallic core is defined as a material having a magnetostrictive coefficient, L , at saturation which is less than or equal to that of iron under the same conditions. For example, the saturation magnetostrictive coefficient of iron is reported to be about $1.1\text{-}2.0 \times 10^{-5}$ (see Brown, W. F., *Magnetic Materials*, Ch 8 in the *Handbook of Chemistry and Physics*, Condon and Odishaw, eds., McGraw-Hill, 1958). Accordingly, a magnetostrictively inactive core may have a magnetostrictive coefficient at saturation of less than 2.0×10^{-5} .

The term magnetostrictive materials refer to those materials understood by one of skill in the art to be useful for converting magnetic energy into kinetic energy, or the reverse, as demonstrated by their use in building actuators and sensors. The property can be quantified by the magnetostrictive coefficient, L , which is the fractional change in length as the magnetization of the material increases from zero to the saturation value. The effect is responsible for the familiar "electric hum" which can be heard near transformers and high power electrical devices.

Examples of magnetostrictive materials for purposes herein include those having similar properties compared to cobalt, which exhibits the largest room temperature magnetostriction of a pure element at 60 microstrains. Other examples include alloys, including Terfenol-D, $Tb_x Dy_{1-x} Fe_2$, and the like which exhibit about 2,000 microstrains in a field of 2 kOe (160 kA/m) at room temperature. Another very common magnetostrictive composite is the amorphous alloy $Fe_{81} Si_{3.5} B_{13.5} C_2$ with its trade name Metglas 2605SC, and the like which has a high saturation magnetostriction constant, λ , of about 20 microstrains or more, coupled with a low magnetic anisotropy field strength, H_A , of less than 1 kA/m (to reach magnetic saturation).

In an embodiment, an insert receivable in an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply comprises a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil.

In an embodiment, the ultrasonic handpiece acts as a source of power for the electrical devices present on, imbedded in, or associated with the insert and/or the handpiece. In an embodiment, the electrical devices may comprise piezo actuators embedded in, disposed on, attached to, or otherwise associated with an insert.

Turning to FIG. 1, the handpiece generally comprises a primary coil P disposed about a well in which the magnetostrictive insert is normally received. In an embodiment the insert need not comprise a magnetostrictive stack, but may comprise a rod or other suitably shaped object which functions as a core element to the secondary coil receivable within the well of the handpiece made of stainless steel or another core material having a relative magnetic permeability greater than one. In an embodiment, the insert may comprise a magnetostrictive stack, which also functions as the core element to the secondary coil.

A secondary coil S is wound about the core with a number of turns about one or more axes. The alternating current I_p and voltage V_p supplied from the magnetogenerator G passing through the primary coil P in the handpiece induces a current in the secondary coil S to apply a secondary voltage V_s and secondary current I_s to the one or more electrical devices C of the insert. Accordingly, the secondary coil of the insert in proximity to the primary coil of the handpiece and inductively coupled to the primary coil and thus functions as a transformer to convert the primary coil electrical potential E_p to the secondary coil electrical potential E_s , as is readily understood by one of minimal skill in the art. In an embodiment, no movement of the insert is required to produce power for the one or more electrical devices of the insert, the handpiece, or both. Even when the insert includes a magnetostrictive stack and thus undergoes oscillation when power is supplied to the primary coil of the handpiece, the mechanical energy produced by the oscillation provided to the insert by the magnetostrictive stack is not converted into electrical energy. In an embodiment, all of the power supplied to the one or more electrical devices is provided by induction of energy present in the primary coil into the secondary coil disposed on the insert.

For example, the voltage induced across the secondary coil can be estimated from Faraday's law of induction and the turns ratio, N_s/N_p , where N_s is the number of turns of the secondary coil (on the insert) and N_p is the number of turns of the primary coil (in the handpiece). Since inductively coupled coils have a relatively high efficiency, the ideal transformer equations, $V_s/V_p = N_s/N_p = I_p/I_s$, are a reasonable approximation, i.e., $V_s/V_p \approx N_s/N_p \approx I_p/I_s$, as shown in FIG. 1.

For example, the voltage induced across the secondary coil can be estimated from Faraday's law of induction and the turns ratio, N_s/N_p , where N_s is the number of turns of the secondary coil (on the insert) and N_p is the number of turns of the primary coil (in the handpiece). Since inductively coupled coils have a relatively high efficiency, the ideal transformer equations, $V_s/V_p = N_s/N_p = I_p/I_s$, are a reasonable approximation, as shown in FIG. 1.

Piezoelectric oscillators used in dental scalers typically have a series of quartz or other crystals with resonant frequency around 25 to 30 kHz, which is coincidentally similar to that of magnetostrictive devices. However, piezoelectric oscillators typically operate at a much higher voltage than required by a magnetostrictive ultrasonic transducer. The piezo insert for a particular handpiece/generator unit may be designed with a matching resonant frequency. The turn ratio of the secondary coil relative to the primary coil will normally be greater than 1 in one embodiment, greater than 5 or greater than 10 in other embodiments, as is required to step up the voltage from the normal operating range of the magnetostrictive handpiece to that required to operate the piezo unit or another electrical device. Likewise, in an embodiment, the turn ratio of the secondary coil relative to the primary coil may be less than 1 in one embodiment, less than 0.5 or less than 0.10 in other embodiments, as is required to step down or lower the voltage from the normal operating range of the magnetostrictive handpiece to that required to operate the particular electrical device.

In an embodiment, the power supply module of the handpiece also supplies water and/or compressed air to the handpiece which provides cooling and facilitates debris removal from the dental working surfaces being cleaned. As shown in FIG. 2, the water flow diagram for a piezo and magneto scaler handpiece is similar, passing from the water supply 1, through a solenoid valve 2 and regulator 3 which may if desired be disposed in the power supply unit. From the regulator 3, the

water flows through a tube in the cable **4** to the handpiece **5** to provide cooling to the piezo or other insert **6** and finally flows out of the insert through a discharge port **7**, which may be located to clean and/or cool the working surface or area. In one embodiment the cable **4** supplying the water is the same cable supplying electrical power to the handpiece **5** via electrically insulated wires.

The ultrasonic handpiece suitable for use herein are readily available and known in the art. In one embodiment, the handpiece is based on a power generating unit and handpiece available from Ultrasonic Services, Inc. under the trade designation USI 25 MPLC (Ultrasonic Services, Inc., Houston, Tex.) using power level control technology, or one of the power generators as disclosed in U.S. Pat. Nos. 6,164,968; 6,503,081; 6,893,261; 6,976,843; 7,150,629; or the like, each of which incorporated herein by reference in its entirety.

As seen in FIGS. **3** and **4**, the insert **10** is placed inside a suitable handpiece **12** by frictional engagement, for example, by means of O-ring **14**, and supplied with power to the primary coil **20**. The handpiece **12** in one embodiment comprises an inner cylindrical **16**, with an inside diameter forming the well **18** and around which the wire is wrapped to form the primary coil **20**, and an outer cylindrical piece **22** threaded to the inner cylindrical piece **16** at one end and threaded to engage tail nut **24** at the other end.

The water tubing **26** and primary power supply wires **28** are protected in a cable sheath **30** which is in fluid and electrical connection with a conventional power/water supply unit (not shown). Commercially available power supply units include the USI 25 PLC, USI 30 PLC (Ultrasonic Services, Inc., Houston, Tex.) and/or the like. In an embodiment, water or another fluid is supplied to the handpiece **12** via the tubing **26** and nipple fitting **32** and flows through well **18** receiving the insert **10** to provide cooling to the secondary coil **11** disposed about at least a portion of insert **10** dimensioned and arranged to be disposable within well **18** such that secondary coil **11** is inductively coupled to primary coil **20**. Secondary coil **11** is in electrical communication with at least one electrical device **13** powered by secondary coil **11**.

As is shown in FIG. **4**, after the water contacts at least a portion of insert **10** proximate to secondary coil **11**, the water may exit the handpiece, conventionally adjacent the tip **34** through flow passages **15** formed in insert **10**. Accordingly, in an embodiment wherein the ultrasonic handpiece further comprises a water supply in fluid connection with the well, and wherein water supplied to the ultrasonic handpiece contacts at least a portion of the insert proximate to the secondary coil prior to the water exiting the ultrasonic handpiece.

Secondary coil **11** is excited or energized by passing an alternating current supplied via wires **28** through primary coil **20** formed in the shell of handpiece **12**. A voltage and electrical current is produced in secondary coil **11** via induction from primary coil **20**. The voltage from secondary coil **11** causes the one or more electrical devices **13** (e.g., a piezo crystal stack) to oscillate, and the vibration is transmitted conventionally through the piezo horn **17** and then to tip **34**.

In an embodiment, a handheld electrical tool system comprises a handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply (see FIG. **2**); an insert **10** comprising a distal portion **31** and a proximal portion **33**. In an embodiment, the proximal portion **33** being magnetostrictively inactive. In an alternative embodiment, the proximal portion may be magnetostrictive. In an embodiment, the proximal portion **33** is dimensioned and arranged to be removably disposed within the well **18**. The handheld electrical tool system further including an electrical device **13** located on the insert **10**; a secondary coil **11**

disposed about and in contact with the proximal portion **33** of the insert **10** to inductively couple to the primary coil **20** when the proximal portion **33** of the insert **10** is disposed within the well **18** to provide a secondary current supply; and a circuit **35** to electrically connect the electrical device **13** to the secondary current supply.

In an embodiment, the electrical device powered by the secondary coil may comprise one or more of a piezoelectric crystal stack, caries detectors, cancer detectors, temperature detectors, density detectors, strain detectors, conductivity detectors, power level detectors, high speed rotary machines, low speed rotary machines, spectroscopic detectors, prophylactic dispensers, medicament dispensers, imaging devices, operational controllers, microprocessors, memory modules, communication devices, an electromagnet, an ac to dc converter or a combination thereof. In an embodiment, wherein the electrical device comprises an electromagnet, the electromagnet may further include an ac/dc converter and associated control circuitry to produce a direct current from the alternating current produced by the secondary coil. Accordingly, in an embodiment, the electromagnet may be a constant state electromagnet. In an embodiment, the electromagnet may be a variable field electromagnet suitable to produce varying magnetic flux.

In an embodiment, the electrical device may include an electromagnet suitable for use as a magnetic pickup tool. In an embodiment, the electrical device may include an electromagnet suitable for use in producing a cure in magnetically cured composites.

In an embodiment, the electrical device powered by the secondary coil may comprise illumination lights, curing lights, or a combination thereof, wherein the insert comprises a magnetostrictively inactive core.

In an embodiment, the electrical device may comprise an operating characteristic controller enabled to control a value of an operating characteristic of at least one other electrical device. In an embodiment, the insert may further comprise a microprocessor coupled to the operating characteristic controller, the microprocessor comprising an algorithm for determining a desired value of an operating characteristic for the at least one other electrical device and adjusting the operating characteristic delivered to the at least one other electrical device to the desired value via the operating characteristic controller. In an embodiment, the operating characteristic comprises a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

An example of an insert **10A** is shown in FIGS. **5**, **6** and **7**. In this embodiment, the electrical device comprises a piezo insert, and thus may be used in retrofitting a magnetostrictive ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a magnetostrictive primary current supply by inserting a piezo insert according to an embodiment of the instant disclosure into the handpiece.

In an embodiment, insert **10A** comprises a secondary coil **102** disposed around at least a portion of a magnetostrictively inactive metallic core **100** having a relative magnetic permeability of greater than 1, or greater than 5, or greater than 100, or greater than 1000, or greater than 10,000. In an embodiment, the metallic core **100** may comprise stainless steel. In an embodiment, core **100** is wound with a secondary coil **102** to supply a secondary current to one or more electrical devices, e.g., a piezo crystal stack **104**, which transmits vibration through the horn **106** to the tip **108** connected thereto,

e.g., by threading. Accordingly, in an embodiment, the electrical device comprises a piezoelectric stack mechanically coupled to a horn, the horn coupled to or couple-able to a tip, wherein a tip if couple-able if it can be removed and then reattached.

Accordingly, in an embodiment, the handheld electrical tool system may further comprise an insert inventory comprising a plurality of the inserts **108** for the handpiece **100**, wherein the inserts are interchangeable in the handpiece and the electrical devices of the respective ones of the plurality of inserts are the same or different.

Likewise, in an embodiment, the handheld electrical tool system may further comprise an insert inventory comprising a plurality of interchangeable inserts for the handpiece, wherein the inventory comprises at least the electrical device insert and an ultrasonic magnetostrictive insert, and a magnetostrictive power generator to provide the primary current with characteristics to selectively operate the ultrasonic magnetostrictive insert and the electrical device insert.

In an embodiment, core **100** includes an enlarged distal end **110** which is dimensioned and arranged to retain secondary coil **102** and may further provide a back mass for the piezo crystal stack **104**.

In an embodiment, a proximal end of core **100** supports an o-ring **112** for frictional engagement in the handpiece as described above, and a washer **114** to retain the piezo crystal stack **104**. The washer **114** is shouldered around a proximal extension **118** of core **100** which extends into a bore in the annular-shaped piezo crystal stack **104** to provide engagement of the piezo stack to horn **106**, e.g., by threading. A non-conductive (e.g., plastic) case **120** may be provided for piezo stack **104**, and/or for other electrical devices to provide isolation of the electrical device from water or an external environment. An overall or outer housing **122** may also be provided for proximal end of the insert **10A**.

In an embodiment, core **100** may include a lateral bore or conduit **113** arranged behind O-ring **112** in communication with a central proximal bore **115** to supply cooling water from the handpiece well, through or around the electrical device (e.g., crystal stack **104**) in fluid communication with an external environment through one or more outlets **117** located at or near tip **108**. In an embodiment, secondary coil **102** comprises wires insulated with a thin resin coating with similarly insulated leads **119** to provide direct electrical communication with the one or more electrical devices, e.g., piezo crystal stack **104**.

In an embodiment, the insert **10A** is adapted to be powered and used in a conventional magnetostrictive handpiece with a magnetostrictive power supply. Thus the magnetostrictive handpiece and the associated power supply unit can be converted to a piezo type unit with an insert comprising a piezo stack, with no other changes to the magnetostrictive handpiece or power supply unit required, other than changing the insert according to an embodiment of the instant disclosure. In an embodiment, tuning of the power supply unit may be required for operation. The magnetostrictive power supply can employ manual tuning or automatic tuning with a feedback circuit as is known in the art to detect resonant frequency based on power consumption, with or without offset tuning.

A magnetostrictive ultrasonic power scaler can thus be adapted or retrofit to power a piezo insert, based on micro-processor technology in one embodiment, and provide advanced features such as comfort and ease of a manual tuned unit, utilization of any operating frequency, automatic water control, RFID technology, or any combination thereof. For example the unit can use one or more features from U.S. Pat.

Nos. 6,503,081 6,893,261; 6,976,843; 7,150,629; or the like, each of which incorporated herein by reference in its entirety.

In an embodiment as shown in FIGS. **8-10**, the insert **200** may comprise a conventional or specially adapted insert having a portion **202** dimensioned and arranged to be disposable within a well of a handpiece such that the secondary coil **208** is inductively coupled to the primary coil of the handpiece. The secondary coil **208** is wrapped around or otherwise disposed around at least a portion of a magnetostrictively inactive metallic core **206** having a relative magnetic permeability of greater than 1. Core **206** is attached to horn/connector body **210** comprising one or more electrical devices **211** in electrical communication with secondary coil **208**, and a grip member **212**. Horn **210** is coupled or couple-able to tip **204**. In an embodiment, insert **200** is constructed in the same general manner as the assembly of FIGS. **3-7**, except core **206** comprises a high magnetic permeability material having a relative magnetic permeability of greater than 1, or greater than 5, or greater than 10, or greater than 100, or greater than 1,000, or greater than 10,000 and comprises at least three longitudinal sections **213** and **214** spaced laterally apart and joined via transverse members **215** and **216** at either end. Secondary coil **208** is wound around central longitudinal section **214**, passing through the spaces between the outer longitudinal members **213**. Such an arrangement improves the efficiency of the induction of the power from a primary coil. In an embodiment, secondary coil **208** may be encased in a non-conductive polymer matrix, e.g., epoxy. In an embodiment, a plurality of secondary coils may be similarly arranged in the insert collinear with the secondary coil, or sequentially arranged along a central axis of the core (not shown) depending on the power needs for the one or more electrical devices powered by the secondary coils.

As shown in FIG. **11**, in an embodiment an insert **1000** according to the instant disclosure may comprise one or more secondary coil(s) **1002** disposed about a core comprising a magnetostrictive stack **1004**, wherein secondary coil **1002** is in electrical connection with one or more electrical devices, which may include one or more light-emitting diode (LED) assemblies **1006** or another light producing element, which in an embodiment may be further optically associated with light guide **1008** which may be annular and disposed between an outer grip **1010**, which may be opaque, and a centrally disposed shank **1012** of a velocity transducer **1014**.

The insert **1000** in one embodiment thus provides for vibration of the tip **1018** or other tool as well as power for the lighting element **1006** to light the work area as required by the operator.

In operation, insert **1000** is placed in the handpiece H and operated as a scaler in the normal fashion wherein ultrasonic oscillation is provided by magnetostrictive stack **1004**. The handpiece H provides magnetic induction via primary coil **1016** in the wall of the handpiece. The magnetostrictive stack **1004** is oscillated by the magnetic flux in the usual manner, except that a relatively minor portion of the flux produced by primary coil **1016** is induced as an electrical current in the secondary coil(s) **1002**, which powers the LED assembly **1006**, and any other electrical device present. Light from the LED assembly **1006** passes through the light guide **1008** to illuminate a work area near the tip **1018** or other tool. It is to be understood that in an embodiment according to the instant disclosure, when the insert includes a magnetostrictive stack and thus undergoes oscillation when power is supplied to the primary coil of the handpiece, the mechanical energy produced by the oscillation provided to the insert by the magnetostrictive stack is not converted into electrical energy. In an embodiment, all of the power supplied to the one or more

electrical devices associated with the insert is provided by induction of energy present in the primary coil into the secondary coil disposed on the insert.

In an embodiment, insert **900** may comprise secondary coil(s) **902** disposed along substantially all (see FIG. **12**) or a portion (see FIG. **13**) of core **904**. Core **904** may include a standard profile (i.e., having the same diameter along the length of the core) with secondary coil(s) **902** wound thereon or provided in the form of a sleeve which is fitted over core **904**, where the insert is to be employed in a handpiece **H** with adequate clearance to accommodate the increased transverse dimensions from addition of the secondary coil(s).

In another embodiment, the insert **900** may include a core **904** comprising a profile which has a recess **920** (see FIG. **14a**) to receive the secondary coil(s) **902** so that the coil does not increase the transverse dimensions of the core **902**, or increases the transverse dimensions only where the lead wires from the coil(s) **902** traverse the outer surface of the core **904** to provide electrical connection between the secondary coil **902** and the one or more electrical device (not shown) As shown in FIG. **14b**, a plurality of coils **902** may be used, which may be the same of different, and may be disposed end to end along the core **904**, or they can be nested or intertwined (not shown), or any desired combination. The use of a plurality of different secondary coils allows for providing different voltages and power requirements to various electrical devices. In addition, a plurality of coils **902** can be wired in parallel and/or in series.

As shown in FIG. **15**, secondary coil(s) **902**, the one or more electrical device, (e.g., LED assembly) **906** and the associated wires and components are constructed and arranged on or in the core to resist fatigue stresses due to the vibration of the insert **900**. To avoid overpowering the one or more electrical device **906** and to maintain a constant level of power to the device regardless of any modulation of the power input to the primary coil **916**, the insert may further comprise a voltage regulator or other control circuitry **922** as shown in the circuit diagram of FIG. **15**.

With reference to FIG. **16**, in an embodiment, the insert **900** may comprise a tool-control schema comprising circuitry configured to modify the energy available to the secondary coil to control power to the one or more electrical devices. When the insert comprises a magnetostrictive stack **1604**, control circuitry **1622** embedded in the insert **900** (see FIGS. **12** to **14B**) may be adapted to modify the vibration of the driven element associated with the magnetostrictive stack such as a tip, cutting tool, or the like, by dampening or enhancing the vibrations of the magnetostrictive stack **1604**. In an embodiment, the magnetic energy available to magnetostrictive stack **1604** can be attenuated or intensified by using the one or more secondary coil(s) **1602** which function by adjusting the amount of power drawn from the secondary coil(s) **1602**, e.g., by draining power from the handpiece primary coil **1616** and increasing or reducing the amount of power drained, and/or by using one or more of the secondary coils **1602** to produce dampening or reinforcing magnetic fields. In an embodiment wherein the insert does not comprise a magnetostrictive core element, one or more secondary coil(s) **1602** may be employed as an auxiliary or control coil coaxially aligned or otherwise positioned within the flux field of another secondary coil which supplies power to one or more electrical devices.

Placement of control circuitry **1622** and a secondary coil **1602** which functions as a control coil in the insert **900** (see FIGS. **12** to **14B**) provides primary control of the tool within the tool and/or insert, allowing some or all of the conventional control functionality to be removed from the generating

device. Some benefits of this schema would include faster response time to varying tool load conditions (e.g., when the calculus is removed or tissue is penetrated), control of tool operating or other characteristics by the tool itself rather than the generator (allowing a wider range of generators equipped or not with the appropriate conventional controls to be otherwise used for the tool), higher performance qualities which could reduce operator skill level requirements (e.g., where a skilled operator might use "feel" to operate the tool), faster learning curve for operators, enhanced patient comfort, and the like.

In an embodiment, the insert may comprise bidirectional communication circuitry powered by a secondary coil to provide electronic communication with the ultrasonic generator **G**, for example, via an RFID **1626** (FIG. **16**) and reader **1628** as disclosed in U.S. Patent publication US 2010/0036535, which is fully incorporated by reference herein, such that the insert provides some or all of the control functions and cooperate with any generator control functionality to further enhance operation of the insert.

In an embodiment, the insert may comprise bidirectional communication circuitry powered by a secondary coil to provide electronic communication with the ultrasonic generator **G**, for example, via an RFID **1026** (FIG. **16**) and reader **1028** as disclosed in U.S. Patent publication US 2010/0036535, which is fully incorporated by reference herein, such that the insert provides some or all of the control functions and cooperate with any generator control functionality to further enhance operation of the insert.

In an embodiment, a tip-based computer-controlled tool system comprises an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply, an insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil, the electrical device comprising an operating characteristic controller enabled to control a value of an operating characteristic of at least one other electrical device, and a microprocessor coupled to the operating characteristic controller, the microprocessor comprising an algorithm for determining a desired value of an operating characteristic for the at least one other electrical device and adjusting the operating characteristic delivered to the at least one other electrical device to the desired value via the operating characteristic controller, the operating characteristic comprising a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

As shown in FIG. **17**, in an embodiment, the handheld electrical tool system **1700** comprises a handpiece **1702** comprising a primary coil **1704** disposed about a well **1706** and electrically connected to a primary current supply **1708**; an insert **1710** comprising a distal portion **1712** and a proximal portion **1714**, the proximal portion **1714** dimensioned and arranged to be removably disposed within the well **1706**; an electrical device **1716** located on the insert **1710**, wherein the electrical device **1716**. A secondary coil **1718** is disposed about and in contact with the proximal portion **1714** of the insert **1710** to inductively couple to the primary coil **1704** when the proximal portion **1714** of the insert **1710** is disposed within the well **1706** to provide a secondary current supply

1728 to a tertiary coil 1720 disposed within a grip 1722 of the insert 1710 located on the distal portion 1712 of the insert 1710; and a quaternary coil 1724 inductively coupled to the tertiary coil 1720; and a circuit 1726 to electrically connect the electrical device 1716 to the quaternary coil 1724.

In an embodiment, the handheld electrical tool system further comprises a tertiary coil disposed within a grip located on the distal portion electrically connected to the secondary coil; and a quaternary coil disposed about and in contact with the distal portion inductively coupled to the tertiary coil to provide a tertiary current supply, and a circuit to electrically connect the electrical device to the tertiary current supply.

In an embodiment, the electrical device 1716 is selected from the group consisting of a piezoelectric crystal stack, caries detector, cancer detector, temperature detector, density detector, strain detector, conductivity detector, power level detector, high speed rotary machine, low speed rotary machine, illumination light, curing light, spectroscopic detector, prophylactic dispenser, medicament dispenser, imaging device, operational controller, microprocessor, memory module, communication device, electromagnet, ac/dc converter, and combinations thereof.

In an embodiment, a method of operating an ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply, comprises disposing an insert according to an embodiment of the instant disclosure into the well of the ultrasonic handpiece, wherein the insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil being in electrical communication with at least one electrical device, and supplying power to the primary coil via the primary current supply; and powering the at least one electrical device with the secondary coil via induction of the power from the primary coil into the secondary coil.

In an embodiment, a method of using a handheld electrical tool system comprising a generator electrically connected to a handpiece comprising a primary coil disposed about a well and an insert adapted to be received in the well of the handpiece, the method comprising placing a proximal portion of the insert in the well; activating the generator to provide a primary current supply to the primary coil; positioning a secondary coil wound on the proximal portion of the insert within the primary coil to induce a secondary current supply from the secondary coil without inducing magnetostrictive vibration of the proximal portion of the insert; and powering an electrical device located on a distal portion of the insert with the secondary current supply.

In an embodiment, a method of retrofitting a magnetostrictive ultrasonic handpiece comprising a primary coil disposed about a well and electrically connected to a magnetostrictive primary current supply comprises inserting an insert according to an embodiment of the instant disclosure into the well of the ultrasonic handpiece, the insert comprising a secondary coil disposed about at least a portion of the insert dimensioned and arranged to be disposable within the well such that the secondary coil is inductively coupled to the primary coil, the secondary coil in electrical communication with at least one electrical device powered by the secondary coil. In an embodiment, the electrical device comprises a piezoelectric stack mechanically coupled to a horn, the horn couple-able to a tip.

In an embodiment, a method of using a magnetostrictive ultrasonic dental scaler system for piezoelectric dental scaling, comprises removing a magnetostrictive ultrasonic insert from a well of a handpiece comprising a primary coil dis-

posed about the well; connecting the handpiece to a generator to provide a primary power supply to the primary circuit, the generator enabled to provide the primary power supply having characteristics for operation of the magnetostrictive ultrasonic insert; placing in the well a proximal portion of an insert comprising a secondary coil; positioning the secondary coil within the primary coil to induce a secondary current supply from the secondary coil; and powering a piezoelectric stack located on a distal portion of the insert and mechanically coupled to a horn with the secondary current supply to ultrasonically vibrate a tip coupled to the horn.

Embodiments

Accordingly, the present invention provides the following embodiments of the invention:

- A. A handheld electrical tool system, comprising:
 - a handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply;
 - an insert comprising a distal portion and a proximal portion, the proximal portion dimensioned and arranged to be removably disposed within the well;
 - an electrical device located on the insert, wherein the electrical device is selected from the group consisting of: a piezoelectric crystal stack, caries detector, cancer detector, temperature detector, density detector, strain detector, conductivity detector, power level detector, high speed rotary machine, low speed rotary machine, illumination light, curing light, spectroscopic detector, prophylactic dispenser, medicament dispenser, imaging device, operational controller, microprocessor, memory module, communication device, an electromagnet, an ac to dc converter, and combinations thereof, with the proviso that if the proximal portion of the insert is magnetostrictively active the electrical device is not an illumination light;
 - a secondary coil disposed about the proximal portion of the insert to inductively couple to the primary coil when the proximal portion of the insert is disposed within the well to provide a secondary current supply; and
 - a circuit to electrically connect the electrical device to the secondary current supply.
- B. A handheld electrical tool system, comprising:
 - a handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply;
 - an insert comprising a distal portion and a proximal portion, the proximal portion being magnetostrictively inactive and dimensioned and arranged to be removably disposed within the well;
 - an electrical device located on the insert;
 - a secondary coil disposed about and in contact with the proximal portion of the insert to inductively couple to the primary coil when the proximal portion of the insert is disposed within the well to provide a secondary current supply; and
 - a circuit to electrically connect the electrical device to the secondary current supply.
- C. The handheld electrical tool system according to Embodiment B, wherein the electrical device comprises one or more a piezoelectric crystal stack, caries detector, cancer detector, temperature detector, density detector, strain detector, conductivity detector, power level detector, high speed rotary machine, low speed rotary machine, illumination light, curing light, spectroscopic detector, prophylactic dispenser, medicament dispenser, imaging device, operational controller, microprocessor, memory module, communication device, an electromagnet, an ac to dc converter, or a combination thereof.
- D. The handheld electrical tool system according to Embodiment A, B or C, wherein the proximal portion of the

insert comprises a metallic core having a relative magnetic permeability of greater than 1 and wherein the secondary coil is disposed around the metallic core.

E. The handheld electrical tool system according to Embodiment A, B, C or D, wherein the electrical device comprises a piezoelectric stack mechanically coupled to a horn, and wherein the horn is releasably coupled to a tip.

F. The handheld electrical tool system according to Embodiment A, B, C, D, or E, further comprising an insert inventory comprising a plurality of the inserts for the handpiece, wherein the inserts are interchangeable in the handpiece and the electrical devices of the respective ones of the plurality of inserts are the same or different.

G. The handheld electrical tool system according to Embodiment A, B, C, D, E, or F, further comprising an insert inventory comprising a plurality of interchangeable inserts for the handpiece, wherein the inventory comprises at least the electrical device insert and an ultrasonic magnetostrictive insert, and a magnetostrictive power generator to provide the primary current with characteristics to selectively operate the ultrasonic magnetostrictive insert and the electrical device insert.

H. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, or G, wherein the proximal portion of the insert comprises an ultrasonic magnetostrictive stack and wherein the secondary coil is disposed around and in contact with the magnetostrictive stack.

I. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, or H, further comprising a water supply in fluid communication with the well, and a water flow passage from the well through the insert.

J. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, H, or I, wherein the insert further comprises an operating characteristic controller enabled to control a value of an operating characteristic of the electrical device.

K. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, H, I or J, wherein the operating characteristic controller is electrically connected to the secondary current supply.

L. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, H, I, J, or K, further comprising a microprocessor coupled to the operating characteristic controller, the microprocessor comprising an algorithm to determine a desired value of the operating characteristic and to set the value of the operating characteristic of the electrical device to the desired value.

M. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, H, I, J, K, or L, wherein the operating characteristic comprises a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

N. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, H, I, J, K, L, or M, the proximal insert portion comprising three longitudinal members spaced laterally apart, wherein the secondary coil is wound around a central longitudinal member passing through the spaces between the central longitudinal member and opposing outer longitudinal members, wherein each of the longitudinal members has a relative magnetic permeability greater than 10.

O. The handheld electrical tool system according to Embodiment A, B, C, D, E, F, G, H, I, J, K, L, M, or N, further

comprising a tertiary coil disposed within a grip located on the distal portion electrically connected to the secondary coil; and a quaternary coil disposed about and in contact with the distal portion inductively coupled to the tertiary coil to provide a tertiary current supply, and a circuit to electrically connect the electrical device to the tertiary current supply.

P. A method of using a handheld electrical tool system comprising a generator electrically connected to a handpiece comprising a primary coil disposed about a well and an insert adapted to be received in the well of the handpiece, comprising:

placing a proximal portion of the insert in the well;
activating the generator to provide a primary current supply to the primary coil;

positioning a secondary coil wound on the proximal portion of the insert within the primary coil to induce a secondary current supply from the secondary coil without inducing magnetostrictive vibration of the proximal portion of the insert; and

powering an electrical device located on a distal portion of the insert with the secondary current supply.

Q. The method according to Embodiment P, wherein the electrical device comprises one or more of a piezoelectric crystal stack, caries detector, cancer detector, temperature detector, density detector, strain detector, conductivity detector, power level detector, high speed rotary machine, low speed rotary machine, illumination light, curing light, spectroscopic detector, prophylactic dispenser, medicament dispenser, imaging device, operational controller, microprocessor, memory module, communication device, or a combination thereof.

R. The method according to Embodiment P or Q, wherein the secondary coil is disposed around at least a portion of a magnetostrictively inactive metallic core having a relative magnetic permeability of greater than 1.

S. The method according to Embodiment P, Q, or R, wherein the electrical device comprises a piezoelectric stack mechanically coupled to a horn, the horn coupled to a tip.

T. The method according to Embodiment P, Q, R, or S, further comprising:

maintaining an insert inventory comprising a plurality of the inserts for the handpiece, wherein the inserts are interchangeable in the handpiece and the electrical devices of the respective ones of the plurality of inserts are the same or different; and selecting one of the plurality of inserts from the inventory for the placement in the handpiece.

U. The method according to Embodiment P, Q, R, S, or T, further comprising:

selecting another one of the plurality of inserts from the inventory for placement in the handpiece;
removing the one of the plurality of inserts from the handpiece and returning the removed insert to the inventory; and placing the selected other one of the plurality of inserts in the handpiece.

V. The method according to Embodiment P, Q, R, S, T, or U, further comprising:

maintaining an insert inventory comprising a plurality of interchangeable inserts for the handpiece, wherein the inventory comprises at least the electrical device insert and an ultrasonic magnetostrictive insert; and

connecting the handpiece to a magnetostrictive power generator to provide the primary current with characteristics to operate either of the ultrasonic magnetostrictive insert or the electrical device insert;

selecting one of the plurality of inserts from the inventory; placing the selected one of the plurality of inserts the handpiece; and

operating the insert placed in the handpiece with the magnetostrictive power generator.

W. The method according to Embodiment P, Q, R, S, T, U, or V, wherein the inventory comprises an ultrasonic magnetostrictive insert comprising the secondary coil disposed around a magnetostrictive stack.

X. The method according to Embodiment P, Q, R, S, T, U, V, or W, further comprising supplying water to the well, and flowing the water from the well through a water flow passage formed in the insert.

Y. The method according to Embodiment P, Q, R, S, T, U, V, W, or X, further comprising using an operating characteristic controller in the insert to control a value of an operating characteristic of the electrical device.

Z. The method according to Embodiment P, Q, R, S, T, U, V, W, X, or Y, further comprising inputting at least one control parameter into the operating characteristic controller.

A1. The method according to Embodiment P, Q, R, S, T, U, V, W, X, Y, or Z, wherein the operating characteristic or control parameter comprises: a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

B1. A method of using a magnetostrictive ultrasonic dental scaler system for piezoelectric dental scaling, comprising: removing a magnetostrictive ultrasonic insert from a well of a handpiece comprising a primary coil disposed about the well;

connecting the handpiece to a generator to provide a primary power supply to the primary circuit, the generator enabled to provide the primary power supply having characteristics for operation of the magnetostrictive ultrasonic insert;

placing in the well a proximal portion of an insert comprising a secondary coil;

positioning the secondary coil within the primary coil to induce a secondary current supply from the secondary coil; and

powering a piezoelectric stack located on a distal portion of the insert and mechanically coupled to a horn with the secondary current supply to ultrasonically vibrate a tip coupled to the horn. The foregoing disclosure and description of the invention is illustrative and explanatory thereof and it can be readily appreciated by those skilled in the art that various changes in the size, shape and materials, as well as in the details of the illustrated construction or combinations of the elements described herein can be made without departing from the spirit of the invention.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only some embodiments have been shown and described and that all changes and modifications that come within the spirit of the inventions are desired to be protected. It should be understood that while the use of words such as preferable, preferably, preferred, more preferred or exemplary utilized in the description above indicate that the feature so described may be more desirable or characteristic, nonetheless may not be necessary and embodiments lacking the same may be contemplated as within the scope of the invention, the scope being defined by the claims that follow. In reading the claims, it is intended that when words such as “a,” “an,” “at least one,” or “at least one portion” are used there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. When the

language “at least a portion” and/or “a portion” is used the item can include a portion and/or the entire item unless specifically stated to the contrary.

What is claimed is:

1. A handheld electrical tool system, comprising:

a handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply;

an insert comprising a distal portion and a proximal portion, the proximal portion dimensioned and arranged to be removably disposed within the well;

an electrical device located on the insert, wherein the electrical device comprises a piezoelectric crystal stack mechanically coupled to a horn, and wherein the horn is releasably coupled to a tip;

a secondary coil disposed about the proximal portion of the insert to inductively couple to the primary coil when the proximal portion of the insert is disposed within the well to provide a secondary current supply; and

a circuit to electrically connect the electrical device to the secondary current supply.

2. The handheld electrical tool system of claim 1, wherein the proximal portion of the insert comprises a metallic core having a relative magnetic permeability of greater than 1 and wherein the secondary coil is disposed around the metallic core.

3. The handheld electrical tool system of claim 1, further comprising a water supply in fluid communication with the well, and a water flow passage from the well through the insert.

4. The handheld electrical tool system of claim 1, wherein the insert further comprises an operating characteristic controller enabled to control a value of an operating characteristic of the electrical device.

5. The handheld electrical tool system of claim 4, wherein the operating characteristic controller is electrically connected to the secondary current supply.

6. The handheld electrical tool system of claim 4, further comprising a microprocessor coupled to the operating characteristic controller, the microprocessor comprising an algorithm to determine a desired value of the operating characteristic and to set the value of the operating characteristic of the electrical device to the desired value.

7. The handheld electrical tool system of claim 6, wherein the operating characteristic comprises a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

8. The handheld electrical tool system of claim 7, wherein the operating characteristic controller is responsive to varying tool load conditions.

9. The handheld electrical tool system of claim 1, the proximal insert portion comprising three longitudinal members spaced laterally apart, wherein the secondary coil is wound around a central longitudinal member passing through the spaces between the central longitudinal member and opposing outer longitudinal members, wherein each of the longitudinal members has a relative magnetic permeability greater than 10.

10. The handheld electrical tool system of claim 1, wherein the primary and secondary coils have a different number of turns to provide the secondary coil with a different voltage and current with respect to the primary coil.

11. A handheld electrical tool system comprising:
 a handpiece comprising a primary coil disposed about a well and electrically connected to a primary current supply;
 an insert inventory comprising a magnetostrictively inactive insert and an ultrasonic magnetostrictive insert for the handpiece, wherein the inserts are interchangeable in the handpiece;
 wherein the magnetostrictively inactive insert comprises: a distal portion and a proximal portion, the proximal portion dimensioned and arranged to be removably disposed within the well; a piezoelectric crystal stack mechanically coupled to a horn, and wherein the horn is releasably coupled to a tip; a secondary coil disposed about the proximal portion of the insert to inductively couple to the primary coil when the proximal portion of the insert is disposed within the well to provide a secondary current supply; and a circuit to electrically connect the piezoelectric crystal stack to the secondary current supply; and
 wherein the magnetostrictive insert comprises: a distal portion and a proximal portion, the proximal portion dimensioned and arranged to be removably disposed within the well.

12. The handheld electrical tool system of claim 11, further comprising a magnetostrictive power generator to provide the primary current supply with characteristics to selectively operate the ultrasonic magnetostrictive insert and the magnetostrictively inactive insert.

13. The handheld electrical tool system of claim 11, wherein the proximal portion of the magnetostrictive insert comprises an ultrasonic magnetostrictive stack and wherein a secondary coil is disposed around and in contact with the magnetostrictive stack.

14. A method of using a handheld electrical tool system comprising a generator electrically connected to a handpiece comprising a primary coil disposed about a well and an insert adapted to be received in the well of the handpiece, comprising:
 placing a proximal portion of the insert in the well;
 activating the generator to provide a primary current supply to the primary coil;
 positioning a secondary coil wound on the proximal portion of the insert within the primary coil to induce a secondary current supply from the secondary coil without inducing magnetostrictive vibration of the proximal portion of the insert; and
 powering an electrical device located on a distal portion of the insert with the secondary current supply, wherein the electrical device comprises a piezoelectric crystal stack mechanically coupled to a horn, and wherein the horn is releasably coupled to a tip.

15. The method of claim 14, wherein the secondary coil is disposed around at least a portion of a magnetostrictively inactive metallic core having a relative magnetic permeability of greater than 1.

16. The method of claim 14, further comprising using an operating characteristic controller in the insert to control a value of an operating characteristic of the piezoelectric crystal stack.

17. The method of claim 16, further comprising inputting at least one control parameter into the operating characteristic controller.

18. The method of claim 17, wherein the operating characteristic or control parameter comprises: a tip device profile corresponding to a tool attached to the insert, a proximity to one or more operating boundary parameters, a power level, a

dental site temperature, a tool temperature, a dental hygiene material, a fluid type contained in a fluid supply, a safety feedback loop, an error circumstance, a pressure, a strain, or a combination thereof.

19. The method of claim 14, further comprising supplying water to the well, and flowing the water from the well through a water flow passage formed in the insert.

20. The method of claim 14, wherein the primary and secondary coils have a different number of turns to provide the secondary coil with a different voltage and current with respect to the primary coil.

21. A method of using a handheld electrical tool system comprising a power generator electrically connected to a handpiece comprising a primary coil disposed about a well and a plurality of inserts adapted to be interchangeably received in the well of the handpiece, comprising:

maintaining an insert inventory wherein the plurality of inserts comprise an ultrasonic magnetostrictive insert and an ultrasonic piezo insert;

wherein the ultrasonic piezo insert comprises: a piezoelectric crystal stack mechanically coupled to a horn, and wherein the horn is releasably coupled to a tip; a secondary coil disposed about the proximal portion of the insert to inductively couple to the primary coil when the proximal portion of the insert is disposed within the well to provide a secondary current supply; and a circuit to electrically connect the piezoelectric crystal stack to the secondary current supply and
 selecting one of the plurality of inserts from the inventory for the placement in the handpiece.

22. The method of claim 21, further comprising:
 selecting another one of the plurality of inserts from the inventory for placement in the handpiece;
 removing the one of the plurality of inserts from the handpiece and returning the removed insert to the inventory; and
 placing the selected other one of the plurality of inserts in the handpiece.

23. The method of claim 21, further comprising:
 connecting the handpiece to the power generator to provide the primary current with characteristics to operate either of the ultrasonic magnetostrictive insert or the ultrasonic piezo insert;
 selecting one of the plurality of inserts from the inventory;
 placing the selected one of the plurality of inserts the handpiece; and
 operating the insert placed in the handpiece with the power generator.

24. The method of claim 23, wherein the ultrasonic magnetostrictive insert comprises a secondary coil disposed around a magnetostrictive stack.

25. The method of claim 21, wherein the primary and secondary coils have a different number of turns to provide the secondary coil with a different voltage and current with respect to the primary coil.

26. A method of using a magnetostrictive ultrasonic dental scaler system for piezoelectric dental scaling, comprising:

removing a magnetostrictive ultrasonic insert from a well of a handpiece comprising a primary coil disposed about the well;

connecting the handpiece to a generator to provide a primary power supply to the primary circuit, the generator enabled to provide the primary power supply having characteristics for operation of the magnetostrictive ultrasonic insert;

placing in the well a proximal portion of an insert comprising a secondary coil;

positioning the secondary coil within the primary coil to induce a secondary current supply from the secondary coil; and

powering a piezoelectric stack located on a distal portion of the insert and mechanically coupled to a horn with the secondary current supply to ultrasonically vibrate a tip coupled to the horn. 5

27. The method of claim 26, wherein the primary and secondary coils have a different number of turns to provide the secondary coil with a different voltage and current with respect to the primary coil. 10

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专利名称(译)	用于具有电气装置的超声波手持件的能量收集插入物		
公开(公告)号	US9050161	公开(公告)日	2015-06-09
申请号	US13/456051	申请日	2012-04-25
[标]申请(专利权)人(译)	FEINE JAMES 小号		
申请(专利权)人(译)	FEINE JAMES S.		
[标]发明人	FEINE JAMES S		
发明人	FEINE, JAMES S.		
IPC分类号	A61C1/07 A61C17/20 A61C1/00 A61B5/00		
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代理人(译)	LUNDEEN, DANIEL N.		
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摘要(译)

一种装置和手持式电动工具系统，包括可接收在超声波手持件中的插入件，该插入件包括围绕阱设置并且电连接到主电流源的初级线圈，该插入件包括围绕插入件的至少一部分设置的次级线圈。布置成在井内是一次性的，使得次级线圈感应地耦合到初级线圈，次级线圈与由次级线圈供电的至少一个电气装置电连通。还公开了一种操作手持件和改装手持件的方法。

