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- (54) **ELECTROSURGICAL INSTRUMENT**
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- (52) **U.S. Cl.** **606/41; 606/45; 606/49**
- (58) **Field of Search** **606/41, 45, 49**

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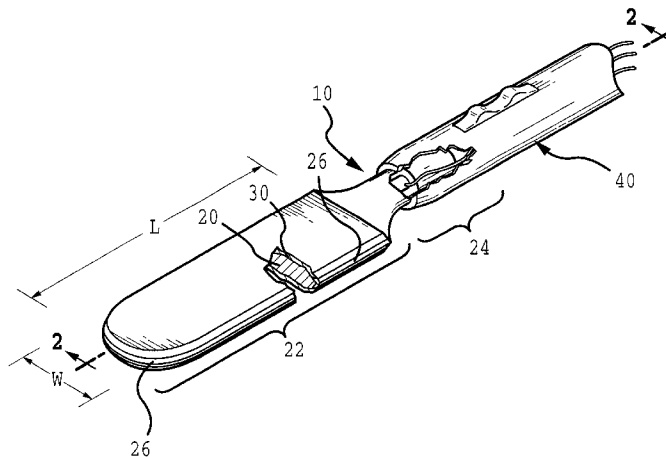
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(57) **ABSTRACT**

An improved electrosurgical instrument and method is disclosed for reducing smoke generation at a surgical site. The electrosurgical instrument comprises a metal body having an outer insulating layer to reduce thermal/electrical discharge from non-functional portions of the instrument. In one aspect of the invention, an insulating layer having a thermal conductance of about 1.2 W/cm²° K and a dielectric withstand strength of at least about 50 volts is employed. Such insulating layer may advantageously comprise silicon and/or carbon. In another aspect of the invention, the metal body is provided to have a thermal conductivity of at least about 0.35 W/cm° K, and may advantageously comprise a metal selected from the group: gold, silver, aluminum, and copper. Heat sink means may be included in various embodiments to establish a thermal gradient away from functional portions of the instrument (i.e., by removing heat from the metal body). In one embodiment, the heat sink means may comprise a phase change material that changes from a first phase to a second phase upon absorption of thermal energy from the metal body.

28 Claims, 3 Drawing Sheets



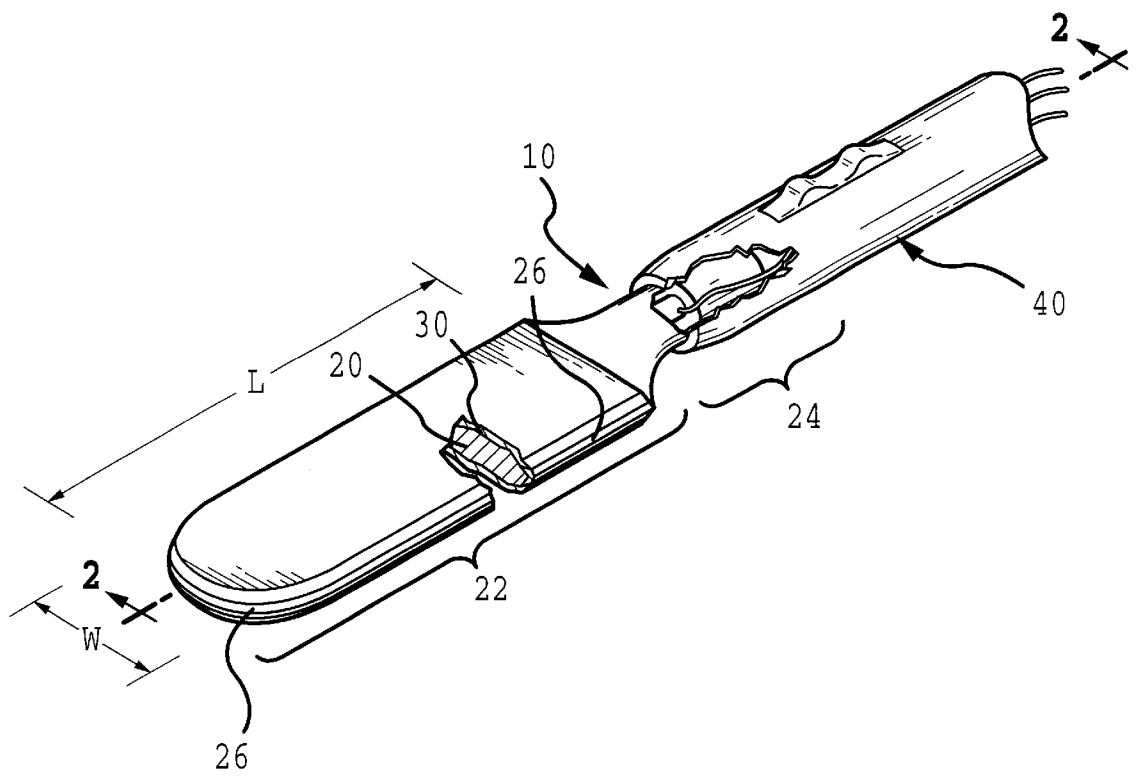


FIG. 1

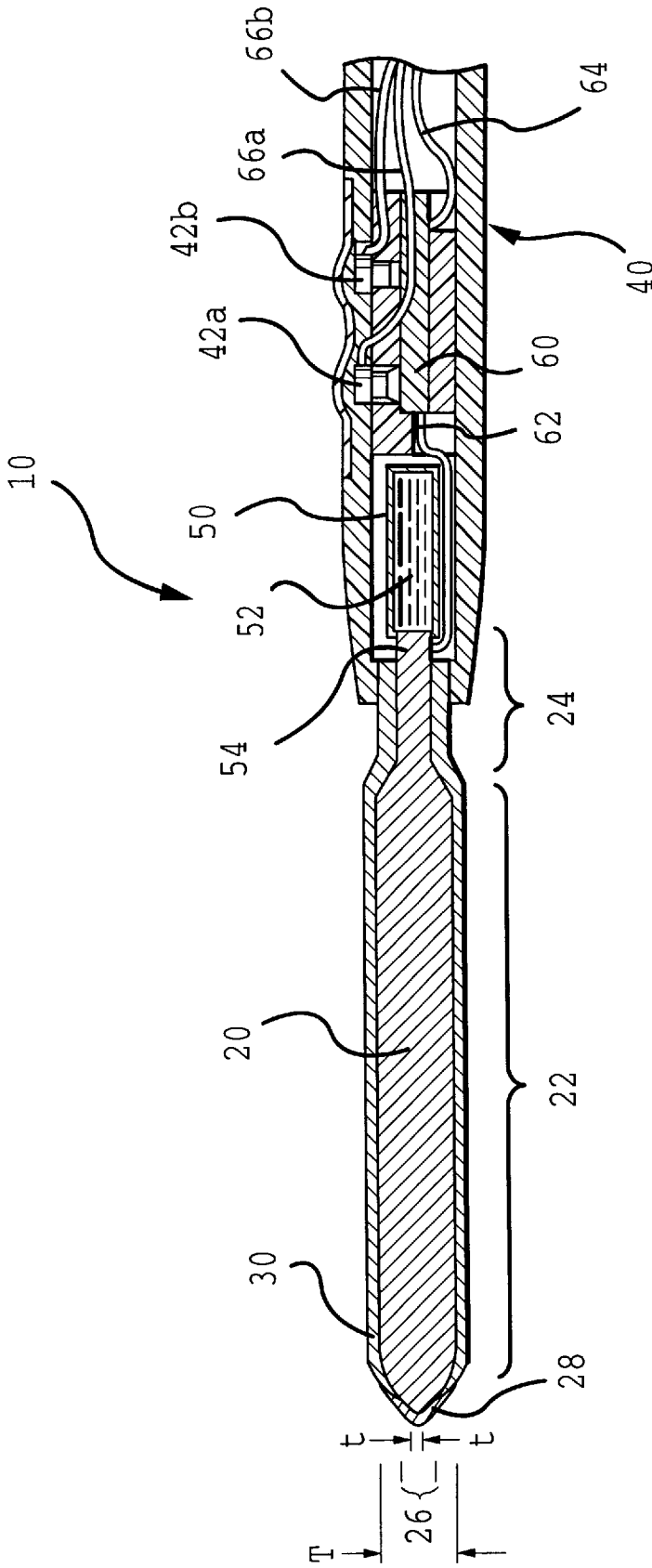


FIG.2

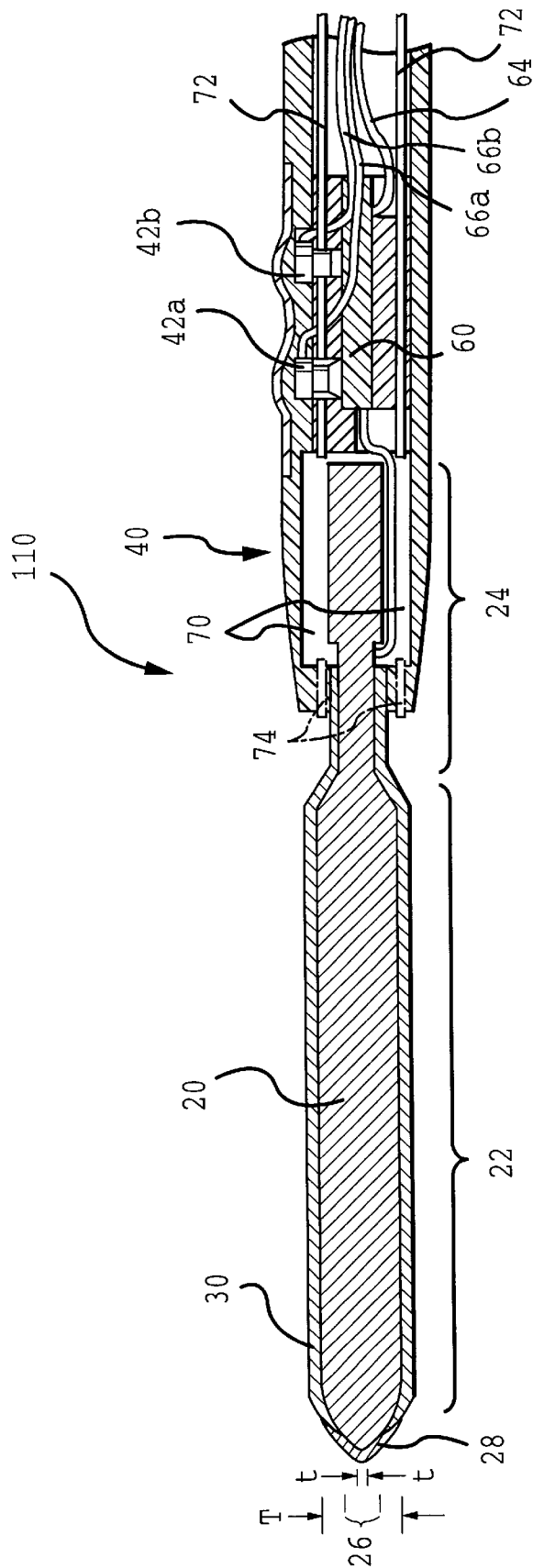


FIG.3

ELECTROSURGICAL INSTRUMENT**FIELD OF THE INVENTION**

The present invention relates to surgical methods and apparatus for applying an electrosurgical signal to a tissue site to achieve a predetermined surgical effect, and more particularly, to an improved electrosurgical instrument and method to achieve such effect with reduced attendant smoke generation at the surgical site.

BACKGROUND OF THE INVENTION

The potential applications and recognized advantages of employing electrical energy in surgical procedures continue to increase. In particular, for example, electrosurgical techniques are now being widely employed to provide significant localized surgical advantages in both open and laparoscopic applications, relative to traditional surgical approaches.

Electrosurgical techniques typically entail the use of a hand-held instrument, or pencil, that transfers radio frequency (RF) electrical energy to a tissue site, a source of radio frequency (RF) electrical energy, and an electrical return path device, commonly in the form of a return electrode pad positioned under a patient (i.e. a monopolar system configuration) or a smaller return electrode positionable in bodily contact at or immediately adjacent to the surgical site (i.e. a bipolar system configuration). The waveforms produced by the RF source yield a predetermined electrosurgical effect, namely tissue cutting or coagulation.

Despite numerous advances in the field, currently-employed electrosurgical techniques often generate substantial smoke at the surgical site. Such smoke occurs as a result of tissue heating and the associated release of hot gases/vapor from the tissue site (e.g., in the form of an upward plume). As will be appreciated, any generation of smoke may impede observation of the surgical site during surgical procedures. Additionally, the generation of smoke results in attendant fouling of the atmosphere in the surgical theater.

Clearly, these environmental impacts may adversely detract from the performance of medical personnel. Further, there is growing concern that the smoke may be a medium for the transport of pathogens away from the surgical site, including viruses such as HIV. Such concerns have contributed to the use of face shields and masks by surgical personnel.

To date, implemented approaches to deal with smoke have focused on the use of devices that either evacuate the smoke by sucking the same into a filtering system, or that merely blow the smoke away from the surgical site by a pressurized gas stream. Smoke evacuators typically require the movement of large amounts of air to be effective. As such, evacuators tend to be not only noisy but also space consuming. Approaches for blowing smoke away from the surgical site fail to address many of the above-noted concerns, since smoke is not actually removed from the surgical environment. Moreover, both of the abovenoted approaches entail the use of added componentry, thereby increasing the cost and complexity of electrosurgical systems.

SUMMARY OF THE INVENTION

Accordingly, a primary objective of the present invention is to provide an apparatus and method for use in electrosurgery that results in reduced generation of smoke at a surgical site.

Another objective of the present invention is to provide an apparatus and method for use in electrosurgery that yields less eschar accumulation on the electrosurgical instrument utilized.

An additional objective of the present invention is to provide an apparatus and method for use in electrosurgery that provides for reduced charring along an electrosurgical incision.

Yet another objective is to realize one or more of the foregoing objectives in a manner which does not significantly impact space or cost requirements, and which maintains and potentially enhances the effectiveness of electrosurgical procedures.

In addressing these objectives, the present inventors have recognized that a large portion of the smoke generated utilizing known electrosurgical instruments results from the transmission of electrosurgical energy to tissue from areas of known electrosurgical instruments that are actually intended to be "non-functional" for purposes of achieving the desired electrosurgical effect (i.e. cutting or coagulation). That is, while known electrosurgical instruments include "functional" portions which are designed to be selectively positioned to direct an electrosurgical signal to an intended surgical location (e.g. along a desired incision line), the discharge of energy is not effectively restricted to the functional portions.

More generally in this regard, energy discharge from electrosurgical instruments may be in the form of electrical energy and/or thermal energy. Electrical energy is transferred whenever the electrical resistance of a region between an electrosurgical instrument and tissue can be broken down by the voltage of the electrosurgical signal. Thermal energy is transferred when thermal energy that has accumulated in the electrosurgical instrument overcomes the thermal resistance between the instrument and the tissue (i.e. due to temperature differences therebetween).

The discharge of electrical and thermal energy from nonfunctional areas of known electrosurgical instruments results in unnecessary heating of tissue at a tissue site. In the case of electrical energy discharge, thermal energy is generated as a result of tissue resistance. As the amount of thermal energy at a tissue site increases, the electrical resistance at the surgical site also increases, thereby resulting in the further generation of heat. Such increased heating may in turn result in tissue charring as well as the splattering of tissue matter onto the electrosurgical instrument employed. The splattered tissue matter may accumulate as eschar on the electrosurgical instrument and present a further resistance/heat source to the surgical site. Eschar accumulation on electrosurgical instruments also raises the need for medical personnel to periodically suspend a procedure in order to clean the eschar from the electrosurgical instrument. As can be appreciated, such disturbances can adversely impact an electrosurgical procedure.

In short, the present inventors have recognized that any undesired and unnecessary discharge of electrosurgical energy from non-functional portions of an electrosurgical instrument to a surgical site can have a negative and cascading effect of unnecessary heat generation and resultant smoke generation, eschar build-up on the electrosurgical instrument and unnecessary tissue charring. In the later regard, it is believed that tissue charring may adversely affect healing.

In conjunction with the above-referenced recognition, the present invention provides an apparatus and method for reducing unnecessary/undesired electrical and/or thermal

discharge during electrosurgical procedures. Such reduction (s) are achieved via enhanced localization of electrical and thermal energy transmission to a tissue site. More particularly, the present invention markedly reduces electrical/thermal discharge from non-functional areas of an electrosurgical instrument by insulating the nonfunctional areas and/or by providing for an effective level of heat removal away from functional portions of an electrosurgical instrument.

In this regard, the present invention comprises an electrosurgical instrument that includes a metal body for carrying an electrosurgical signal and an outer insulating layer positioned over at least a portion of the metal body (i.e., a non-functional portion). The metal body includes a main body portion and a peripheral edge portion, the peripheral edge portion being functional for the conveyance of the electrosurgical signal to a tissue site.

In one aspect of the present invention, the outer insulating layer may be advantageously provided to have a maximum thermal conductance of about $1.2 \text{ W/cm}^2\text{-}^\circ \text{K}$ when measured at about 300°K , more preferably about $0.12 \text{ W/cm}^2\text{-}^\circ \text{K}$ or less when measured at about 300°K , and most preferably about $0.03 \text{ W/cm}^2\text{-}^\circ \text{K}$ when measured at about 300°K . For purposes hereof, thermal conductance is intended to be a measure of the overall thermal transfer across any given cross section (e.g. of the insulation layer), taking into account both the thermal conductivity of the materials comprising such layer and the thickness of the layer (i.e. thermal conductance of layer=thermal conductivity of material comprising the layer ($\text{W/cm}^\circ \text{K}$)/ thickness of the layer (cm)). In relation to the foregoing aspect, the insulation layer should also exhibit a dielectric withstand voltage of at least the peak-to-peak voltages that may be experienced by the electrosurgical instrument during surgical procedures. The peak voltages will depend upon the settings of the RF source employed, as may be selected by clinicians for particular surgical procedures. For purposes of the present invention, the insulation layer should exhibit a dielectric withstand voltage of at least about 50 volts, and more preferably, at least about 150 volts. As employed herein, the term dielectric withstand voltage means the capability to avoid an electrical breakdown (e.g. an electrical discharge through the insulating layer).

In one embodiment, the outer insulating layer advantageously comprises a polymeric compound. More particularly, such polymeric compound includes at least about 10% (by weight), and most preferably at least about 20% (by weight), of a component selected from a group comprising: silicon and carbon. In this regard, silicon-based, polymeric, insulating layers have been found to be of particular benefit. Such silicon-based, polymeric layers have a thermal conductivity of about $0.003 \text{ W/cm}^\circ \text{K}$ or less when measured at about 300°K . Such silicon-based, polymeric layers have been found to be effective when having a thickness of about 0.25 mm or more. Further, such silicon-based, polymeric layers have had a dielectric strength of at least about 12 Kv/mm. In another embodiment, the insulation layer may comprise polytetrafluoroethylene.

In another aspect of the present invention, the metal body of the inventive electrosurgical instrument may be provided to have a thermal conductivity of at least about $0.35 \text{ W/cm}^\circ \text{K}$ when measured at about 300°K . By way of primary example, the metal body may advantageously comprise at least one metal selected from a group comprising: silver, copper, aluminum and gold. Alloys comprising at least about 50% (by weight) of such metals may also be employed. Additional metals that may be employed include zinc, bronze and brass.

In yet another aspect of the present invention, at least a portion of the peripheral edge portion of the metal body is not insulated (i.e. not covered by the outer insulating layer). In connection therewith, when the metal body comprises copper, the outer peripheral edge portion may be coated (e.g. about 10 microns or less) with a biocompatible metal. By way of example, such biocompatible metal may be selected from the group comprising: nickel, silver, gold, chrome and titanium. It has also been determined that a laterally tapered, uninsulated peripheral edge portion having a maximum cross-sectional thickness which is about $\frac{1}{10}$ of the maximum cross-sectional thickness of the main body portion is particularly effective. Relatedly, the outer extreme of the peripheral edge may preferably have a thickness of about 0.001 inches or less.

In a further aspect of the present invention, the inventive electrosurgical instrument further comprises a heat sink for removing thermal energy from the metal body. In this regard, the provision of a heat sink establishes a thermal gradient away from the peripheral edge of the metal body, thereby reducing undesired thermal transfer to a tissue site. More particularly, it is preferable for the heat sink to operate so as to maintain the maximum temperature on the outside surface of the insulating layer at about 160°C . or less, more preferably at about 80°C . or less, and most preferably at 60°C . or less. Relatedly, it is preferable for the heat sink to operate to maintain an average metal body temperature of about 500°C . or less, more preferably of about 200°C . or less, and most preferable of about 100°C . or less.

In one approach, the heat sink may comprise a vessel comprising a phase change material that either directly contacts a portion of the metal body (e.g. a support shaft portion) or that contacts a metal interface provided on the vessel which is in turn in direct contact with a portion of the metal body (e.g. a support shaft portion). Such phase change material changes from a first phase to a second phase upon absorption of thermal energy from the metal body. In this regard, the phase change temperature for the material selected should preferably be greater than the room temperature at the operating environment and sufficiently great as to not change other than as a consequence of thermal heating of the electrosurgical instrument during use. Such phase change temperature should preferably be greater than about 30°C . and most preferably at least about 40°C . Further, the phase change temperature should be less than about 225°C . Most preferably, the phase change temperature should be less than about 85°C .

The phase change may be either from solid to liquid (i.e., the phase change is melting) or from liquid to vapor (i.e., the phase change is vaporization) or from solid to vapor (i.e., the phase change is sublimation). The most practical phase changes to employ are melting and vaporization. By way of example, such phase change material may comprise a material that is an organic substance (e.g., fatty acids such as stearic acid, hydrocarbons such as paraffins) or an inorganic substance (e.g., water and water compounds containing sodium, such as, sodium silicate (2-)-5-water, sodium sulfate-10-water).

In another approach, the heat sink may comprise a gas flow stream that passes in direct contact with at least a portion of the metal body. Such portion may be a peripheral edge portion and/or a shaft portion of the metal body that is designed for supportive interface with a holder for hand-held use. Alternatively, such portion may be interior to at least a portion of the to part of the metal body such as interior to the exposed peripheral edge portion and/or the shaft portion of the metal body that is designed for supportive interface with a holder for hand-held use.

In one arrangement of the present invention, an electro-surgical instrument comprises a main body portion having a blade-like configuration at a first end and an integral, cylindrical shaft at a second end. At least a portion of the flattened blade end of the main body is coated with a silicon-based, polymer insulating layer, except for the peripheral edge portion thereof. The cylindrical shaft of the main body is designed to fit within an outer holder that is adapted for hand-held use by medical personnel. Such holder may also include a chamber comprising a phase-change material as noted hereinabove. Additionally, electrical, push-button controls may be incorporated into the holder for selectively controlling the application of one or more, predetermined, electro-surgical signal(s) from an RF energy source to the flattened blade via the shaft of the main body portion.

Numerous modifications and additions will be apparent to those skilled in the art upon further consideration of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a perspective, partial cut-away view of an electro-surgical instrument in one embodiment of the present invention.

FIG. 2 illustrates a side, cross-sectional view of the electro-surgical instrument embodiment of FIG. 1

FIG. 3 illustrates a side, cross-sectional view of another electro-surgical instrument embodiment of the present invention.

DETAILED DESCRIPTION

FIGS. 1 and 2 illustrate one embodiment of an electro-surgical instrument having a blade-like, pencil configuration. As will be appreciated, the present invention may also be readily embodied in other instrument configurations, including for example, ball electrodes and forceps.

As illustrated in FIGS. 1 and 2, the electro-surgical instrument 10 includes a main body 20 having an outer, insulating layer 30. The main body 20 includes a flattened, forwardly-extending blade portion 22 and a rearwardly-extending cylindrical shaft portion 24. The blade portion 22 is tapered laterally outward (i.e. in cross-sectional thickness) to a relatively thin outer peripheral edge about at least a rounded, forward end to define peripheral edge portion 26. In the illustrated embodiment, peripheral edge portion 26 is not covered by insulating layer 30. Preferably, peripheral edge portion 26 has outer, extreme edge thickness t of about 0.001 inches or less. Further, the maximum thickness of edge portion 26 is preferably no more than about $\frac{1}{10}$ of the maximum thickness T of main body 20.

The main body 20 should comprise a metal having a relatively high thermal conductivity (e.g. at least about 0.35 W/cm² K when measured at 300° K). In particular, main body 20 may advantageously comprise a metal selected from the group comprising: copper, silver, gold, and aluminum. Alloys of such metals (e.g., at least about 50% by weight), may also be employed. Additional acceptable metals include zinc, brass and bronze. The use of such metals in the main body 20 allows for not only effective delivery of an electro-surgical signal therethrough for transmission via peripheral edge portion 26 to a tissue site, but additionally facilitates the removal of heat rearwardly away from peripheral edge portion 26 during operation. Such heat removal reduces undesired heat transfer from the electro-surgical instrument 10 to a tissue site during use. In the event copper is utilized for main body 20, a biocompatible plating 28 (e.g.

nickel, gold, silver, chrome or titanium) may be selectively applied to peripheral edge 26.

The insulating layer 30 should provide both thermal and electrical insulation capabilities so as to reduce the discharge of thermal and electrical energy, respectively, from electro-surgical instrument 10 during use. For example, the outer insulating layer 30 should most preferably comprise a material having a thermal conductivity of about 0.009 W/cm² K or less when measured at about 300°K. Further, the insulation layer should exhibit a dielectric withstand voltage of at least about 50 volts, and more preferably at least about 150 volts. By way of primary example, layer 30 may comprise a silicon-based, polymeric material (e.g., at least about 10% silicon by weight).

While several production techniques may be utilized to apply the insulating layer 30 to the main body 20, one approach that has been found particularly effective is to first treat the metal surface of main body 20 with an appropriate primer, such as a silane, before applying the insulating layer. Such priming further enhances the ability of silicon-based polymers to adhere to the outer surface of the main body 20. Such adherence is particularly advantageous since during use the main body 20 and insulating layer 30 may be bent or otherwise configured by medical personnel in the course of an electro-surgical procedure. By way of example, when a silicon-based polymer such as RTV160, offered by General Electric Company, is employed, a suitable primer would be Z6020, offered by General Electric Company. Alternatively, when MED4940, offered by NuSil Technology, is employed as a silicon-based polymer, a suitable primer is CF2-135, offered by NuSil Technology.

Following priming, the insulating layer 30 may be selectively applied to main body portion 20 so as to substantially cover main body 20. Preferably, the peripheral edge portion 26 is selectively left uncovered by coating 30. Selective coating may be accomplished by several techniques, including, for example, the use of an injection molding process, by a masking/coating/mask removal process, or by coating the entirety of the main body 20 with insulating layer 30 and selectively removing the coating 30 from the peripheral edge portion 26.

As best shown in FIG. 2, the shaft portion 24 of the main body 20 is supportably fitted into a forward end of an elongated holder assembly 40 that is adapted for hand-held use and manipulation by medical personnel. Such supportive interface may be either permanent (e.g. wherein the entire electro-surgical instrument 10 is disposed of after use), or the interface may be designed for selective insertion/removal of the main body 20 into/from welder assembly 40 (e.g. wherein the holder assembly 40 may be reused). In the embodiment of FIGS. 1 and 2, the holder assembly 40 houses a vessel 50 containing a phase change material 52. The vessel 50 is provided with a thermally conductive interface such as a thermally conductive pad 54, which may butt against the end of the shaft portion 24 of main body 20, as shown in FIG. 2, or which may partially or totally surround the shaft portion, at one end for direct contact and thermal interface with the end of shaft portion 24 of the main body 20.

The phase change material 52 should be selected to provide an effective heat sink for removal of thermal energy from main body 20. More particularly, the phase change material 52 should preferably maintain main body 20 at an average temperature of about 500° C. or less, more preferably at about 200° C. or less, and most preferably at about 100 ° C. or less. For such purposes, the phase change

material may be provided to change from a first phase to a second phase (e.g., solid to liquid) at a predetermined temperature of at least about 40° C. Further, for the arrangement of FIG. 1, it has been found that when a 100 W signal is applied to main body 20, phase change material 52 should be capable of removing at least about 8 W of thermal energy.

By way of example, phase change material 52 may comprise a material that is an organic substance (e.g., fatty acids such as stearic acid, hydrocarbons such as paraffins) or an inorganic substance (e.g., water, and water compounds containing sodium, such as sodium silicate (2-)-5 water, sodium sulfate-10-water). Phase change material 52 may undergo phase changes of melting, vaporization, or sublimation, although melting and vaporization are preferred. Most preferably, the phase change temperature is greater than about 40° C. and less than about 85° C. While FIGS. 1-2 illustrate that phase change material 52 is contained within vessel 50, phase change material 52 may be alternatively disposed within and circulated through a sealed passageway within holder assembly 40.

The holder assembly 40 may further comprise one or more switch buttons 42a, 42b for the selective application of a predetermined electrosurgical signal to the main body portion 20. More particularly, switch button 42a may be depressed to electrically contact a metal plate 60, wherein an electrosurgical signal for tissue cutting may be provided to plate 60 and in turn to main body 20 via line 62. Similarly, switch button 42b may be depressed to electrically contact metal plate 60, wherein an electrosurgical signal for tissue coagulation may be provided to plate 60 and in turn main body 20 via line 62. Source signal line 64 as well as source signal return lines 66a and 66b may all be provided for receiving/returning signals to an RF electrosurgical source generator in a conventional fashion.

In one arrangement, electrosurgical instrument 10 comprises a blade portion 22 having a thickness T of about 0.040 inches (see FIG. 3), a width W of about 0.140 inches and length L of about 1 inch. In such arrangement, the main body 20 comprises copper (e.g., about 98% by weight) and coating 30 has a thickness of about 0.010 inches and comprises a polymeric, silicon-based material. Further, a phase change material comprises about 2 grams of stearic acid. This arrangement has been found particularly effective to yield reduced smoke generation and tissue charring.

FIG. 3 illustrates an alternate embodiment of an electrosurgical instrument 110 and is largely of the same construction as electrosurgical instrument 10 illustrated in FIGS. 1 and 2. As opposed to utilizing a phase change material 52 for the removal of thermal energy from main body 20, however, the embodiment illustrated in FIG. 3 utilizes a cooling gas stream that is circulated through an internal channel 70 of holder assembly 40 to remove thermal energy from shaft portion 24 of main body 20. As illustrated, channel 70 may be interconnected to a gas source via tubing lines 72 for circulation/cooling. In a modification of the embodiment shown in FIG. 3, channel 70 may be modified to pass directly on through conduits 74 at the forward extreme of holder assembly 70, and through an annular outlet 76 positioned immediately about the main body 20, wherein the cooling gas passing therethrough contacts the peripheral edge portion 26 for heat removal purposes. In yet other arrangements, the heat sink employed may utilize a liquid stream, a combination liquid/gas stream, or gas and liquid streams that are separate (e.g., a heat pipe).

Numerous additional embodiments and modifications will be apparent to those skilled in the art and are encompassed by the present invention as defined by the claims which follow.

What is claimed is:

1. An electrosurgical instrument for conveying an electrosurgical signal to tissue to achieve a predetermined electrosurgical effect, comprising:

5 a metal body for carrying an electrosurgical signal, wherein said metal body has a thermal conductivity of at least about 0.35 W/cm²-° K when measured at about 300° K, wherein said metal body includes a main body portion and a peripheral edge portion, and wherein said metal body is laterally-tapered down in cross-sectional thickness from said main body portion to said peripheral edge portion; and

an outer insulating layer positioned over at least a portion of said metal body and having a thermal conductance of about 1.2 Watt/cm²-° K or less when measured at about 300° K and a dielectric withstand voltage of about at least 50 volts.

2. An electrosurgical instrument as recited in claim 1, said metal body having a main body portion and a peripheral edge portion, wherein said electrosurgical signal is conveyed to tissue substantially entirely through said peripheral edge portion.

3. An electrosurgical instrument as recited in claim 2, wherein said metal body comprises at least one metal selected from the group consisting of: aluminum, silver, copper and gold.

4. An electrosurgical instrument as recited in claim 3, wherein an outer portion of said peripheral edge portion is not covered by said outer insulating layer, and wherein said instrument further comprises:

a biocompatible coating disposed on at least said outer portion of said peripheral edge portion of said metal body.

5. An electrosurgical instrument as recited in claim 4, wherein said biocompatible coating includes a component selected from the group consisting of:

nickel, silver, gold, chrome and titanium.

6. An electrosurgical instrument as recited in claim 2, wherein said metal body comprises a metal alloy having a first component selected from the group consisting of:

aluminum, silver, copper and gold; and

wherein said first component comprises at least about 50% of said metal body by weight.

7. An electrosurgical instrument as recited in claim 2, wherein said peripheral edge portion having a thickness of less than about 0.001 inches or less.

8. An electrosurgical instrument as recited in claim 2, wherein said outer insulating layer substantially covers said main body position.

9. An electrosurgical instrument is recited in claim 1, wherein said outer insulating layer contains at least one material having a thermal conductivity of less than about 0.009 W/cm²-° K when measured at about 300° K.

10. An electrosurgical instrument as recited in claim 1, wherein said outer insulating layer has a thickness of at least about 0.01 mm.

11. An electro surgical instrument as recited in claim 1, wherein said outer insulating layer comprises a polymeric compound.

12. An electrosurgical instrument as recited in claim 11, wherein said polymeric compound includes at least about 10% of a first component by weight, said first component selected from the group consisting of:

silicon and carbon.

13. An electrosurgical instrument as recited in claim 1, further comprising:

heat sink means for removing thermal energy from said metal body.

14. An electrosurgical instrument as recited in claim 13, wherein said heat sink means maintains said metal body at an average maximum temperature of about 500° C. or less. 5

15. An electrosurgical instrument as recited in claim 14, said heat sink means comprising:

- at least one phase change material, wherein said phase change material changes from a first phase to a second phase upon absorption of thermal energy from said metal body. 10

16. An electrosurgical instrument as recited in claim 15, said at least one phase change material being selected from the group consisting of:

- fatty acids, hydrocarbons and water compounds containing sodium. 15

17. An electrosurgical instrument as recited in claim 15, wherein said metal body further includes an integral shaft portion, and wherein said electrosurgical instrument further comprises: 20

- a thermally and electrically insulated hand piece for interconnection to said shaft portion, said hand piece being sized for hand-held use; and,
- a reservoir for containing said phase change material. 25

18. An electrosurgical instrument as recited in claim 1, wherein said peripheral edge portion has a maximum cross-sectional thickness of no more than about one-tenth of the maximum cross-sectional thickness of the main body portion. 30

19. An electrosurgical instrument for conveying an electrosurgical signal to tissue to achieve a predetermined electrosurgical effect, comprising:

- a metal body for carrying an electrosurgical signal, wherein said metal body has a thermal conductivity of at least about 0.35 W/cm° K when measured at about 300° K, and wherein said metal body includes a peripheral edge portion having a maximum cross-sectional thickness of no more than about one-tenth of a maximum cross-sectional thickness of a main body portion thereof; and, 35 40
- an outer insulating layer positioned over at least a portion of said metal body and having a thermal conductance of about 1.2 W/cm²-° K or less when measured at about 300° K and a dielectric withstand voltage of about at least 50 volts. 45

20. An electrosurgical instrument for conveying an electrosurgical signal to tissue to achieve a predetermined electrosurgical effect, comprising: 50

- a metal body for conveying an electrosurgical signal to a tissue site, wherein said metal body comprises at least one metal selected from the group consisting of aluminum, silver, copper and gold, wherein said metal body includes a main body portion and a peripheral edge portion, and wherein said metal body is laterally-tapered down in cross-sectional thickness from said main body portion to said peripheral edge portion; and 55
- an outer insulating layer positioned over at least a portion of said metal body, wherein said insulating layer has a thermal conductance of about 1.2 W/cm²-° K or less when measured at about 300° K. 60

21. An electrosurgical instrument as recited in claim 20, wherein said insulating layer comprises a polymeric compound.

22. An electrosurgical instrument for conveying an electrosurgical signal to tissue to achieve a predetermined electrosurgical effect, comprising:

- a metal body for conveying an electrosurgical signal to a tissue site, said metal body having a thermal conductivity of at least about 0.35 W/cm-° K when measured at about 300° K and said metal body having a main body portion and a peripheral edge portion, wherein said metal body is laterally-tapered down in cross-sectional thickness from said main body portion to said peripheral edge portion; and
- an outer insulating layer positioned over at least a portion of said metal body, wherein said insulating layer has a thermal conductance of about 1.2 W/cm²-° K or less when measured at about 300° K.

23. An electrosurgical instrument as recited in claim 22, wherein said peripheral edge portion has a maximum cross-sectional thickness of no more than about one-tenth of the maximum cross-sectional thickness of the main body portion.

24. An electrosurgical instrument as recited in claim 22, wherein said metal body comprises a first component selected from a group consisting of: aluminum, silver, copper and gold; and wherein said first component comprises at least 50% of said metal body by weight.

25. An electrosurgical instrument as recited in claim 22, wherein said peripheral edge portion has an outer extreme edge having a thickness of less than about 0.001 inches.

26. An electrosurgical instrument for conveying an electrosurgical signal to tissue to achieve a predetermined electrosurgical effect, comprising:

- a metal body for carrying an electrosurgical signal, said metal body having a main body portion and a peripheral edge portion, wherein said metal body is laterally-tapered down in cross-sectional thickness from said main body portion to said peripheral edge portion, wherein said metal body comprises a first component selected from the group consisting of aluminum and copper, and wherein said first component comprises at least 50% of said metal body by weight;
- an outer insulating layer positioned over at least a portion of said main body portion of said metal body, wherein at least an outer portion of said peripheral edge portion is not covered by the outer insulating layer, and wherein said outer insulating layer having a thermal conductance of about 1.2 W/cm²-° K or less when measured at about 300° K and a dielectric that will withstand voltage of at least 50 volts; and
- a biocompatible coating positioned at least said outer portion of said peripheral edge portion of said metal body.

27. An electrosurgical instrument as recited in claim 26, wherein said biocompatible coating includes a component selected from the group consisting of: nickel, silver, gold, chrome and titanium.

28. An electrosurgical instrument as recited in claim 26, wherein said peripheral edge portion has a maximum cross-sectional thickness of no more than about one-tenth of the maximum cross-sectional thickness of the main body portion.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,287,305 B1
DATED : September 11, 2001
INVENTOR(S) : Heim et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 8,

Lines 18-20, delete the words "said metal body having a main body portion and a peripheral edge portion,";

Line 58, delete the words "electro surgical", and insert therefor -- electrosurgical --;

Column 9,

Line 38, delete the word "cress-sectional", and insert therefor -- cross-sectional --.

Signed and Sealed this

Twelfth Day of March, 2002

Attest:



Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office