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Document Description: Power of Attorney

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Application Number	Not Yet Assigned
Filing Date	Concurrently Herewith
First Named Inventor	Philip C. Danby
Title	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	HYP-034C3

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sanjeet K. Dutta/	Date (Optional)	February 25, 2022
Name	Sanjeet K. Dutta	Registration Number	46,145
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of 1 forms are submitted.

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

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[x] I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 162143

OR

[ ] I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

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OR

[ ] The address associated with Customer Number:

OR

[ ] Firm or Individual Name					
Address					
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Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Hyper Ice, Inc.

[ ] Inventor or Joint Inventor (title not required below)

[ ] Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

[x] Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

[ ] Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	James Huether E4D53E30605B42E...	Date (Optional)	
Name	Jim Huether		
Title	Chief Executive Officer		

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Electronic Acknowledgement Receipt

EFS ID:	45091350
Application Number:	17681367
International Application Number:	
Confirmation Number:	8567
Title of Invention:	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH
First Named Inventor/Applicant Name:	Philip C. Danby
Customer Number:	162143
Filer:	Sanjeet Kumar Dutta/Anna Beaulieu
Filer Authorized By:	Sanjeet Kumar Dutta
Attorney Docket Number:	HYP-034C3
Receipt Date:	25-FEB-2022
Filing Date:	
Time Stamp:	17:26:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$7160
RAM confirmation Number	E20222OH26232505
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	HYP-034C3_-_Application_Data_Sheet_Fillable_PDF.pdf	1255941 11fd755de22119dcc0f8b7d5a96f21c2bc605f4b	no	9
Warnings:					
Information:					
2		APPL.pdf	97183 a51fea61c311cf12e578cbcdddebe3a075b3fed3	yes	19

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	14
	Claims	15	18
	Abstract	19	19

Warnings:					
Information:					
3	Oath or Declaration filed	DECS.pdf	221008 b791e10d9210388a1540a78304188d67315f6747	no	2
Warnings:					
Information:					
4	Drawings-only black and white line drawings	DRW.pdf	406451 f04a5a26019ad41708345e27098ae88ae21c90ea	no	7
Warnings:					
Information:					
5	Nonpublication request from applicant	NONPUB_REQ.pdf	17453 cc20de4f81906ebb0d1b317e99177b0d5fa78c50	no	1

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6	Power of Attorney	POA.pdf	114579 065e4abd32ac06f67ea8aebe6ff1f328d92981de	no	2
Warnings:					
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7	Transmittal of New Application	TRNS.pdf	33741 136b8eaeddca8a23b7df173408905979fa2797ff	no	1
Warnings:					
Information:					
8	Track One Request	TRK1_REQ.pdf	34817 097feee8a95b3d8fb5f40b95bad06982bf57fdb6	no	1
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	53089 11dcc907b4a8104dcb5aa6da14a7aeca63a66a3b	no	2
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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH
First Named Inventor/Applicant Name:	Philip C. Danby
Filer:	Sanjeet Kumar Dutta/Anna Beaulieu
Attorney Docket Number:	HYP-034C3

Filed as Large Entity

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4200	4200
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	10	100	1000
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**7160**

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Philip C. Danby	Nonprovisional Application Number (if known):	Not Yet Assigned
Title of Invention:	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.
2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.
3. The applicable box is checked below:

I. [x] **Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)**

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. [ ] **Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)**

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature	/Sanjeet K. Dutta/	Date	February 25, 2022
Name (Print/Typed)	Sanjeet K. Dutta	Practitioner Registration Number	46,145

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

[ ] *Total of 1 forms are submitted.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	MASSAGING DEVICE

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Philip C. Danby Date (Optional): June 28 2013

Signature: Philip Danby

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	MASSAGING DEVICE

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: John Charles Danby Date (Optional): 29/6/2013

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application No. 15/892,665 filed on February 9, 2018, and entitled "MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH", which is a continuation of U.S. Patent Application No. 14/317,573 filed on June 27, 2014, and entitled "MASSAGING DEVICE HAVING A HEAT SINK" (now U.S. Patent No. 9,889,066 issued on February 13, 2018), which claims priority to and the benefits of U.S. Provisional Patent Application No. 61/841,693 filed on July 1, 2013, and entitled "MASSAGING DEVICE", the entireties of which are incorporated herein by reference.

BACKGROUND

[0002] This invention relates generally to medical devices, and more particularly, to a deep muscle-stimulating device used to increase muscle metabolism, increase the lactic acid cycle and relieve pain.

[0003] Vibrating massaging devices are available on the market today; however, those devices suffer from many deficiencies. Many of the prior art massaging devices are bulky, get very hot, are noisy and/or are difficult to use for extended periods of time.

SUMMARY

[0004] Exemplary embodiments of massaging devices are disclosed herein. One exemplary embodiment includes a piston having a longitudinal axis and a massaging head connected to the piston. A motor is located on a first side of the longitudinal axis and a handle is located on a second side of the longitudinal axis. A drive mechanism for moving the piston and massage head is also included.

[0005] Another exemplary embodiment of a massaging device includes a handle, a piston, a massaging head attached to the piston, a motor, a drive mechanism for converting rotary motion of the motor to linear motion to drive the piston back and forth in a reciprocating motion, a

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processor, memory, a data connection in circuit communication with the processor and logic for transmitting data between the massaging device and a remote device.

[0006] Still another exemplary embodiment includes a massaging device that has a handle, a motor, a drive mechanism for converting rotary motion of the motor to reciprocating motion, a piston movable in a linear reciprocating motion connected to the drive mechanism and a massage head attached to the piston. The exemplary embodiment also includes a heat sink in thermal communication with the motor and drive mechanism, and a housing having two cavities. The first cavity at least partially surrounds the motor and the second cavity at least partially surrounds the heat sink. The cavities are separated from one another and the second cavity includes one or more openings for allowing air to flow over the heat sink to dissipate heat from the massager.

[0007] Another exemplary massaging device includes a housing, a handle extending outward from the housing and a piston having a longitudinal axis extending substantially perpendicular to the handle. A massaging head is connected to the piston. In addition, the massaging device includes a motor, a drive mechanism for moving the piston and a control panel. The control panel is located on the housing above the handle.

[0008] In yet another exemplary embodiment, a massaging device includes a handle, a piston, a quick-connection mechanism and one or more massaging heads releasably connectable to the piston by the quick-connection mechanism. The massaging device further includes a motor and a drive mechanism for moving the piston.

[0009] Another exemplary massaging device includes a handle, a piston, a massaging head connected to the piston, a motor and a drive mechanism for moving the piston. The drive mechanism includes a crank bearing that has one or more spring bars.

[0010] Still yet, another exemplary massaging device includes a handle, a piston a massaging head connected to the piston, a drive mechanism for moving the piston in a back and forth motion and a lost motion mechanism located between the massaging head and the drive mechanism.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0011] These and other features and advantages of the present invention will become better understood with regard to the following description and accompanying drawings in which:

[0012] Figure 1 illustrates a perspective view of an exemplary embodiment of a massaging device;

[0013] Figure 2 illustrates a first cross-section of the exemplary massaging device of Figure 1;

[0014] Figure 3 illustrates a second cross-section of the exemplary massaging device of Figure 1;

[0015] Figure 4 illustrates an exploded perspective view of an exemplary drive mechanism of the massaging device;

[0016] Figures 5A and 5B show enlarged side views of a crank bearing having spring bars for use in the exemplary drive mechanism of Figure 4;

[0017] Figures 6, 6A and 6B illustrate an exemplary quick-disconnect mechanism for connecting one or more massaging heads to a massaging device;

[0018] Figure 7 illustrates a schematic view of an exemplary lost motion control mechanism for varying the stroke of the piston driving a massaging head; and

[0019] Figure 8 illustrates an exemplary embodiment of a simplified block circuit diagram for a massaging device.

DETAILED DESCRIPTION

[0020] The Detailed Description merely describes exemplary embodiments of the invention and is not intended to limit the scope of the claims in any way. Indeed, the invention is broader than and unlimited by the exemplary embodiments, and unless specifically indicated otherwise, the terms used in the claims have their full ordinary meaning.

[0021] "Circuit communication" as used herein indicates a communicative relationship between devices. Direct electrical, electromagnetic and optical connections and indirect electrical, electromagnetic and optical connections are examples of circuit communication. Two devices are

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in circuit communication if a signal from one is received by the other, regardless of whether the signal is modified by some other device. For example, two devices separated by one or more of the following--amplifiers, filters, transformers, optoisolators, digital or analog buffers, analog integrators, other electronic circuitry, fiber optic transceivers or satellites--are in circuit communication if a signal from one is communicated to the other, even though the signal is modified by the intermediate device(s). As another example, an electromagnetic sensor is in circuit communication with a signal if it receives electromagnetic radiation from the signal. As a final example, two devices not directly connected to each other, but both capable of interfacing with a third device, such as, for example, a processor, are in circuit communication.

[0022] Also, as used herein, voltages and values representing digitized voltages are considered to be equivalent for the purposes of this application, and thus the term "voltage" as used herein refers to either a signal, or a value in a processor representing a signal, or a value in a processor determined from a value representing a signal.

[0023] "Signal," as used herein includes, but is not limited to one or more electrical signals, analog or digital signals, one or more computer instructions, a bit or bit stream, or the like.

[0024] "Logic," synonymous with "circuit" as used herein includes, but is not limited to hardware, firmware, software and/or combinations of each to perform a function(s) or an action(s). For example, based on a desired application or needs, logic may include a software-controlled processor, microprocessor or microcontroller, discrete logic, such as an application specific integrated circuit (ASIC) or other programmed logic device. Logic may also be fully embodied as software. The circuits identified and described herein may have many different configurations to perform the desired functions.

[0025] Any values identified in the detailed description are exemplary, and they are determined as needed for a particular massaging device. Accordingly, the inventive concepts disclosed and claimed herein are not limited to particular values or ranges of values used to describe the embodiments disclosed herein.

[0026] Figure 1 is a perspective view of an exemplary embodiment of a hand-held massaging device 100. The exemplary massaging device 100 includes a main housing 102 that houses a

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motor and a drive unit and an upper housing 104 that includes a heat sink and a fan. In addition, massaging device 100 includes a first handle 106, and a second optional handle 108. Handle 106 has a longitudinal axis that extends away from the housing 102. The massaging device 100 also includes a massaging head 130. As discussed in more detail below, in some embodiments massaging head 130 includes a quick-release connection.

[0027] Massaging device 100 includes a control panel 124. In one embodiment, control panel 124 comprises a first momentary pushbutton 126 and a second momentary pushbutton 128. First and second pushbuttons 126, 128 may serve multiple purposes. In one embodiment, pushing the first pushbutton 126 once moves the massaging device 100 to a first preset speed. Pushing the first pushbutton 126 a second time moves the massaging device 100 to a second preset speed. Accordingly, multiple preset speeds may be selected by pushing a single pushbutton. In addition, pushing pushbutton 126 and holding it down may increase the speed of the massaging head until the user releases the pushbutton 126.

[0028] In addition, if the massaging device 100 is turned off, pushing second pushbutton 128 once and holding it in for a period of time turns on the massaging device 100. Pushing the second pushbutton 128 in and holding it in for a period of time, such as, for example one second, causes massaging device 100 to turn off. While massaging device 100 is turned on, pushing and releasing second pushbutton 128 decreases the speed of the massaging device 100 to the next lowest preset speed. Pushing and releasing pushbutton 128 again further reduces the speed of the massaging device 100. In some embodiments, the operating speed of the massaging device is generally between about 600 and 3600 strokes per minute.

[0029] The control panel 124 is located above handle 106 on upper housing 104. Control panel 124 is located off of the handle 106, which prevents accidental contact between a user's hand and the control panel 124 and allows a user to move her hand to any position on the handle 106 during operation. Preferably, control panel 124 is located so that it is reachable by a user's thumb without the user having to remove her hand from the handle 106. In addition, massaging device 100 includes a power cord 132 for providing power to the massaging device 100.

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[0030] Although the exemplary control panel 124 illustrates two pushbuttons 126, 128, other controls may be used, such as dials and switches. In addition, visual or audible signals may be generated and displayed on control panel 124. To that extent, control panel 124 may include a visual display (not shown), an audible device (not shown) or the like, such as, for example a speaker, or the like. If a visual or audible device is used, the visual or audible device may be located proximate the pushbuttons or other controls, or may be located apart from such controls.

[0031] Upper housing 104 includes an air intake aperture covered by intake grate 120 and one or more air outlet apertures covered by outtake grate(s) 122. As described in more detail below, the heat-generating internal components of massaging device 100 are cooled by air passing through upper housing portion 104.

[0032] Figures 2 and 3 are cross-sections of massaging device 100. Located within handle 106 is control circuitry 260. Control circuitry 260 is in circuit communication with power cord 132, control panel 124, fan 222 and motor 210.

[0033] Motor 210 is located in housing 102 opposite handle 106. Motor 210 is a variable speed DC motor; however, motor 210 may be a constant speed motor, an AC motor or the like. In one embodiment, motor 210 has an operating speed of between about 600 and 3600 revolutions per minute (RPMs).

[0034] Motor 210 includes a shaft 211 that extends into a flywheel 212. Flywheel 212 includes a cylindrical projecting member or crank pin 213 positioned offset from the centerline 400 (Figure 4) of the flywheel 212. Crank pin 213 is inserted in an aperture 410 (Figure 4) of a crank bearing 214. Crank bearing 214 is inserted into a pocket 232 of a piston 230. The piston also has an elongated cutout 402 to receive part of the flywheel 212 for compactness while permitting piston reciprocation. Crank bearing 214 is cuboid in the exemplary embodiment, however, in some exemplary embodiments, crank bearing 214 may cylindrical.

[0035] Figure 4 is an exploded perspective view of piston 230, flywheel 212 and crank bearing 214. Piston 230 may be made of any suitable material, and in some embodiments, piston 230 is made of aluminum. As illustrated in the drawings, in some embodiments, motor 210 is located on one side of the longitudinal axis of piston 230 and handle 106 is located on a second side of the

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longitudinal axis. Piston 230 includes a pocket 232 (or transverse slot) having a first wall 232A and a second wall 232B. In some embodiments, piston 230 is hollow on either side of pocket 232 to reduce weight.

[0036] Flywheel 212 includes a cylindrical projecting member 213. Crank pin 213 is off set from the centerline 400 of flywheel 212. Accordingly, as flywheel 212 rotates, crank pin 213 rotates in a circular path around the centerline 400 of the flywheel 212. Rotation of crank pin 213 causes crank bearing 214 to travel in a circular motion within piston pocket 232 causing reciprocal motion of piston 230.

[0037] Piston 230 is restrained by two spaced apart bearings 310, 311 (Figure 3). Bearing 310 is located on a first side of flywheel 212 and bearing 311 is located on a second side of flywheel 212. Accordingly, piston 230 may only move in a back-and-forth motion along its longitudinal axis. The arrangement of the bearings 310, 311 on both ends of the piston 230 provides for a very sturdy and robust drive mechanism. Because piston 230 is constrained to a linear back-and-forth motion, as crank bearing 214 rotates in a circular motion, it acts against side walls 232A and 232B of pocket 232. This mechanism for converting rotary to linear motion is known as a "Scotch yoke."

[0038] In order to correctly assemble the components of a Scotch yoke drive, the pocket 232 (or walls of transverse slot) must be milled larger than the outside dimensions of the crank bearing 214. The gap between the inside of pocket 232 and the outside of crank bearing 214 is typically 0.1 mm inches. Motor 210 rotates at between about 600 and 3600 RPMs and each time the crank bearing 214 switches from moving, for example, toward side wall 232A of pocket 232 to moving toward the other side wall 232B, the bearing block 214 travels the small gap and smacks or strikes the side wall, e.g., side 232B, which causes a significant amount of noise and wear.

[0039] In one exemplary embodiment, crank bearing 214 is made with one spring bar 412. Figure 5A is an enlarged elevation view of side 420 of crank bearing 214 and Figure 5B is an enlarged plan view showing top 422 of crank bearing 214. The spring bars 412 are created by milling the outside of the spring block 214 proud by 0.4 mm in the area of the desired spring bar.

[0040] As illustrated in Figure 5A, the surface of spring bar 412 bows outward. The size of the bow is set to increase the width of the crank bearing 214 to be slightly larger (0.4 mm) than the

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width of the pocket 232. In some embodiments, slots 502 and 504 are milled into the surfaces of side 420 and top 422 below the spring bar 412 to allow spring bar 412 to deflect inwards. In some embodiments, slots 502 and 504 intersect thereby leaving spring bar 412 supported only on each end.

[0041] Thus, when crank bearing 214 is inserted into pocket 232, the spring bar 412 contacts the corresponding surface of the pocket 232 and deflects inward which causes crank bearing 214 to fit snuggly in pocket 232. Accordingly, as crank bearing 214 changes directions from, for example, moving toward side wall 232A to moving toward side wall 232B, the spring bar 412 takes up the slack in the gap and prevent noise and wear that would otherwise be generated by the crank bearing 214 striking the side walls 232A, 232B of the pocket 232.

[0042] Crank bearing 214 may be made of any suitable material; in some embodiments, crank bearing 214 is made of plastic. Although the exemplary embodiment is shown and described as having one spring bar, exemplary embodiments may have any number of spring bars.

[0043] Massaging device 100 includes a drive housing 218. Drive housing 218 is made of a heat conducting material, such as, for example, aluminum and has a longitudinal bore 327 passing therethrough to receive piston 230. As shown in Figure 3, drive housing 218 includes a first internal cylindrical groove 308 for holding bearing 310 and a second internal cylindrical groove 309 for holding bearing 311. Spaced bearings 310 and 311 mount and guide the piston 230 relative to the drive housing 218. Drive housing 318 surrounds piston 230 and flywheel 212. In some embodiments, drive housing 318 is made up of multiple components, such as an upper drive housing and a lower drive housing.

[0044] In addition, motor 210 includes a motor housing 209 that bolts onto drive housing 218. Motor housing 209 is also made of a heat-conducting material, such as, for example, aluminum. Secured to drive housing 218 is heat sink 220. Heat sink 220 includes a plurality of fins 221. Heat sink 220 is made of a heat conducting-material, such as, for example, aluminum.

[0045] Main housing 102 contains a first cavity 281. Upper housing 104 contains a second cavity 282. First cavity 281 and second cavity 282 are separated by a barrier 280. Motor housing 209 and drive housing 218 are located in the first cavity 281. Heat sink 220 is located in second cavity

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282. The exemplary embodiment describes a main housing 102 and upper housing 104. These may be portions made up of a single structure or multiple structures secured to each other.

[0046] Second cavity 282 includes an air inlet aperture 340 which is covered by grate 120 and one or more air outlet apertures 342 covered by one or more grates 122. A fan 222 is located in second cavity 282. When the fan 222 is activated, air enters second cavity 282 through air inlet aperture 340 and passes over cooling fins 221 of heat sink 220, and the air then passes out of second cavity 282 through the one or more air outlets 342. The fan may be activated by a switch (not shown) on control panel 124, activated automatically when the massaging device 100 is turned on, or may be activated by a thermostat (not shown). Thus, the cooling system for massaging device 100 is located in second cavity 282 and is isolated from the other components in the massaging device 100.

[0047] In typical massaging devices, cooling air is blown over the motor. Because the massaging devices operate for long periods of time in an atmosphere that is subject to a significant amount of dust and lint because the massaging device is often used on a person wearing clothes, a towel or a robe. Over time, the dust and lint may build up on the motor and cause the prior art massaging devices to overheat. Locating the cooling system in a cavity 282 that is isolated from the rest of the internal components minimizes this type of failure. The air outlet grates 122 may be sized larger to allow any lint and dust to freely pass out of the cavity 282. In addition, the surface of the heat sink 220 is smooth and thus, there will be few pockets for dust and lint to get trapped.

[0048] Figures 6 and 6A illustrate an exemplary embodiment of a quick-connect system 600 for connecting a massaging head 620 to a piston 602. When providing a deep tissue massage using a massaging device, such as, for example, massaging device 100, it may be desirable to switch massaging heads to work on different muscles or different portions of muscles during the massage. The exemplary quick-connect system 600 allows a user to quickly switch massaging heads 620. Moreover, the exemplary quick-connect system 600 may be used without turning off the massaging device 100.

[0049] Quick-connect system 600 includes a piston 602 that has a hollow-end bore 608 for receiving the shaft 621 of a massaging head 620. Located within the bore 608 of piston 602 is a

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cylindrical seat 604. Cylindrical seat 604 retains a magnet 606. Magnet 606 is illustrated with its north pole located flush with the seat and facing toward the opening in bore 608. Massaging head 620 includes a shaft 621 having a cylindrical pocket 622 at the distal end. Located within the cylindrical pocket 622 is a magnet 624. Magnet 624 is positioned so that its south pole is located at the distal end of shaft 621. Accordingly, when the shaft 621 of massaging head 620 is slid into opening in bore 608, the magnets 606 and 624 are attracted to one another and magnetically hold massaging head 620 firmly in place.

[0050] To remove massaging head 620, a user need only apply a sufficient amount of force to separate the two magnets 606, 624. The strength of the magnets 606, 624 are sized to prevent the massaging head 620 from separating from the piston 602 during normal use, and yet allow a user to quickly remove and replace the massaging head 620. In some embodiments the end 626 of the massaging head 620 is rounded, pointed or tapered (not shown) to allow it to easily slip into the opening 608 even while the piston 608 is moving.

[0051] Figure 6B illustrates another quick-connect massaging head 630. Quick-connect massaging head 630 is substantially the same as massaging head 620 except that the head portion 639 has a different shape than head portion 629 of massaging head 620.

[0052] In some instances, it may be desirable to adjust the throw or the stroke length of the massaging head to work on larger or smaller muscle groups, or deeper or shallower points of stress or soreness in the muscles. Figure 7 illustrates an exemplary embodiment of a lost motion system 700. Although lost motion system 700 is a hydraulic lost motion system, other mechanical lost motion devices may be used in accordance with embodiments of the present invention.

[0053] Lost motion system 700 is contained in housing 702. Housing 702 may be similar to drive housing 218 described above except it may need to be larger to accommodate lost motion system 700. Housing 702 includes a floating piston 720 located in first cylindrical bore 708. Floating piston 720 includes a sealing member 722 for forming a seal between floating piston 720 and first cylindrical bore 708. A cam 706 secured to housing 702 may be rotated to adjust the amount of travel that floating piston 720 may move. A passage 710 fluidically connects first cylindrical bore 708 to second cylindrical bore 704.

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[0054] A drive piston 730 is located in second cylindrical bore 704. Drive piston 730 includes a sealing member 732 to seal between the drive piston 730 and second cylindrical bore 704. Drive piston 730 may be driven in substantially the same way as described above with respect to piston 230. A passage 705 fluidically connects second cylindrical bore 704 and passage 710 to third cylindrical bore 706. Located within third cylindrical bore 706 is an output piston 740.

[0055] Output piston 740 includes a sealing member 742, such as, for example, an o-ring to form a seal between drive piston 730 and third cylindrical bore 706. Hydraulic fluid 712 is located in passages 705, 710 and portions of the first, second, and third cylindrical cavities 708, 704 and 706 as illustrated. A massaging head (not shown) is connected to output piston 740.

[0056] During operation, if cam 706 is set so that floating piston 720 is retained at the proximate end of first cylindrical bore 708 (as illustrated), movement of the drive piston 730 moves output piston 740 its maximum stroke length. If cam 706 is set so that floating piston 720 moves to adjacent the distal end of first cylindrical bore 708, movement of the drive piston 730 moves output piston 740 its minimum stroke length. The cam may also be selectively rotated to intermediate positions to choose different magnitudes of floating piston movement resulting in different selected magnitudes of output piston movement.

[0057] In some embodiments, floating piston 720 is physically connected to the cam or other adjustment mechanism so that it is positioned in a predetermined position and remains stationary during operation of the drive piston 730. Thus, floating piston 720 does not float during operation of the massaging device.

[0058] In some embodiments, the lost motion system may be contained in the massaging head itself, or in an adaptor that connects between the piston and the massaging head. Thus, rather than having a cam in the housing of the massaging device, different applicator heads or adaptors having a set lost motion, or variable lost motion systems integral therein may be used. In some embodiments, such adaptors and massaging heads may be adapted with a quick-connect system similar to the ones described with respect to Figures 6 and 6A.

[0059] Figure 8 illustrates a simplified exemplary electrical schematic diagram 800 of an embodiment of a massaging device. The components disclosed as being on a particular circuit

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board may be on multiple circuit boards or individually mounted and hardwired to one another. Circuit board 801 includes memory 804, motor control circuitry 810 and fan control circuitry 816, which are in circuit communication with processor 802. Fan control circuitry 816 is in circuit communication with fan 817.

[0060] Power circuitry 812 may be included on circuit board 801 or may be located on its own external to the massager. Power circuitry 812 includes the necessary power conditioning circuitry to provide power to both the electronics and the motors. In circuit communication with power circuitry 812 is plug 814. Optionally two or more power circuits may be utilized. All of the connections between power circuitry 812 and the other components may not be shown in Figure 8; however, those skilled in the art have the required knowledge to provide power to the devices that require power. Motor control circuitry 810 is in circuit communication with drive motor 811. Drive motor 811 is used to drive the piston and massaging head as described above.

[0061] Memory 804 is a processor readable media and includes the necessary logic to operate the massaging device. Examples of different processor readable media include Flash Memory, Read-Only Memory (ROM), Random-Access Memory (RAM), programmable read-only memory (PROM), electrically programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), magnetic disk, and optically readable mediums, and others. Still further, the processes and logic described herein can be merged into one large process flow or divided into many sub-process flows. The order in which the process flows herein have been described is not critical and can be rearranged while still accomplishing the same results. Indeed, the process flows described herein may be rearranged, consolidated and/or reorganized in their implementation as warranted or desired.

[0062] In addition, processor 802 is in circuit communication with control panel 806. Control panel 806 includes any desired pushbuttons, dials, displays or the like. Control panel 806 provides the operator interface to operate and control the massaging device.

[0063] Processor 802 is also in circuit communication with data connection 820. Representative data connections 820 include an Ethernet wire, Bluetooth, WiFi, optical transmitter/reader, an IR reader and the like. Combinations of two or more different data connections 820 may be used.

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Data connection 820 may be used to transmit data to an outside device, such as, for example, a computer or hand-held portable device. Various uses for transmitting such data are described below.

[0064] In some embodiments, processor 802 includes logic to collect and store data related to use of the massaging device. Exemplary types of data may include usage rates, operating times or the like. In some embodiments, different massaging heads include an RFID chip and when inserted into the massaging device, an RFID reader (not shown) identifies and stores the type of massaging head utilized. In some embodiments, a customer number may be associated with the data. This data may be used to determine lease rates of the massaging device, for calculating cost/benefit analysis, or for setting up customized massages.

[0065] In some embodiments, data may be uploaded from a computer or hand-held portable device to the massaging device. Such data may include customized massaging programs tailored for individual needs. In some embodiments, the customized massaging program may be reflective of prior massages given to a customer that were particularly well-received by the customer.

[0066] In some embodiments, the customized massaging program may indicate to the user on a display on the control panel 806 massage times, locations, type of massage head to use or the like to ensure covering the desired locations with the customized massage.

[0067] While various inventive aspects, concepts and features of the inventions may be described and illustrated herein as embodied in combination in the exemplary embodiments, these various aspects, concepts and features may be used in many alternative embodiments, either individually or in various combinations and sub-combinations thereof. Unless expressly excluded herein all such combinations and sub-combinations are intended to be within the scope of the present inventions. Still further, while various alternative embodiments as to the various aspects, concepts and features of the inventions--such as alternative materials, structures, configurations, methods, circuits, devices and components, software, hardware, control logic, alternatives as to form, fit and function, and so on--may be described herein, such descriptions are not intended to be a complete or exhaustive list of available alternative embodiments, whether presently known or later developed. Those skilled in the art may readily adopt one or more of the inventive aspects,

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concepts or features into additional embodiments and uses within the scope of the present inventions even if such embodiments are not expressly disclosed herein. Additionally, even though some features, concepts or aspects of the inventions may be described herein as being a preferred arrangement or method, such description is not intended to suggest that such feature is required or necessary unless expressly so stated. Still further, exemplary or representative values and ranges may be included to assist in understanding the present disclosure; however, such values and ranges are not to be construed in a limiting sense and are intended to be critical values or ranges only if so expressly stated. Moreover, while various aspects, features and concepts may be expressly identified herein as being inventive or forming part of an invention, such identification is not intended to be exclusive, but rather there may be inventive aspects, concepts and features that are fully described herein without being expressly identified as such or as part of a specific invention. Descriptions of exemplary methods or processes are not limited to inclusion of all steps as being required in all cases, nor is the order that the steps are presented to be construed as required or necessary unless expressly so stated.

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CLAIMS

WHAT IS CLAIMED IS:

1. An apparatus comprising:

a housing;

a handle on the housing;

a piston having a proximal end and a distal end;

a motor within the housing operatively connected to the proximal end of the piston, wherein the motor is configured to cause the piston to reciprocate between a minimum reciprocation stroke length and a maximum reciprocation stroke length at a first speed;

a cam having a first rotational position that controls a predetermined stroke length of the piston to the minimum reciprocation stroke length, a second rotational position that controls the predetermined stroke length of the piston to the maximum reciprocation stroke length, and a plurality of intermediate rotational positions that control the predetermined stroke length of the piston to a plurality of intermediate stroke lengths between the minimum reciprocation stroke length and the maximum reciprocation stroke length;

a connection mechanism at the distal end of the piston; and

a first massaging head releasably coupled to the distal end of the piston via the connection mechanism.

2. The apparatus of claim 1, wherein the maximum reciprocation stroke length corresponds to the distal end of the piston being positioned furthest from the housing.

3. The apparatus of claim 1, further comprising:

a second massaging head configured to releasably couple to the distal end of the piston via the connection mechanism.

4. The apparatus of claim 1, wherein the connection mechanism is a quick release connector.

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5. The apparatus of claim 1, wherein the motor is configured to cause the piston to reciprocate between the minimum reciprocation stroke length and the maximum reciprocation stroke length at a second speed.

6. The apparatus of claim 5, wherein the first speed and the second speed are each less than or equal to 3600 strokes per minute.

7. The apparatus of claim 5, wherein the first speed and the second speed are each greater than or equal to 600 strokes per minute.

8. The apparatus of claim 5, wherein the first speed and the second speed are each selectable from a plurality of predetermined speeds in a range of 600 strokes per minute to 3600 strokes per minute.

9. The apparatus of claim 5, further comprising:
a control panel positioned on an exterior of the housing.

10. The apparatus of claim 9, wherein the control panel is configured to display one or more visual indicators.

11. The apparatus of claim 9, wherein the control panel has a display device.

12. The apparatus of claim 9, wherein the control panel has one or more inputs.

13. The apparatus of claim 12, wherein the one or more inputs comprise at least one of: a button, a switch, and a dial.

14. The apparatus of claim 12, wherein the first speed and the second speed are each selectable via the one or more inputs.

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15. The apparatus of claim 12, wherein a first selection of the one or more inputs is configured to cause the apparatus to power on and wherein a second selection of the one or more inputs is configured to cause the apparatus to power off.

16. The apparatus of claim 1, further comprising an audible feedback device configured to generate one or more audible signals.

17. The apparatus of claim 1, further comprising a controller having, a processor, a memory, and a data connection.

18. The apparatus of claim 17, wherein the data connection is a wireless data connection.

19. The apparatus of claim 17, wherein the controller is configured to send, by the data connection, first data to an external computing device.

20. The apparatus of claim 19, wherein the first data is indicative of usage of the apparatus for providing a massage.

21. The apparatus of claim 17, wherein the controller is configured to receive, by the data connection, second data from an external computing device.

22. The apparatus of claim 21, wherein the second data is indicative of a massage program having at least one of a massage duration, a massage location, and a type of massaging head.

23. The apparatus of claim 1, wherein the housing comprises a cavity, wherein the motor and the cam are positioned within the cavity.

24. The apparatus of claim 23, further comprising a thermally conductive motor housing positioned within the cavity proximal to the motor.

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25. The apparatus of claim 24, further comprising a heat sink positioned proximal to the thermally conductive motor housing.

26. The apparatus of claim 1, wherein the motor is positioned within the housing opposite the handle.

27. A method of assembling an apparatus, the method comprising:

positioning a motor within a housing, wherein a handle is on the housing;

operatively connecting the motor to a proximal end of a piston, wherein the motor is configured to cause the piston to reciprocate between a minimum reciprocation stroke length and a maximum reciprocation stroke length at a first speed; and

positioning a cam within the housing, wherein the cam has a first rotational position that controls a predetermined stroke length of the piston to the minimum reciprocation stroke length, a second rotational position that controls the predetermined stroke length of the piston to the maximum reciprocation stroke length, and a plurality of intermediate rotational positions that control the predetermined stroke length of the piston to a plurality of intermediate stroke lengths between the minimum reciprocation stroke length and the maximum reciprocation stroke length,

wherein a distal end of the piston has a connection mechanism,

wherein a first massaging head is configured to releasably couple to the distal end of the piston via the connection mechanism.

28. The method of claim 27, wherein the maximum reciprocation stroke length corresponds to the distal end of the piston being positioned furthest from the housing.

29. The method of claim 27, wherein a second massaging head is configured to releasably couple to the distal end of the piston via the connection mechanism.

30. The method of claim 27, wherein the connection mechanism is a quick release connector.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

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☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

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Application Information:

Title of the Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH		
Attorney Docket Number	HYP-034C3	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	7	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

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☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

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This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)	
	Continuation of	15/892665	2018-02-09	
Prior Application Status	Patented			Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/892665	Continuation of	14/317573	2014-06-27	9889066	2018-02-13

Prior Application Status	Expired			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)	
14/317573	Claims benefit of provisional	61/841693	2013-07-01	

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Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Hyper Ice, Inc.		
Mailing Address Information For Applicant:			
Address 1	525 Technology Drive, Suite 100		
Address 2			
City	Irvine	**State/Province**	CA
Country	US	Postal Code	92618
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Sanjeet K. Dutta/			Date (YYYY-MM-DD)	2022-02-25
First Name	Sanjeet	Last Name	Dutta	Registration Number	46,145

Additional Signature may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	HYP-034C3
	Application Number	
Title of Invention	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ABSTRACT

Exemplary embodiments of massaging devices are disclosed herein. One exemplary embodiment includes a piston having a longitudinal axis, a massaging head connected to the piston, a motor located on a first side of the longitudinal axis and a handle located on a second side of the longitudinal axis. A drive mechanism for moving the piston and massage head is also included.

Petitioner Therabody Ex-1013, 0038

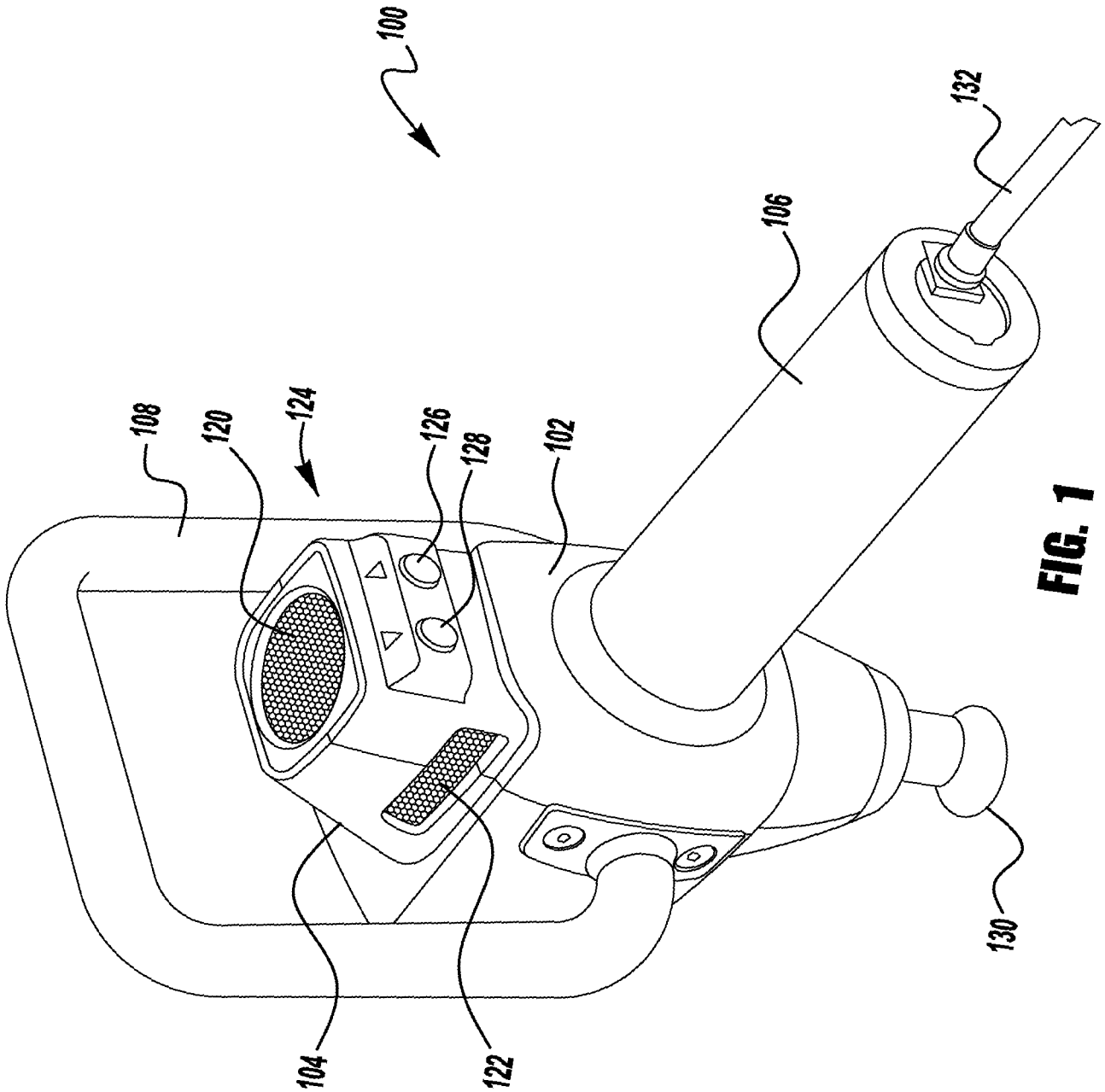


FIG. 1

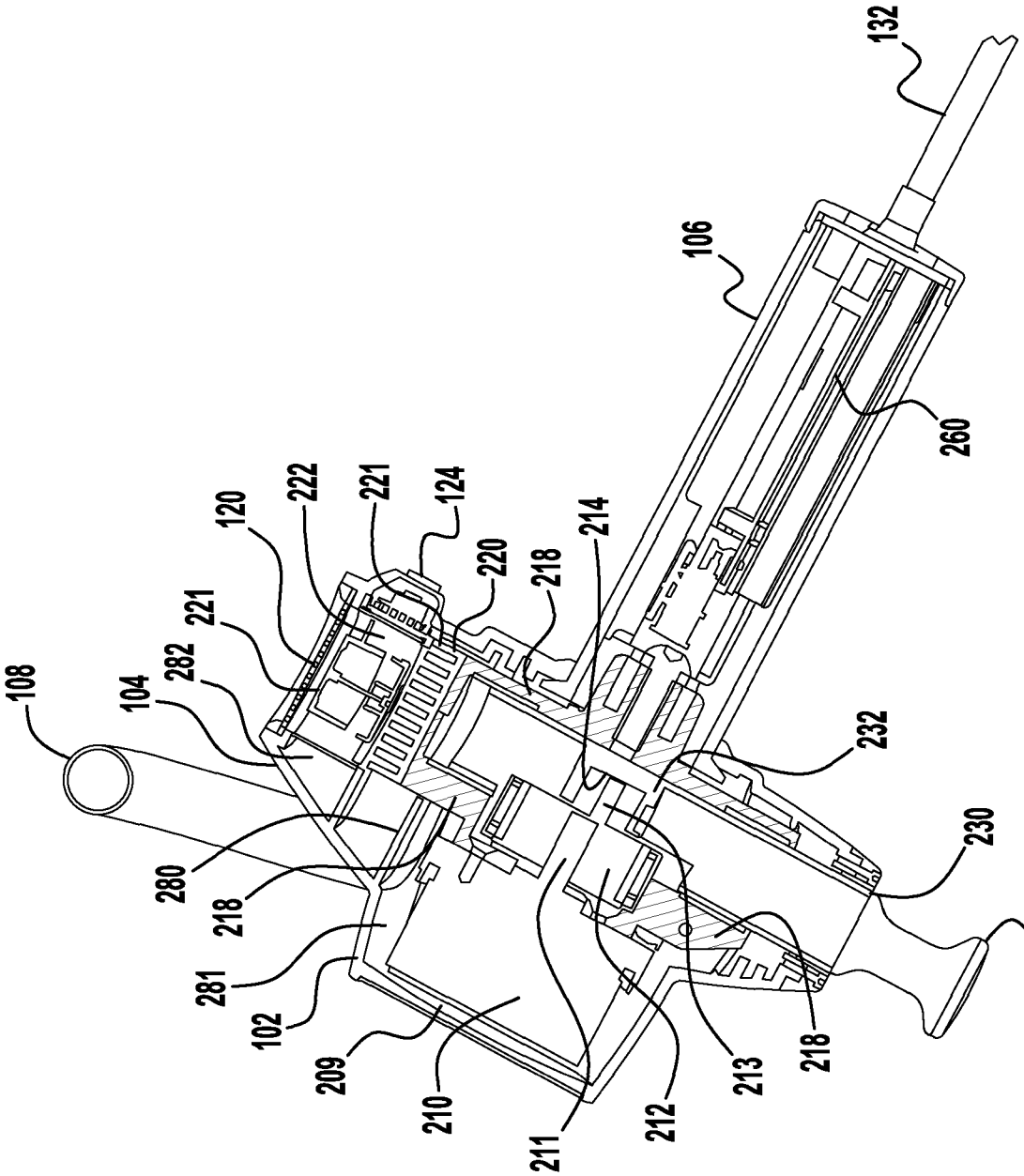

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FIG. 2

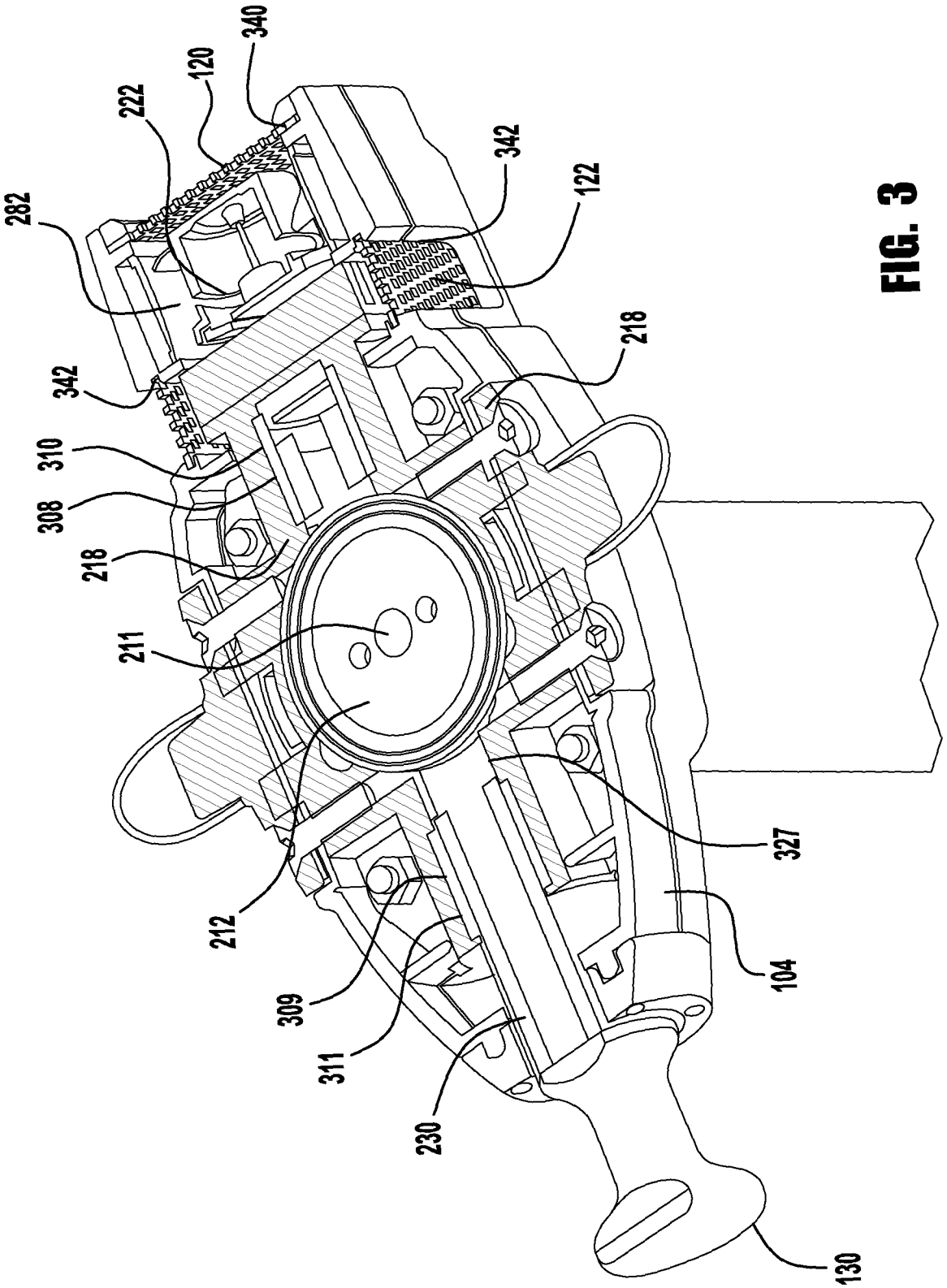

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FIG. 3

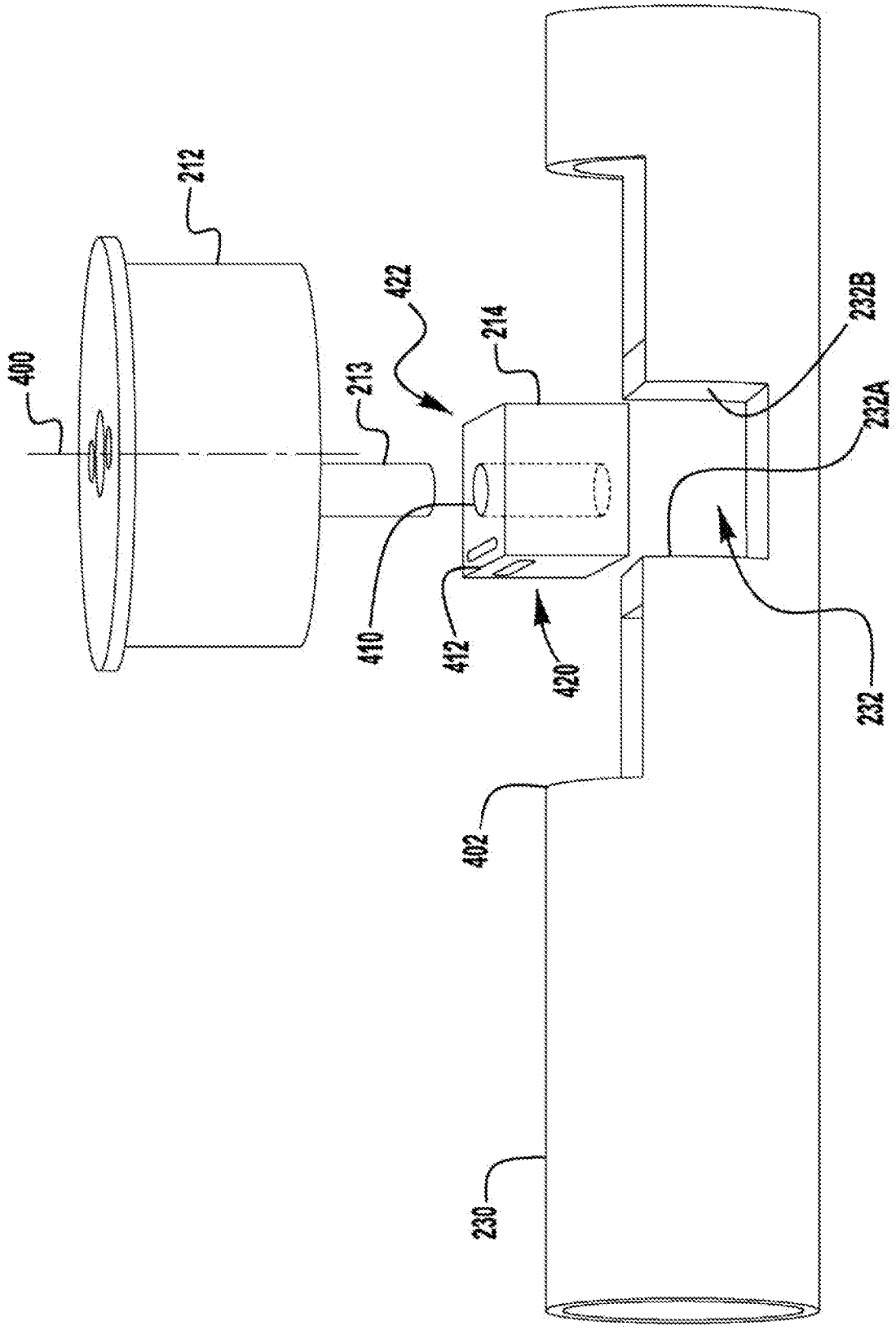


FIG. 4

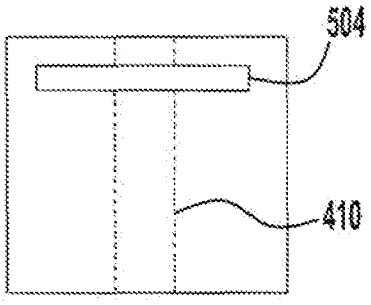


FIG. 5A

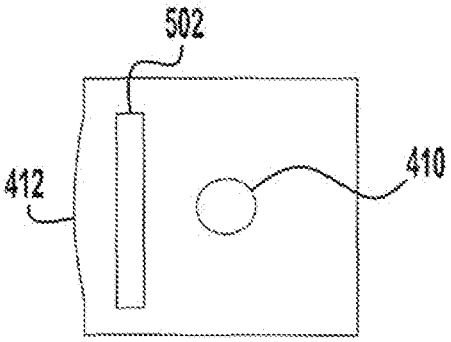


FIG. 5B

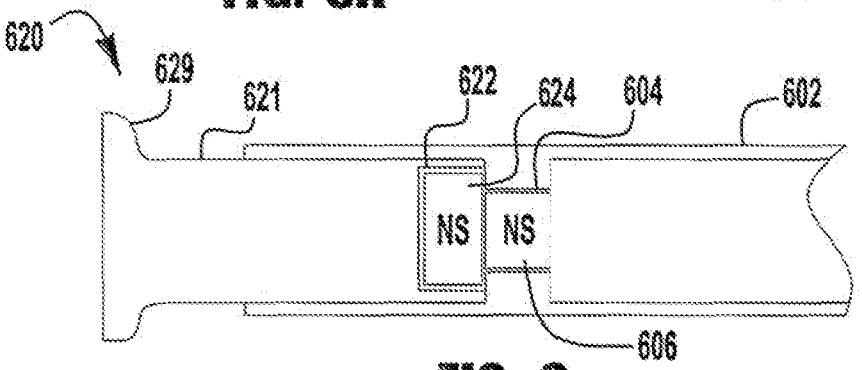


FIG. 6

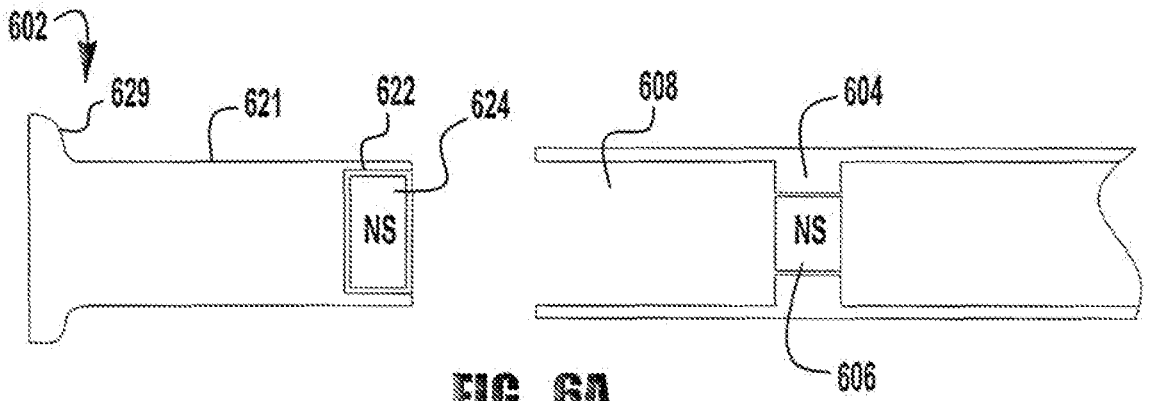


FIG. 6A

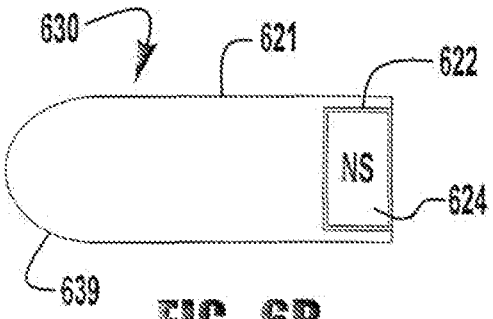


FIG. 6B

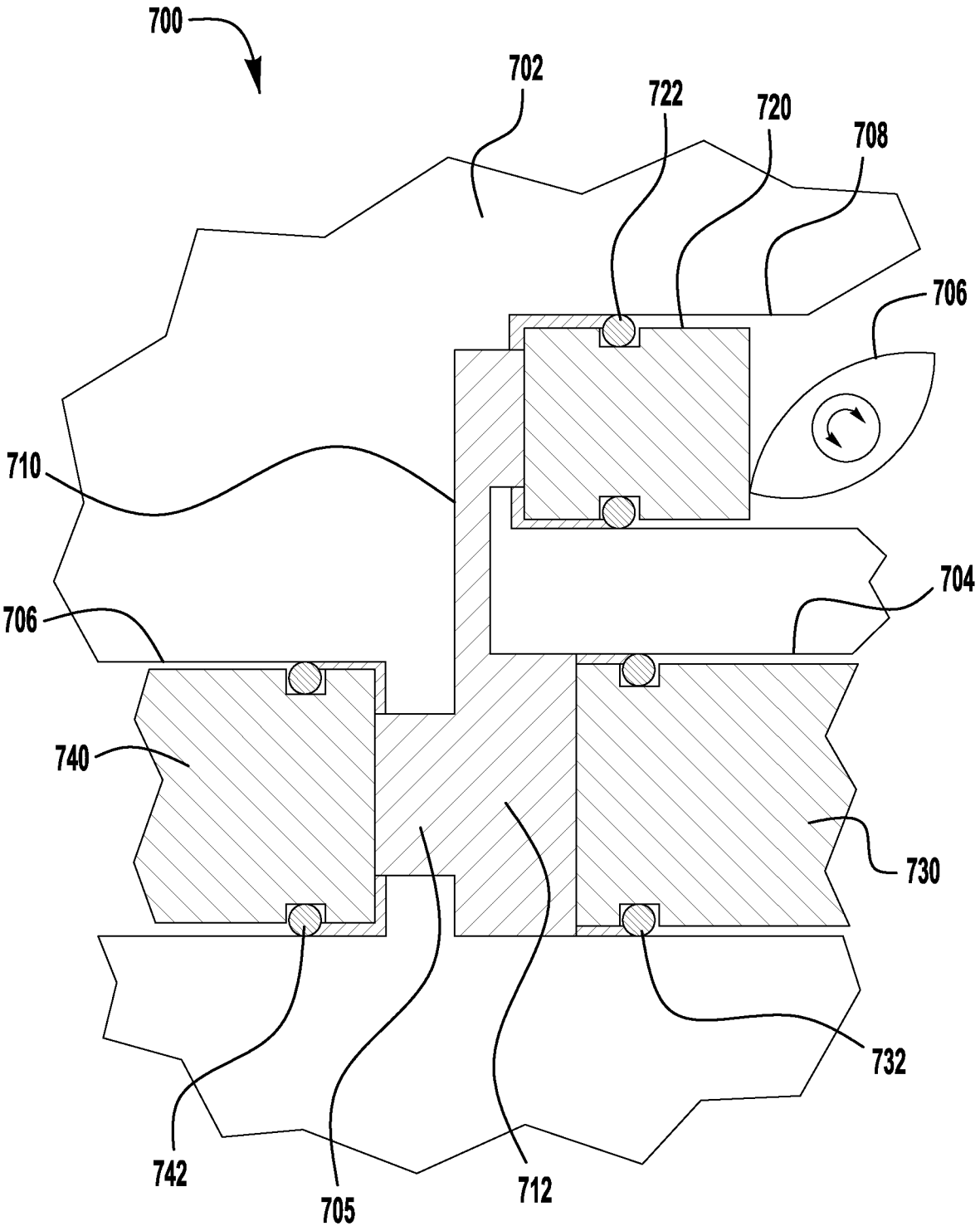


FIG. 7

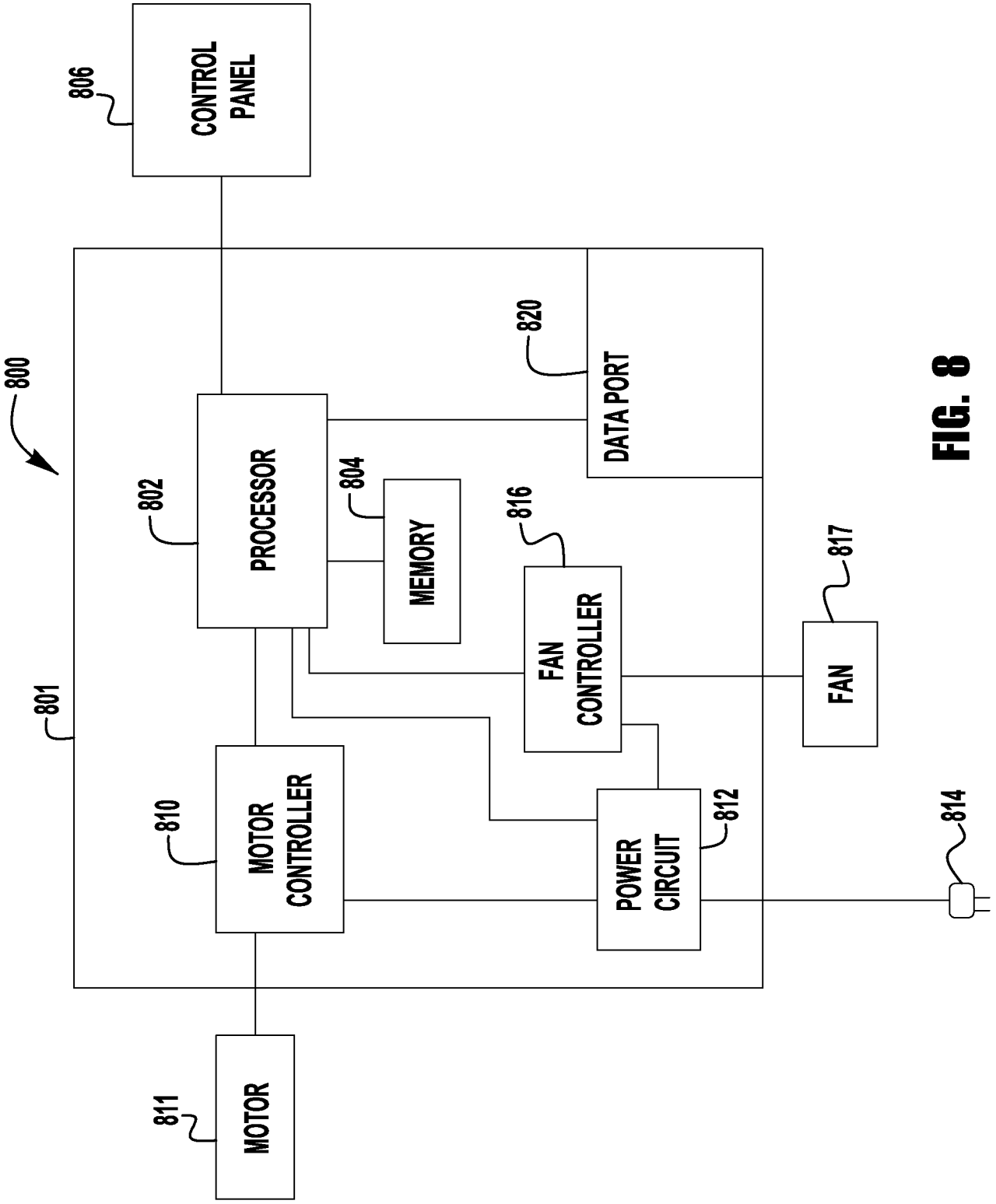

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PROCESSOR
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MEMORY
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CONTROL PANEL
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MOTOR CONTROLLER
811
MOTOR
812
POWER CIRCUIT
814
816
FAN CONTROLLER
817
FAN
820
DATA PORT

FIG. 8

PTO/SB/35 (07-09)
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NONPUBLICATION REQUEST UNDER 35 U.S.C. 122(b)(2)(B)(i)	First Named Inventor	Philip C. Danby
	Title	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH
	Attorney Docket Number	HYP-034C3

I hereby certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

I hereby request that the attached application not be published under 35 U.S.C. 122(b).

/Sanjeet K. Dutta/
Signature

February 25, 2022
Date

Sanjeet K. Dutta
Typed or printed name

46,145
Registration Number, if applicable

(650) 752-3260
Telephone Number

This request must be signed in compliance with 37 CFR 1.33(b) and submitted with the application **upon filing.**

Applicant may rescind this nonpublication request at any time. If applicant rescinds a request that an application not be published under 35 U.S.C. 122(b), the application will be scheduled for publication at eighteen months from the earliest claimed filing date for which a benefit is claimed.

If applicant subsequently files an application directed to the invention disclosed in the attached application in another country, or under a multilateral international agreement, that requires publication of applications eighteen months after filing, the applicant **must** notify the United States Patent and Trademark Office of such filing within forty-five (45) days after the date of the filing of such foreign or international application. **Failure to do so will result in abandonment of this application (35 U.S.C. 122(b)(2)(B)(iii)).**

PTO/AIA/15 (10-17)
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	HYP-034C3
First Named Inventor	Philip C. Danby
Title	MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [ ] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [ ] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [X] **Specification** [*Total Pages* 19] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [X] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 7]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [ ] Newly executed (original or copy)
   b. [X] A copy from a prior application (37 CFR 1.63(d))
7. [X] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [X] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [X] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [X] **Other:** CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e)

***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[X] The address associated with Customer Number: 162143 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Sanjeet K. Dutta/	Date	February 25, 2022
Name (Print/Type)	Sanjeet K. Dutta	Registration No. (Attorney/Agent)	46,145

IPTS/115437886.1

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/681,367	02/25/2022	3785	2820	HYP-034C3	30	2

CONFIRMATION NO. 8567

FILING RECEIPT

162143
GOODWIN PROCTER LLP/SILICON VALLEY
PATENT ADMINISTRATOR
100 NORTHERN AVENUE
BOSTON, MA 02210

OC000000132190234

Date Mailed: 03/03/2022

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Philip C. Danby, Key Biscayne, FL;
John Charles Danby, Witham, UNITED KINGDOM;

Applicant(s)

Hyper Ice, Inc., Irvine, CA;

Power of Attorney: The patent practitioners associated with Customer Number 162143

Domestic Priority data as claimed by applicant

This application is a CON of 15/892,665 02/09/2018
which is a CON of 14/317,573 06/27/2014 PAT 9889066
which claims benefit of 61/841,693 07/01/2013

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Petitioner Therabody Ex-1013, 0048

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/02/2022

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/681,367**

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

Early Publication Request: No

Title

MASSAGE DEVICE HAVING VARIABLE STROKE LENGTH

Preliminary Class

601

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/681,367

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	30 minus 20 =	* 10			OR	x 100 =	1000
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2820

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/681,367	02/25/2022	Philip C. Danby	HYP-034C3	8567

162143 7590 04/13/2022

GOODWIN PROCTER LLP/SILICON VALLEY
PATENT ADMINISTRATOR
100 NORTHERN AVENUE
BOSTON, MA 02210

EXAMINER
CENTRAL, DOCKET

ART UNIT	PAPER NUMBER
OPAP	

NOTIFICATION DATE	DELIVERY MODE
04/13/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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US-PatentBos@goodwinlaw.com

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Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 17/681,367	**Applicant(s)** Danby et al.	
	Examiner TERRI S JOHNSON	**Art Unit** OPET	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 25 February 2022 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to TERRI JOHNSON at (571)272 -2991. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/TERRI S JOHNSON/ Paralegal Specialist, OPET	

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A world-wide collection of designs data; including WIPO Hague registrations and information from participating offices.

European Designs

004377638-0002 - Percussion drills (Registered and fully published)

(19)
Identification, using the two-letter code according to WIPO Standard ST.3, of the authority publishing or registering the industrial design
EM
Design number
004377638-0002
(21)
Application number
004377638
(25)
Application language code
de
Second language code
en
(22)
Filing date
2017-09-29
Application reference
D17-231
(15)
Date of the national registration
2017-09-29
Publication Date
2017-10-25
(57)
Description of the characteristic features of the design(s), or matter for which protection is not sought
No
Renewal current status code
Renewal period open
(18)
Expected expiration date of the registration/renewal
2022-09-29
Current status code
Registered and fully published
Current status date
2017-10-23
(54)
Indication of products

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- **en:** Percussion drills
- **fr:** Perceuses à percussion
- **es:** Taladradoras de percusión
- **de:** Schlagbohrmaschinen

(51)
Class and subclass of the Locarno Classification
08-01
(71)
Name(s) and address(es) of the applicant(s)
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ALEMANIA

-



No search results.

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Petitioner Therabody Ex-1013, 0057

Electric toothbrush

List of publications

PCT Application number 20...	Publication date
WO2013/141359 A1 P...	2013-09-26

Abstract

Provided is an economical electric toothbrush that can reliably vibrate a head part while ensuring teeth-cleaning operability in the mouth, and in which a smaller size and lighter weight are achieved, and portability is improved. This electric toothbrush (10) comprises a head part (13), a neck part (12), and an operating part (11), wherein the head part (13) has a coin-shaped vibrating motor (17) on the bottom surface side of the head part, and a detachable brush plate (22) on the upper surface side of the head part; a battery and switch part are stored in the operating part (11); and the toothbrush is vibrated by the vibrating motor that is operated by electricity supplied from the battery.

English Abstract (Native or MT)

Provided is an economical electric toothbrush that can reliably vibrate a head part while ensuring teeth-cleaning operability in the mouth, and in which a smaller size and lighter weight are achieved, and portability is improved. This electric toothbrush (10) comprises a head part (13), a neck part (12), and an operating part (11), wherein the head part (13) has a coin-shaped vibrating motor (17) on the bottom surface side of the head part, and a detachable brush plate (22) on the upper surface side of the head part; a battery and switch part are stored in the operating part (11); and the toothbrush is vibrated by the vibrating motor that is operated by electricity supplied from the battery.

Abstract - French

La présente invention se rapporte à une brosse à dents électrique bon marché qui peut faire vibrer une partie de tête de manière fiable tout en garantissant une aptitude au nettoyage de dents dans la bouche, et qui permet une taille plus petite et un poids plus léger, et dont la portabilité est améliorée. Cette brosse à dents électrique (10) comprend une partie de tête (13), une partie de col (12), et une partie de fonctionnement (11), la partie de tête (13) comportant un moteur vibrant (17) en forme de pièces de monnaie sur la face inférieure latérale, et une plaque de brosse amovible (22) sur la surface supérieure latérale de la partie de tête; une pile et une partie interrupteur sont stockées dans la partie de fonctionnement (11); et la brosse à dents est mise en vibration par le moteur vibrant actionné par l'électricité fournie par la pile.

Other Abstracts

口腔内での歯磨き操作性を確保しつつヘッド部を確実に振動させることができ、しかも、小型化及び軽量化を実現し得て、携帯性を向上することができ、且つ、経済的である電動歯ブラシを提供する。本発明の電動歯ブラシ（１０）は、ヘッド部（１３）、ネック部（１２）、操作部（１１）からなる電動歯ブラシであって、ヘッド部底面側にはコイン型振動モータ（１７）、ヘッド部上面側には着脱自在の植毛プレート（２２）を有するヘッド部（１３）と、操作部（１１）には電池とスイッチ部を収容し、前記電池からの給電によって作動する前記振動モータにより、歯ブラシが振動することを特徴とする。

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Application Numbers & Dates	WOJP2013/058294 2013-03-22 [2013WO-JP58294]
Priority Numbers & Dates	JP2012068043 2012-03-23 [2012JP-0068043]

Technology domain Medical technology

IPC codes A61C-017/22*

CPC codes A46B-005/00/41* A46B-017/04 A61C-017/22/5A61C-017/34/81

Notes Extended kind: x

Cited Patents International Search Report [Examiner]
-JP2009106355 (A) (Cat. Y) [JP2009106355] LION CORP; -US2011247153 (A1) (Cat. Y) [US20110247153] BYEON DAEGIL; -US2006156496 (A1) (Cat. Y) [US2006

Claims

1. The head portion, the neck portion, and the operation unit consisting of a toothbrush, said head portion to the bottom surface side of the vibrating motor coin type is, on the top side of said head portion has a flocked may include a removable plate, said operation portion includes a switch and a battery is housed, wherein the supply of power from the battery to the vibration motor actuated by said coin type by, characterized in that the vibration of the toothbrush is an electric toothbrush.

2. A neck portion of the interposition member that isolates vibrations according to claim 1 characterized in that the electric toothbrush.

3. // / Foldable cap sliding feeding formula formula used in the method of replacing the wheel is provided with a mechanism extends to an electric toothbrush according to claim 1.

4. Wherein the upper surface of the coin type vibration motor vibration transmission section is provided in the electric toothbrush according to claim 1.

Original Claims

1. ヘッド部、ネック部、及び操作部からなる電動歯ブラシであって、
前記ヘッド部の底面側にはコイン型振動モータを、前記ヘッド部の上面側には着脱自在の植毛プレートを有し、
前記操作部には電池とスイッチ部を収容し、前記電池からの給電によって作動する前記コイン型振動モータにより、歯ブラシが振動することを特徴とする電動歯ブラシ。

2. ネック部に振動を遮断する部材を介在させることを特徴とする請求項１に記載の電動歯ブラシ。

3. スライド式 / 繰り出し式 / 折りたたみ式 / キャップ付け替え式の方法で使用時にはハンドルが延びる機構を備えた請求項１に記載の電動歯ブラシ。

4. 前記コイン型振動モータ上面に振動伝達部を備えた請求項１記載の電動歯ブラシ。

Description

The electric toothbrush

TECHNICAL FIELD

[0001] The present invention, a mobile electric toothbrush. The present application, on 23 March 2012, Japanese Patent Publication 2012-068043 filed Japan claiming priority based on, the contents of which are incorporated by reference herein.

BACKGROUND ART

[0002] In recent years, as well as in the home, office or even outside the travel destination such as a paste is being performed. For this reason, the portability toothbrush is found, in the case of the electric toothbrush, for the size of the whole, a problem of inferior portability has occurred. As the electric toothbrush, the brush head portion with a plurality of brush rotation-rotating, the brush head portion with a plurality of brush vibration of the vibrating and have been known. The vibrating type, provided on the output shaft of the motor vibrates the entire brush by eccentric weight configuration, the components are small, as compared with a rotary electric toothbrush can be made compact as a whole.

[0003] As a vibrating electric toothbrush, for example, the electric toothbrush shown in Fig. 6 and 1. 1 Is an electric toothbrush, the user grips the operating portion 2, the operation unit 2 and the neck portion is attached to the 3, 3 provided at the distal end of the neck portion and head portion 4, is provided.

[0004] In the inside of the operation unit 2, for example, a power source such as a single 4 and 5, which is driven by the power supply from the power supply 5 and the motor 6, the output shaft of the motor 6 mounted on the eccentric weights 6a and 7, the driving of the motor 6 a switch 8 ON/OFF and the like. And the eccentric weight 7 is the motor 6, the head portion 4 through the neck portion 3 to the vibration is applied to the vibration generating mechanism is configured. And the neck portion 3 and the head section 4,

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integral with, the operation unit 2 is detachably mountable to the neck portion 3 thereof.

[0005] In this way, according to the electric toothbrush, the operation section, such as a motor of an electric motor or at least a power source such as from a stage must be taken, the size is not yet satisfactory in the surface of, an inconvenience for the portable device has been caused a problem.

[0006] Thus, excellent in compact and portable in order to provide an electric toothbrush, and various proposals have been made. For example, the brush is implanted and the head portion and the neck 2 integrally formed of a toothbrush, a driving unit or the like can be removed from the operation portion, and an operating unit body 2 of the toothbrush are brought together and housed in a single case (Patent Document 1), the operation unit is attached to the cylindrical body of the toothbrush (Patent Document 2) are covered with a case of the toothbrush, the root of the neck motor is arranged at the end which is reduced in size (Patent Document 3, 4), and the like may be typically used. Alternatively, embedded in the head portion of the so-called linear motor (Patent Document 5, 6) and electric toothbrush, exchange portion of the drive unit, the electric toothbrush comprises a brush (Patent Document 7) has been proposed.

CITATION LIST

PATENT LITERATURE

[0007] PATENT CITATIONS

Japanese Patent Application Laid-Open 8-80220

Patent Publication 4681079

Japanese Patent Application Laid-Open 2003-93415

Patent Publication 4748267

Japanese Patent Application Laid-Open 2009-106355

Japanese Patent Application Laid-Open 2009-45202

Japanese Patent Application Laid-Open 2011-143057

TECHNICAL PROBLEM

[0008] However, for example, the toothbrush body 2 of the operation unit together with the case of containing one described in Patent Document 1 is to be assumed that, in use of the toothbrush body is attached to the drive shaft of the operation unit, when not used from the drive shaft does not become a toothbrush body is not removed, the problem is troublesome detachment has occurred. Moreover, junkyard a limited space such as the washroom or the like, during the brushing operation is carried out, the other 1 holds the toothbrush of the cases where to put which causes a problem.

[0009] An operation unit attached to the cylindrical body is covered with a case of the toothbrush of the toothbrush according to the Patent Document 2, a relation among specific dimensions are not, but the actual size of the estimation, at least, the portability of the overall size of the home is not taken into consideration is substantially the same size, specific to a mobile configuration was not.

[0010] The root of the neck portion of the motor to realize miniaturization of the arrangement of Patent Document 3, it is to be 4, and a base side of the neck portion is extremely becomes thick, the length of the neck portion to secure the distal end side of the toothbrush and does not inhibit the workability of the problem. In addition, the technique disclosed in Patent Document 3 as, with the brush body in the interior of the neck portion of the fixing motor in the case where, due to consumption of the toothbrush when it is in the replacement timing, the neck portion does not replace the entire motor is not formed, leading to an increase in cost has been a problem.

[0011] In addition, a drive unit (linear motor) to the head portion is embedded in Patent Document 5 has been described, it is difficult to reduce the size of the linear motor, and weight of the head portion or an increase in the degradation of the use. In addition, linear motor, with respect to the bristles of the brush, the extending direction of the only vibration, a good cleaning effect is hardly obtained. Furthermore, the linear motor, large consumption of power, or frequent replacement of the power supply, or power needs to be increased. The power supply is increased, the size of the operation unit cannot be achieved. Furthermore, the head portion of the drive unit (linear motor) is mounted in the Patent Document 6, when replacing the brush head with a linear motor for each need to be replaced, is not economical.

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[0012] In addition, the head portion of the drive unit (linear motor) is mounted in the Patent Document 7, a support comprising a linear motor can be inserted into the hollow head part in the specification, the head portion, so as to freely customize the motor specification in which the electric toothbrush. However, a support comprising a motor with an eccentric weight of the brush head portion is inserted into the hollow of the brush part and a thin, strength remains a concern. For securing the strength can also be in the wall thickness, the neck portion becomes thick in the oral cavity which deteriorates the operability.

[0013] Other, the size of a vibrating electric toothbrush as means, to shorten the neck portion, a small battery (a button battery or the like) to, and such a method. However, the neck portion of the simply shortened, the head portion to reach the back teeth, is put into the mouth until a thick operating unit and thus, deterioration of the operability. In addition, in order to reduce the operation unit such as a button battery or batteries in the case of a small, which may cause insufficient torque of the motor, and frequent replacement of the battery, and frequently cause the problem of the charging.

[0014] Therefore, the present invention, the driving part (a coin type vibration motor) is mounted to a head part, only the brush part (flocked plate, a brush) can be exchangeable cassette type, it is not necessary to dispose of the driving unit, and while ensuring the strength of the neck portion, excellent operability in the oral cavity of an object to provide an electric toothbrush. Further, without compromising use, excellent in compact and portable, vibration to ensure that the head part can be applied to an object to provide an electric toothbrush.

TECHNICAL SOLUTION

[0015] In order to solve the above problems, the present invention the first aspect of the electric toothbrush 1, the head portion 1, the neck portion, and an operation unit composed of the electric toothbrush, said head portion of the coin type vibration motor in the bottom side, the head part of the brush may include a removable upper surface side of a plate, a battery and a switch operation unit is housed, the operating the battery by the power supply from the coin type vibration motor, and the vibration of the toothbrush. In such a configuration according to the electric toothbrush, brushing the oral cavity while ensuring the operability of the head can be oscillated reliably with, in addition, can realize the size and weight, portability can be improved, and, that it is economical.

[0016] In addition, the present invention electric toothbrushes of the first embodiment is a 2, 2 in the neck member is provided to absorb vibration and in the electric toothbrush 1. According to the electric toothbrush in such a configuration, the vibration transmitted to the operation unit can be relaxed, the operation unit is holding a vibration is transmitted to the hand of a user with a feeling of discomfort can be reduced.

[0017] Further, the present invention electric toothbrushes of the first aspect of the 3, the sliding/folding/formula/3 out of the cap are used during the production of replacement of the handle is provided with a mechanism extending in the electric toothbrush 1. According to an electric toothbrush having such a configuration, while ensuring the operability at the time of use, more compact at the time of nonuse can be improved.

[0018] Further, the present invention electric toothbrushes of the first embodiment is a 4, a coin type vibration motor 4 The vibration transmission section is provided in the upper surface 1 in the electric toothbrush. According to an electric toothbrush having such a configuration, and to amplify the vibration frequency, to determine the specific orientation of the vibration, it is possible to change the amplitude and further, the cleaning properties of the oral cavity can be improved. To amplify the vibration frequency may include for example, fiber reinforced plastic such as fiber orientation in a coin-type motor is combined with the vibrating direction. In addition, to control the direction of vibration is a fiber-reinforced plastic as fiber orientation in a certain direction such as by putting, in a direction parallel to the direction of the fiber that amplifies the vibration, vibration of the vertical direction are brought about. Further, providing a weight may also be used to change the amplitude.

ADVANTAGEOUS EFFECTS

[0019] The electric toothbrush of the present invention, the driving unit (a coin type vibration motor) is mounted to a head part, only the brush part (flocked plate, a brush) can be exchangeable cassette type, it is not

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necessary to dispose of the driving unit, while ensuring the strength of the neck portion and, excellent operability in the oral cavity. Further, without compromising use. excellent in compact and portable, to ensure that the vibration can be applied to the head portion.

DESCRIPTION OF DRAWINGS

[0020] The electric toothbrush according to one embodiment of the present invention is shown, a cross-sectional view of the electric toothbrush. Electric toothbrush according to one embodiment of the present invention is shown, in a rear view of an essential portion of the electric toothbrush. Electric toothbrush according to one embodiment of the present invention is shown, a modification of the electric toothbrush head section view of the disclosure. Electric toothbrush according to one embodiment of the present invention is shown, a cross-sectional view of a modification of the electric toothbrush head portion of the disclosure. According to an embodiment of the present invention shows an electric toothbrush, a toothbrush head portion of a modification of the cross-sectional view of the disclosure. Electric toothbrush according to one embodiment of the present invention is shown, a modification of the electric toothbrush head section view of the disclosure. Electric toothbrush according to one embodiment of the present invention is shown, a modification of the electric toothbrush head section view of the disclosure. According to an embodiment of the present invention a modification of the electric toothbrush shown in Fig. 1, the non-use of the cross-sectional view of the electric toothbrush. According to an embodiment of the present invention a modification of the electric toothbrush 1, a cross-sectional view of the electric toothbrush during use. According to an embodiment of the present invention a modification of the electric toothbrush is shown in Fig. 2, when not in use to a side view of the electric toothbrush. According to an embodiment of the present invention a modification of the electric toothbrush 2, a side view of the toothbrush during use. According to an embodiment of the present invention a modification of the electric toothbrush shown in Fig. 3, when not in use to a side view of the electric toothbrush. According to an embodiment of the present invention a modification of the electric toothbrush 3, a side view of the toothbrush during use. According to an embodiment of the present invention is a modification of the electric toothbrush shown in Fig. 4, when not in use to a side view of the electric toothbrush. According to an embodiment of the present invention a modification of the electric toothbrush 4, a side view of the toothbrush during use. A conventional electric toothbrush described in more detail.

DESCRIPTION OF EMBODIMENTS

[0021] Then, the electric toothbrush according to one embodiment of the present invention will be, described with reference to the drawings. Incidentally, in the following embodiment of the present invention and in the preferred embodiment electric toothbrush, preferably a limitation of the various reference numerals in the art for such a case, the scope of the present invention, unless otherwise described to limit the invention in particular, these embodiments are not limited. In addition, the elements in the exemplary embodiments described below as appropriate, to allow replacement of the existing components and the like, and, in combination with other existing components of a wide variety of variations are possible. Therefore, with the following description of the embodiment of, the invention described in the appended claims are not limited to the contents.

[0022] Figure 1A-g according to an embodiment of the present invention shows an electric toothbrush, a toothbrush-sectional view of Fig. 1A, Fig. 1B is a rear view of the main portion, the head portion in Fig. 1C-g illustrates an enlarged view of a modification of the cross-sectional view. Fig. 1C is, the vibration transmission unit 90 to the head portion 13d, for example by insert molding method known as direct contact with the vibration motor 17, and, the bristle brush 21 press the side plate 22 as to protrude in a convex shape. And then, bonding the head portion 13e. The vibration transmission unit 90 and the motor 17 are in contact with the vibration of the vibration motor can be efficiently transmitted. In addition, the brush head portion 13d and ensure that the fitting strength of the plate 22. Fig. 1D is, the vibration transmission unit 90 to the head portion 13d, by the insert molding method as for example a vibration motor 17 so as to direct contact with, the vibration transmission unit 90, a brush head portion 13d so as not to protrude toward the 21. The vibration transmission unit 90 and the motor 17 are in contact with the vibration of the vibration motor can be efficiently transmitted. In the case of Fig. 1C and Fig. 1D, the vibration transmission unit 90 by the insert molding

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method in accordance with a known vibration motor 17 is provided so as to contact the other, known vibration transmission unit 90 to the head part 13d of the insert molding method and thereafter, the head part 13e and the vibration motor 17 is contained in each of the concave portions may be bonded. In addition, in this case, a head portion including a vibration motor 17 by suitable means such as a known 13e after the insert molding, a head portion including the vibration transmission unit 90 and 13d may be bonded. Fig. 1E is, the head portion 13d and the head section 13e is sandwiched between the vibration motor 17, so as to prevent water from entering the adhesive. The head portion 13d to the vibration transmission unit 90 in advance, for example by insert molding method known in the art can also be provided. At that time, the vibration transmission unit 90 to push the plate 22 by planting a brush 21 to press on the provided so as to protrude in a convex shape, and the efficient transmission of vibration of the vibration motor, the brush head portion 13d and ensure that the fitting strength of the plate 22. Fig. 1F is, the head portion 13d and the head section 13e is sandwiched between the vibration motor 17, so as to prevent water from entering the adhesive. The head portion 13d to the vibration transmission unit 90 in advance, for instance a can also be provided by the insert molding method, the vibration transmission unit 90, a brush head portion 13d so as not to protrude toward the 21. The vibration transmission unit 90 and the motor 17 and thus the vibrating close to the vibration of the motor can be efficiently transmitted. Fig. 1 g is, the head portion 13d and the head section 13e is sandwiched between the vibration motor 17, so as to prevent water from entering the adhesive. At this time, the head portion 13d at the side of the vibration motor 17, the brush plate 22 to push the brush 21 to press the protruding convex portions (corresponding to the vibration transmission unit) is provided, and the efficient transmission of vibration of the vibration motor, the brush head portion 13d and ensure that the fitting strength of the plate 22.

[0023] As shown in Fig. 1A-g, 10 is an electric toothbrush, the user grips the operating portion 11, the operation unit 11 and the neck portion is attached to the 12, 12 provided at the distal end of the neck portion and head portion 13, a.

[0024] The operation unit 11, and a cylindrical handle 14 made of resin, the handle 14 provided on the inside of the battery, for example, a single interchangeable type 4 (single 3 type, or may be a single 5 type or the like) or a rechargeable battery and a power supply 15, a switch for operating the driving of the power supply unit 16 and 15, is provided. Incidentally, the power supply 15 in the case of using a rechargeable battery, the charging unit of the rear end of the provided known. Therefore, as described in the prior art, the electric motor or the operation unit 11 (transmission mechanism) eccentric weights are not provided from the air, the size of the operation unit 11 (the diameter and shorten the length of the short diameter) can contribute to, and it becomes possible to improve the portability. At this time, the operation unit 11, which is not shown in detail, for example, the handle 14 along the axial direction of sliding relative to the inner-layer structure including a displaceable, the outer side thereof as an extension of the operation unit 11 is slid and displaced toward the rear end of the length of the operation part 11 can be varied. In addition, extension of the switch unit 16 is also possible to link, the length of the handle 14 at the same time with the adjustable short/switch can be ON/OFF. The material of the operation unit 11, generally the material used for the electric toothbrush, for example ABS resin or the like is used, but are not limited to them.

[0025] The neck portion 12, the same material as the handle 14, the distal end side, that is, the head portion 13 is formed to be tapered. In this case, the diameter of the taper and concentric with the center of the handle 14 is displaced or is optional. In addition, the handle 14 and coloring material and may be different. The head portion 13 on the distal end of the neck portion 12 is formed, a bottom surface side of its head a coin type vibration motor (hereinafter, simply referred to as the vibration motor) 17 is provided. Furthermore, the interior of the neck portion 12, and the power supply 15 and the vibration motor 17 is electrically connected to the wiring 18, is routed to 19. The wiring 18, is 19, the neck portion and a wiring cord 12 may be insert molded when injection molding or may be a plate-like, or may be a combination of these. That is, the vibration motor 17 from power supply 15 as long as it can ensure the supply of power to, and its structure is not particularly limited. Therefore, the neck portion 12 is, for example, a cylindrical hollow through which the cord may be a body, at least the head portion 13 of the tapered portion may be a solid body. In addition, the neck

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portion 12 and an elastic body itself vibrates the entire absorbing part of the neck portion 12 may also be used. In the present embodiment, the intermediate portion of the neck portion 12, is disposed in the vibration absorber 20, thereby the neck portion 12 which is divided. Therefore, the vibration absorber 20 of the handle 14 side (base side) than the neck portion of the hollow body 12a and the wiring 18 a, the code 19, the vibration absorber 20 of the head part 13 side (tip side) than the neck portion 12b and the wiring 18 is composed of a solid body, and the insert molding is 19.

[0026] The vibration absorber 20, the vibration of the vibration motor 17 and the neck portion 12 between the operation unit 11, to be easily transferred to the operation unit 11 at least in a range of a vibration it, is not particularly limited. The neck portion 12, the vibration absorber 20 to the neck portion 12a from the base side so as to prevent fluids such as saliva, the waterproofing property is ensured. In addition, the neck portion 12 from the power supply 15 via the inside of the wiring connected to the vibration motor 17 18, 19 is penetrated through the vibration absorber 20 is, in such a manner that appropriate contacts and electrical connection is ensured. In the present embodiment, the vibration absorber 20, the elastomer (for example, a styrene-olefin) or a silicon (silicon rubber) or the like is used.

[0027] And the head portion 13 has two parts, one of the flocked plate is formed on the upper surface side of the head portion are constructed from a head portion 13d, the bottom side of the head portion of the other portions in which the head part 13e. And the upper surface side, the head portion is implanted in the side of the brush to the direction, the bottom surface side, the base portion of the head portion (13a) refers to the direction of the side. The upper surface side of the head portion 13d, that is, the brush head portion 13d of the side facing the plate 22 to engage with the flocked plate 22 of the convex portion 13b is formed. Flocked plate 22 facing the convex portion 13b has a thickness, 1.5 mm or more or less than 3.0 mm, preferably 2.0 mm or more or less than 2.5 mm. The vibration motor 17 to the head portion 13e is disposed is formed in the recess 13c, the head portion 13d at a position corresponding to a recess in the housing of the vibration motor 17, fixed, each head unit 13d a and 13e, such as ultrasonic bonding or the like in close contact with the water-tightly by an integral part thereof. Flocked plate 22 is fitted into the head portion 13d of the projections 13b are arranged around the vibration motor is formed so as to surround it. The vibration transmission unit 90 includes a head portion 13d is further provided, in the head portion 13d of the convex portion 13b is arranged. The vibration transmission unit 90 as shown in Fig. 1C and Fig. 1D, for instance a vibration motor 17 by the insert molding method can also be in contact with. In addition, as shown in Fig. 1E and Fig. 1F as for example provided by the insert molding method 13d, the vibration motor 17 is not contact with the vibration transfer unit 90 may be disposed in a manner. Furthermore, as shown in Fig. 1 g the brush plate 22 to push the brush 21 to press on the convex portion is provided and the vibration transmitting portion and in some cases. In the case of Fig. 1C and Fig. 1D, the vibration motor 17 vibration transmission unit 90 includes a head portion 13d after molding, bonding the head portion 13e. The vibration transmission unit 90 and the motor 17 makes contact with the vibration motor can be efficiently transmitted. Or, a known vibration transmission unit 90 to the head part 13d of the insert molding method and thereafter, the head part 13e and the vibration motor 17 is contained in each of the concave portions may be bonded. In addition, in this case, a head portion including a vibration motor 17 by suitable means such as a known 13e after the insert molding, a head portion including the vibration transmission unit 90 and 13d may be bonded. In the case of Fig. 1E and Fig. 1F, a head portion including the vibration transmission unit 90 13e and a head portion 13d is sandwiched between the vibration motor 17, so as to prevent water from entering the adhesive. In the case of Fig. 1 g, the head portion 13d is sandwiched between the vibration motor 13e and the head portion, the adhesive to prevent the entrance of moisture. Fig. 1C, the vibration transmission unit 90 in Fig. 1E to press the brush side planted plate 22 may be provided on the convex, in this case, the brush plate 22 and the head portion 13d of the fitting strength can be ensured. Is flocked plate 22, the hardness of the appropriate thickness or a brush for brushing with the brush 21. The material of the brush plate 22, so that the flocked to ensure the strength, POM high strength, PBT, PTT the like are preferably used. Incidentally, the brush 21 planted brush plate 22 are referred. Is flocked plate 22, the sliding and fixed, may be secured to the undercut. The material of the head portion 13, generally the material used for

the electric toothbrush, for example POM resin or the like is used, but are not limited to them.

[0028] Planting a brush material of the brush plate is not particularly limited, for example, (example: nylon 6-12, nylon 6-10) polyamide, polyester (example: polyethylene terephthalate, polybutylene terephthalate, polytrimethylene terephthalate), polyolefin (example: polypropylene), elastomer (example: olefin, a styrene-based) of a synthetic resin material or the like can be used. In addition, the tips of the bristles in the shape of a brush, a roll tips, and gradually the ends in the width of the tapered outer diameter, further, a spatula-shaped, spherical, the shape of the two-pronged-like can be used. Is the height of the hair brush, less than or equal to 8 mm or more at 13 mm for an adult, the child is 9 mm or less and more preferably 6 mm or more, the smaller the diameter of the selected brush in the oral cavity or the use of a brush from the viewpoint of feeling in use is preferable to be shorter the height of the hair. In addition, a feeling of use, the press , the cleaning effect, taking into consideration the durability, a plurality of different size of the brush may be used in any combination. In addition, there is no profile of the ends is not limited thereto.

[0029] The switch unit 16, the operation unit 11 to the rear end of the rotary as well as known, the operation unit 11 provided in the side of the slide type may be known. Incidentally, in the case of a slide of the slide is displaced unexpectedly ON so as not to provide the lock mechanism may also be present.

[0030] The vibration motor 17, a so-called eccentric motor and, for example, a coin type in the container axis of rotation of the driving part and a driving part provided in the rotor is provided with a semi-circular, so that when the rotating shaft is rotated toward the center of gravity of the vibration motor 17 vibration in which the entire or the like. The vibration motor 17, for example, a thickness of 3.0 mm or less 1.5 mm or more, 2.0 mm or more is preferably 2.5 mm or less, 12.0 mm or less diameter φ 8.0 mm or more, preferably 12 mm or less φ 10mm or more, of the order of is used. By using such an oscillation motor 17, the electric toothbrush 10 with having a compact and lightweight, use can be improved. In addition, the vibration motor 17, 21 can be a vibration in the radial direction of the brush, the brush 21 of the movable area is increased, to enhance the brushing effect. Furthermore, the vibration motor 17, power consumption compared with a linear motor or the like is small, small cell type present in the 1 3-5 a single large enough to drive, and does not need to be replaced frequently. Therefore, the operation unit to be compact is suitable. In addition, the vibration motor 17, for example, 7500 rpm/min or more to 20000 rpm/min or less their frequency can be secured, the size may be smaller than those described above.

[0031] Is the vibration transmission unit 90, provided in the head portion 13d, the convex portion 13b of the head portion 13d is disposed. The vibration transmission unit 90 as shown in Fig. 1C and Fig. 1D, by the insert molding method as for example a vibration motor 17 may be in contact with, for example as shown in Fig. 1E and 1F by the insert molding method known in the art and does not contact the vibration motor 17 may also be provided at 13d. In addition, the brush plate 22 as shown in Fig. 1 g to push the brush 21 to press on the convex portion is provided and the vibration transmitting portion and in some cases. In the vibration transmission unit 90, and to amplify the vibration frequency, to determine the specific direction due to vibration, to change the amplitude further may be the ones that can be, the brush plate 22 and the head section of the fitting portion of the head portion 13d in order to reduce the vibration loss of the upper portion of the position of the location of the vibration motor 17 in the direction of the brush 21 that a protrusion portion 13d provided integrally with the head part is fitted to ensure that the structure, the vibration loss may be decreased. Amplification of the number of vibration, or vibration of the direction in which they can control, as well as long as it can change the amplitude, in particular the material is not limited. In addition, the vibration motor 17, as shown in Fig. 1B, the width of the head portion 13 (for example, 8.5 mm or more or less than 13.0 mm) is used having a smaller diameter than, the head portion 13 is preferably not to protrude from. The vibration motor 17 is commercially available, for example, LE10E0H (φ 10mm, thickness 2.0 mm, mass=about 1 g, the rotation speed of 9000 rpm, manufactured by lexical down japan) and the like.

[0032] The vibration motor 17, the fitting or by burying the head portion 13, without the need for a mechanism for transmitting the vibrations directly to the vibration of the head portion 13 can be. Therefore, when the brushing

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operation is performed in the oral cavity, for the vibration is directly transmitted, to ensure that the brushing effect caused by a vibration can be ensured. In addition, by directly transmitting vibration, the vibration motor 17 is applied to a small number of rotation in a small size and the cost can be used. In addition, the vibration motor 17, or from within the oral cavity during use, the structure and sealed with ultrasonic bonding, to secure the waterproof packing or the like, the outer surface of the vibration motor 17 a waterproof treatment, the insert molding, welding using a known means such as a waterproof or preferably to ensure hermeticity. The head portion 13d and the head section 13e the vibration motor 17 and laminating the built-in, the exposure of the vibration motor 17 can be prevented. The vibration motor 17 to its head portion 13e is disposed is formed in the recess 13c, the head portion 13d at a position corresponding to a recess in the housing of the vibration motor 17, fixed. Each head unit 13d and the head part 13e is, for example ultrasonic bonding or the like in close contact with the water-tightly by an integral part thereof. The material of the head portion 13d and the head part 13e, able to withstand the vibration, POM high strength, PBT, PP or the like is preferably used. Is fixed to the vibration motor 17, in order to eliminate rattling of the motor, in order to fill the gap between the elastic material can be used. In addition, for fixing the vibration motor 17, the protrusions may be present at several locations. A as the elastic material, silicone rubber, epoxy resin, acrylic resin, among which the silicone rubber surface treatment.

[0033] Incidentally, in the above embodiment, the bottom surface side of the head portion 13 by arranging the vibration motor 17, the neck portion 12 of the operation unit 11 and can be made compact, not only the diameter of the operation unit 11, it was possible to shorten the length thereof. However, the user can use a shorter length for grasping operation because. as shown in the Examples below and in the specifications.

[0034] (Example 1) in the head portion of the coin type vibration motor using the electric toothbrush having the above-mentioned embodiment. Fig. 2A is a and B, and a compact electric toothbrush in order to improve the operability of the modification of the 1, the electric toothbrush of Fig. 2A is a cross-sectional view of the non-use condition, the electric toothbrush of Fig. 2B is a cross-sectional view of the time of use. Incidentally, in Fig. 2A and B, the same as those of the above embodiment part of the figure is omitted and, with the same reference numerals and description thereof will be omitted.

[0035] B as shown in Fig. 2A and, at the rear end of the operation unit 11 can be detached from the fitting method of a bottomed cylindrical shape is provided as an extension to the cap 24, the cap 24 when not in use to fit the distal end side of the operation unit 11 of the head unit 13 and the neck portion 12 can be covered and, the operation unit 11 is used when the cap 24 is fitted into the rear end side of the length of the operation part 11 can be extended. That is, the extension of the present embodiment, when not in use and has a neck portion 12 and a head portion 13 covers the distal end side of the operating unit 11 to engage, in use the operation unit 11 and the rear end of the cap 24 are engaged. According to the electric toothbrush in such a configuration, when being not used to ensure the hygiene of the brush head portion of the resultant image, without considering the receptacle when in use as part of the operation unit can be used. In addition, the taper of the neck portion 12, the cap 24 and the cover fitted into the operation unit 11 in consideration of the function, on one side than the center of the operation unit 11 (the back surface side of the head portion) is displaced.

[0036] Here, the extension, the total length of the electric toothbrush 10 as, when not in use, that is, 150 mm or more in Fig. 2A if the length of not more than 110 mm, for example, when the user goes out of a woman carrying a pouch such as a cosmetic can be easily placed in a readily. In addition, the extension, the total length of the electric toothbrush 10, in use, that is, in Fig. 2B, 170 mm or more as long as 180 mm or less, the operability can be ensured. At this time, the cap 24 and the operation unit 11 is 5 mm or more of the D4 lap margin less than or equal to 50 mm.

[0037] Therefore, when it is used as the extension portion 24 of the cap, the operation unit 11 on the tip and the rear end side of the cap 24 is equal to or less than 10 mm of the D1 lap margin 5 mm or more, 65 mm or more is 80 mm or less the entire length of the cap 24 D2, the neck portion 12 and the head section 13 of the cap 24 and the total length of the D3 D2 and D1 and the length of the lap margin in consideration of less than about 70 mm if 60 mm or more, 50 mm or more of the length of the operation unit 11 can be secured to or less than 70 mm, power supply 15 (single 5 type battery: length

30.2 mm, a single 4 type battery: length 44.5 mm, a single 3 type battery: 50.5 mm length) and a switch unit 16 of the storage space can be secured easily.

[0038] (Example 2) in the head portion of the coin type vibration motor having an electric toothbrush the above-mentioned embodiment is used. Fig. 3A is a and B, in order to increase the size of such a modification of the 2, the electric toothbrush of Fig. 3A is a side view of the non-use condition, the electric toothbrush of Fig. 3B is a side view of the time of use. It should be noted that, in Fig. 3A and B, the same as those of the above embodiment part of the figure is omitted and, with the same reference numerals and description thereof will be omitted.

[0039] B and as shown in Fig. 3A, the operation unit 31, the above-described operation is made longer than 11, when not in use, that is, in Fig. 3A, the neck portion 12 and a head portion 13 is concealed and 120 mm length is equal to or less than 155 mm or more. In addition, the operation unit 31, the distal end side of the power supply 15 and a head portion 12 and the neck portion 13 and can be housed, the neck portion of the root side is 12a, power supply 15 is capable of storing a distal end side of the space portion 12c is formed. Furthermore, the operation unit 31, the neck portion 12 integral with the head part 13 to project and retract from the operation unit 31 can be, for the slide operation of the knob 32 is provided. At the time of use, in the embodiment illustrated in Fig. 3B, if 170 mm or more and 180 mm or less, the operation unit 31, the brushing operation is easier to use and to be long enough to, when not in use has a neck portion 12 and the head section 13 are stored in the reduction in size can be reduced. At this time, the operation unit 31 and the neck portion 12 is 5 mm or more of the D5 lap margin less than or equal to 50 mm.

[0040] (Example 3) in the head portion of the coin type vibration motor having an electric toothbrush the above-mentioned embodiment is used. Fig. 4A is a and B, in order to increase the size of such a modification of the 3, the electric toothbrush of Fig. 4A is a side view of the not used, the electric toothbrush of Fig. 4B is a side view of the time of use. Incidentally, in Fig. 4A and B, the same as those of the above embodiment part of the figure is omitted and, with the same reference numerals and description thereof will be omitted.

[0041] B and as shown in Fig. 4A, the operation unit 41, the above-described operation is made longer than 11, not in use, that is, in Fig. 4A, the neck portion 12 and a head portion 13 is concealed and 65 mm length is equal to or less than 80 mm or more. In addition, the operation unit 41, the distal end side of the power supply 15 and a head portion 12 and the neck portion 13 and can store, the root side of the neck portion 12a, the power supply 15 is capable of storing a distal end side of the space portion 12c is formed. Furthermore, the operation unit 41, the head part 13 integrally with the neck portion 12 protruding from the operation unit 41 can be, the base end side operation unit 43 and the distal end-side operation portion 42 is divided into the following, during which the head part 13 has a neck portion 12 formed integrally with the operation unit 41 so as to project and retract from the, the rotating operation of the knob 44 is provided. In this case of the retractable mechanism may be, for example, the neck portion 12 rotates relative to the base end side operation unit 43 in order to prevent the neck portion 12 and the operation unit 42 and the distal end side and the spiral groove, engaged by the spiral spring, the proximal end side operating unit 43 is gripped and fixed to the distal end 44 and knob on operation unit 42 by rotating in and out of the above can be achieved. At the time of use, i.e. in Fig. 4B, 170 mm or more as long as 180 mm or less, the operation unit 41, the brushing operation is easier to use and to be long enough to, when not in use has a neck portion 12 and the head section 13 are stored in the reduction in size can be reduced. At this time, the operation unit 41 and the neck portion 12 is 5 mm or more of the D6 lap margin less than or equal to 50 mm.

[0042] (Example 4) in the head portion of the coin type vibration motor having an electric toothbrush the above-mentioned embodiment is used. Fig. 5A is a and B, in order to increase the size of such a modification of the 4, the electric toothbrush of Fig. 5A is a side view of the not used, the electric toothbrush of Fig. 5B is a side view of the time of use. Incidentally, in Fig. 5A and B, the same as those of the above embodiment part of the figure is omitted and, with the same reference numerals and description thereof will be omitted.

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[0043] As shown in Fig. 5A and B, the operation unit 51, the above-described operation is made longer than 11, not in use, in the embodiment illustrated in Fig. 5A, the neck portion 12 and a head portion 13 by folding the first pin 52 as the center, the length of 120 mm or more of these hidden is less than or equal to 100 mm. In addition, the operation unit 51, 16 and an analog power supply 15 and a switch unit 12 and the head section 13 and the neck portion can be housed in the U-shaped cross section so as to be formed. In addition, at the time of use, i.e. in Fig. 5B, if 180 mm or more or less than 170 mm, the operation unit 51, the brushing operation is easier to use and to be long enough to, when not in use has a neck portion 12 and the head section 13 are stored in the reduction in size can be reduced.

[0044] In this manner, the electric toothbrush 10 according to the present invention, the head, neck, and an operation unit composed of the electric toothbrush, said head portion of the coin type vibration motor in the bottom side, the head part of the brush may include a removable upper surface side of a plate, a battery and a switch operation unit is housed, the operating the battery by the power supply from the coin type vibration motor, and the vibration of the toothbrush. In such a configuration according to the electric toothbrush, brushing the oral cavity while ensuring the operability of the head can be oscillated reliably with, in addition, can realize the size and weight, portability can be improved, and, that it is economical. In addition, a coin type vibration motor is employed, the brush 21 of the coin type vibration motor is vibrated in the radial direction, the brushing effect is increased. A coin type vibration motor is further, due to the small power consumption, small cell type in a single 3-5 1 can be large enough to drive the present invention, and does not need to be replaced frequently.

[0045] In addition, the electric toothbrush 10 according to the present invention, the head portion 13 and the operating unit between the oscillation due to driving of the vibration motor 17 is transmitted to the operation unit 11 to reduce the vibration absorber 20, by a, the operation unit 11 it is possible to absorb vibration transmitted to the, the operation unit 11 is holding a vibration is transmitted to the hand of a user with a feeling of discomfort can be reduced.

[0046] Furthermore, the electric toothbrush 10 according to the present invention, the total length of the operation unit 11 when not in use is short and also during use (for example, cap 24) the longer the extension can be provided, while ensuring the operability at the time of use, more compact at the time of nonuse can be improved. In this case, when the camera is an extension of the neck portion 13 and a head portion 12 covers the distal end side of the operating unit 11 to engage, in use the operation unit 11 is engaged with the rear end side of the cap if, when not used in the head portion 13 to secure the sanitation of the brush 21 is obtained, without considering the receptacle when in use as part of the operation unit 11 can be used.

[0047] Furthermore, the electric toothbrush 10 according to the present invention, the diameter of the vibration motor 17 of a smaller diameter than the width of the head portion 13 by, the head portion 13 can contribute to the compactness of the compatibility, the brushing operation in the oral cavity can be improved.

[0048] In addition, in the electric toothbrush 10 of the present invention, the vibration transmission unit 90, provided in the head portion 13d. The vibration transmission unit 90 as shown in Fig. 1C and Fig. 1D, by the insert molding method as for example a vibration motor 17 may be in contact with, for example as shown in Fig. 1E and Fig. 1F by the insert molding method known in the art can be provided on the head portion 13d. In addition, the brush plate 22 as shown in Fig. 1 g to push the brush 21 to press on the convex portion is provided and the vibration transmitting portion and in some cases. In the vibration transmission unit 90, and to amplify the vibration frequency, to determine the specific orientation of the vibration, and further it is possible to change the amplitude, frequency of amplification, can control the direction of vibration, to change the amplitude even if it can be, in particular the material is not particularly limited. In addition, the vibration transmission unit 90, the brush plate 22 and the head section of the fitting in order to reduce the loss of vibration of the structure, the head portion 13d of the upper portion of the position of the location of the vibration motor 17 in the direction of the brush 21 that a protrusion portion 13d provided integrally with the head part is fitted to ensure that the structure, the vibration loss may be decreased.

[0049] Furthermore, the electric toothbrush 10 according to the present invention, the drive unit, that is, the head portion is mounted to the coin-type motor, only the brush part (flocked plate, a brush) can be exchangeable cassette type, it is not necessary to dispose of the driving unit, and while ensuring the strength of the neck portion, good operability within the oral cavity can provide an electric toothbrush.

[0050] In the above-described embodiment, the base side of the vibration absorber is provided in the vicinity of the neck portion, the present invention is not limited to, vibration absorbing member, a head portion and, between a position of a user to grip any location may be provided. In addition, vibration absorbing member, by the secondary molding, the neck portion of the covering body are covered with an elastomer may be used.

[0051] In the above-described embodiment, the head portion 13d and 13e is adhered to the vibration motor can be placed, the present invention is not limited to, the base portion of the head portion of the back surface of the opening recess is formed, the vibration motor in the recess of the base portion is inserted from the back side, the open surface of the recess in a water-tight sealing of the lid may be configured. Tightly seal the opening surface of the concave structure may include a seal, such as providing the rubber packing of the cover body, and a conventionally known configurations can be adopted.

[0052] (Comparative Example 1) and the mounting position of the motor in the operation, 180 mm of the total length of the electric toothbrush (indenter systema ultrasonic assist brush, produced by Lion Corporation) was used. (Comparative Example 2) of the mounting position of the motor and the brush mounting operation, the total length of about 160 mm (pocket dorutsu, manufactured by Panasonic) electric toothbrush was used.

[0053] (Evaluation method) performed when the user goes out the name of the woman dentifrice 16, Example 1 and Comparative Example 1-2 that contains he or she is carrying electric toothbrush, its usability, the feeling of use were evaluated.

TABLE 1

A: 12-16 may be the person who answers B name: the name of the person C and the answer may be 7-11:0-6 may be the person who answers the name

[0055] As shown in Table 1, Example 1 is the present invention is applied, the size of the carrying of freedom, the size of the degree of use, degree of vibration transmitted to the head part, the lack of discomfort of the vibration transmitted to the hand, the operability in the oral cavity either 'A' was. On the other hand, the electric toothbrush of the comparative example 1, can be thinned and therefore the neck portion, the size of the oral cavity during use of the degree of operability and were excellent. However, the size of the electric toothbrush not become too small, portable applications is inconvenient. The electric toothbrush of the comparative example 2, which can receive a female cosmetic pouch is barely, if obliquely the notion that does not enter a number, which is desired to be more compact. In addition, the operability in the oral cavity of a thick neck.

INDUSTRIAL APPLICABILITY

[0056] The electric toothbrush of the present invention, the driving unit (coin-type motor) is mounted to a head part, only the brush part (flocked plate, a brush) can be exchangeable cassette type, it is not necessary to dispose of the driving unit, and while ensuring the strength of the neck portion, good operability within the oral cavity can provide an electric toothbrush. Further, without compromising use, excellent in compact and portable, to ensure that the vibration can be applied to the head portion.

REFERENCE SIGNS LIST

[0057] 10 Operation unit 12 the electric toothbrush 11 the neck portion 12a of the neck portion 12b (base side) of the head portion 13a neck portion 13 (tip side) of the base part 13b the head portion 13 of the convex portion 13d of the head portion 13c of the recess 13d the head portion 13e (upper surface side) of the head portion 13e of the handle 15 of the head portion 14 (bottom side) of the vibration motor 19 the power supply 16 the switch unit 17 the wiring 20 the wiring 18 (vibration absorbing portion) vibration absorbing plate 23 of the cap 90 24 22 21 implanted in a brush packing the vibration transmission unit

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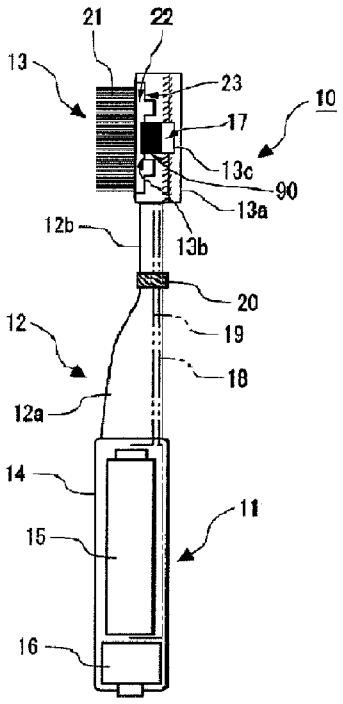
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添付公開書類:

— 国際調査報告（条約第 21 条(3)）

(54) **Title**: ELECTRIC TOOTHBRUSH

(54) 発明の名称 : 電動歯ブラシ



(57) **Abstract**: Provided is an economical electric toothbrush that can reliably vibrate a head part while ensuring teeth-cleaning operability in the mouth, and in which a smaller size and lighter weight are achieved, and portability is improved. This electric toothbrush (10) comprises a head part (13), a neck part (12), and an operating part (11), wherein the head part (13) has a coin-shaped vibrating motor (17) on the bottom surface side of the head part, and a detachable brush plate (22) on the upper surface side of the head part; a battery and switch part are stored in the operating part (11); and the toothbrush is vibrated by the vibrating motor that is operated by electricity supplied from the battery.

(57) 要約: 口腔内での歯磨き操作性を確保しつつヘッド部を確実に振動させることができ、しかも、小型化及び軽量化を実現し得て、携帯性を向上することができ、且つ、経済的である電動歯ブラシを提供する。本発明の電動歯ブラシ（１０）は、ヘッド部（１３）、ネック部（１２）、操作部（１１）からなる電動歯ブラシであって、ヘッド部底面側にはコイン型振動モータ（１７）、ヘッド部上面側には着脱自在の植毛プレート（２２）を有するヘッド部（１３）と、操作部（１１）には電池とスイッチ部を収容し、前記電池からの給電によって作動する前記振動モータにより、歯ブラシが振動することを特徴とする。

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明　細　書

発明の名称 ： 電動歯ブラシ

技術分野

[0001] 本発明は、携帯性に優れた電動歯ブラシに関する。

本願は、２０１２年３月２３日に、日本に出願された特願２０１２－０６８０４３号に基づき優先権を主張し、その内容をここに援用する。

背景技術

[0002] 近年、家庭内だけでなく、勤務先や旅行先といった外出先でも歯磨きを行うことが多くなっている。このため、歯ブラシには携帯性が求められるが、電動歯ブラシの場合、全体が大型化するため、携帯性に劣るという問題が生じていた。

電動歯ブラシとしては、複数のブラシが植毛されたヘッド部が回転する回転式と、複数のブラシが植毛されたヘッド部が振動する振動式とが知られている。振動式は、モータの出力軸に設けられた偏芯錘によってブラシ全体を振動させる構成であり、構成部品が少ないため、回転式に比べて電動歯ブラシ全体を小型化できる。

[0003] 振動式の電動歯ブラシとしては、たとえば、図６に示す電動歯ブラシ１が挙げられる。

電動歯ブラシ１は、使用者が握持操作する操作部２と、操作部２に装着されたネック部３と、ネック部３の先端に設けられたヘッド部４と、を備えている。

[0004] 操作部２の内部には、たとえば、単４電池等の電源５と、電源５から電源供給によって駆動するモータ６と、モータ６の出力軸６ａに装着された偏芯錘７と、モータ６の駆動をＯＮ／ＯＦＦするスイッチ８等を備えている。モータ６及び偏芯錘７は、ネック部３を介してヘッド部４に振動を付与する振動発生機構を構成している。

ネック部３とヘッド部４とは、一体化され、ネック部３を操作部２に対し

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て着脱可能とされている。

[0005] このように、電動歯ブラシにあっては、操作部に、少なくともモータ等の電動機や電池等の電源等を装備しなければならないことから、小型化の面で未だ満足できるものではなく、携帯するには不便であるという問題が生じていた。

[0006] そこで、小型で携帯性に優れた電動歯ブラシを提供するため、種々の提案がなされている。例えば、ブラシが植設されたヘッド部とネック部とが一体の２本の歯ブラシ体を、駆動部等を備えた操作部から取り外した状態で、その２本の歯ブラシ体と操作部とを一緒に一つのケースに収納したもの（特許文献１）、操作部に装着された歯ブラシ体を筒状の歯ブラシケースで覆うもの（特許文献２）、モータをネック部の根元側に配置して小型化を図ったもの（特許文献３，４）、などが代表的に挙げられる。

あるいは、ヘッド部にいわゆるリニアモータを埋設した電動歯ブラシ（特許文献５、６）や、交換部に駆動部、ブラシ部を含む電動歯ブラシ（特許文献７）が提案されている。

先行技術文献

特許文献

[0007] 特許文献1：特開平８－８０２２０号公報

特許文献2：特許第４６８１０７９号公報

特許文献3：特開２００３－９３４１５号公報

特許文献4：特許第４７４８２６７号公報

特許文献5：特開２００９－１０６３５５号公報

特許文献6：特開２００９－４５２０２号公報

特許文献7：特開２０１１－１４３０５７号公報

発明の概要

発明が解決しようとする課題

[0008] しかしながら、例えば、２本の歯ブラシ体と操作部とを一緒に一つのケー

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スに収納した特許文献１に記載されたものにあっては、使用時には歯ブラシ体を操作部の駆動軸に装着し、不使用時には駆動軸から歯ブラシ体を取り外さないとならず、その着脱作業が煩わしいという問題が生じていた。しかも、勤め先のような限られた狭いスペースの洗面所等では、歯磨き作業を行っている間、他の１本の歯ブラシ体を収納したケースの置き場に困るといった問題も生じていた。

[0009] 操作部に装着された歯ブラシ体を筒状の歯ブラシケースで覆う特許文献２にあっては、具体的な寸法関係が明示されていないため、実際の大きさは推測になるが、少なくとも、その全体のサイズは携帯性を考慮していない家庭用と略同じサイズとなり、携帯性に特化した構成とはなっていないものであった。

[0010] モータをネック部の根元側に配置して小型化を図った特許文献３，４にあっては、ネック部の根元側が極端に太くなり、ネック部の先端側の長さをある程度確保しないと歯ブラシ作業の作業性が阻害されるという問題が生じる。しかも、特許文献３に開示された技術のように、ブラシ体と一体のネック部の内部にモータを固着させた場合、歯ブラシ体の消耗により交換時期となった際には、モータを含むネック部全体を交換しないとならないため、コストが高騰してしまうという問題が生じていた。

[0011] また、ヘッド部にいわゆる駆動部（リニアモータ）を埋設した特許文献５にあっては、リニアモータの小型化が困難であり、ヘッド部が大きくなったり重たくなったりして使用性が損なわれる。加えて、リニアモータでは、ブラシの毛に対し、その延在方向の振動を与えるのみであり、良好な清掃効果が得られにくい。さらに、リニアモータは、消費電力が大きいため、電源を頻繁に交換するか、又は電源を大きくする必要がある。電源を大きくすると、操作部の小型化を図れない。

さらに、ヘッド部に駆動部（リニアモータ）を搭載した特許文献６において、ブラシ取替え時にはリニアモータを備えたヘッド部ごと交換する必要があり、経済的ではない。

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[0012] また、ヘッド部に駆動部（リニアモータ）を搭載した特許文献７において、リニアモータを含む支持体を中空のヘッド部内に挿入できる仕様にすることで、ヘッド部、モータ仕様を自由にカスタマイズできるようにした電動歯ブラシである。しかし、偏心分銅付きモータを含む支持体を中空のブラシヘッド部に挿入することでブラシ部が薄肉になり、強度に不安が残る。強度確保のために肉厚にすることもできるが、ネック部が太くなり口腔内操作性が劣る。

[0013] その他、振動式の電動歯ブラシを小型化する手段としては、ネック部を短くする、電池を小さいもの（ボタン電池等）にする、といった方法が挙げられる。しかし、単にネック部を短くすると、ヘッド部を奥歯まで到達させるには、太い操作部まで口の中に入れることとなり、操作性が損なわれる。また、操作部を短くするために電池をボタン電池等の小さいものにすると、モータのトルク不足が生じたり、電池を頻繁に交換したり、充電を頻繁にする等の問題が生じる。

[0014] そこで、本発明は、駆動部（コイン型振動モータ）をヘッド部に搭載し、植毛部（植毛プレート、刷毛）のみを交換可能なカセット式にすることで、駆動部を捨てる必要がなく、かつネック部の強度を確保しつつ、口腔内操作性に優れる電動歯ブラシを提供することを目的とする。また、使用性を損なうことなく、小型で携帯性に優れ、確実に振動をヘッド部に与えることができる電動歯ブラシを提供することを目的とする。

課題を解決するための手段

[0015] 上記課題を解決するため、本発明の電動歯ブラシの第１の態様は、

［１］ヘッド部、ネック部、及び操作部からなる電動歯ブラシであって、前記ヘッド部の底面側にはコイン型振動モータを、前記ヘッド部の上面側には着脱自在の植毛プレートを有し、前記操作部には電池とスイッチ部を収容し、前記電池からの給電によって作動する前記コイン型振動モータにより、歯ブラシが振動することを特徴とする。

このような構成の電動歯ブラシによれば、口腔内での歯磨き操作性を確保

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しつつヘッド部を確実に振動させることができ、しかも、小型化及び軽量化を実現し得て、携帯性を向上することができ、且つ、経済的である。

[0016] また、本発明の電動歯ブラシの第２の態様は、

［２］ネック部に振動を遮断する部材を介在させることを特徴とする［１］に記載の電動歯ブラシである。

このような構成の電動歯ブラシによれば、操作部に伝わる振動を緩和することができ、操作部を握持した使用者の手に振動が伝わる不快感を軽減することができる。

[0017] さらに、本発明の電動歯ブラシの第３の態様は、

［３］スライド式／繰り出し式／折りたたみ式／キャップ付け替え式の方法で使用時にはハンドルが延びる機構を備えた［１］に記載の電動歯ブラシである。

このような構成の電動歯ブラシによれば、使用時の操作性を確保しつつ、不使用時のコンパクト化をより一層向上することができる。

[0018] さらに、本発明の電動歯ブラシの第４の態様は、

［４］前記コイン型振動モータ上面に振動伝達部を備えた［１］記載の電動歯ブラシである。

このような構成の電動歯ブラシによれば、振動数を増幅させることや、振動の方向性を特異的に定めること、さらには振幅を変化させることができ、口腔内の清掃性を向上することができる。振動数を増幅させるものとしては例えば、繊維強化プラスチックなどの繊維の配向性をコイン型モータの振動方向と合わせたものがある。また、振動の方向性を制御するものとしては繊維強化プラスチックなどの繊維の配向性を一定の方向に合わせることで、その繊維方向と平行方向への振動を増幅させ、垂直方向への振動を減衰するようなものがある。さらに、重さを与えることで振幅を変化させることもできる。

発明の効果

[0019] 本発明の電動歯ブラシは、駆動部（コイン型振動モータ）をヘッド部に搭

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載し、植毛部（植毛プレート、刷毛）のみを交換可能なカセット式にすることで、駆動部を捨てる必要がなく、かつネック部の強度を確保しつつ、口腔内操作性に優れる。また、使用性を損なうことなく、小型で携帯性に優れ、確実に振動をヘッド部に与えることができる。

図面の簡単な説明

[0020] [図1A]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシの断面図である。

[図1B]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシ要部の背面図である。

[図1C]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシヘッド部断面図の変形例の拡大図である。

[図1D]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシヘッド部断面図の変形例の拡大図である。

[図1E]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシヘッド部断面図の変形例の拡大図である。

[図1F]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシヘッド部断面図の変形例の拡大図である。

[図1G]本発明の一実施形態に係る電動歯ブラシを示し、電動歯ブラシヘッド部断面図の変形例の拡大図である。

[図2A]本発明の一実施形態に係る電動歯ブラシの変形例１を示し、非使用時の電動歯ブラシの断面図である。

[図2B]本発明の一実施形態に係る電動歯ブラシの変形例１を示し、使用時の電動歯ブラシの断面図である。

[図3A]本発明の一実施形態に係る電動歯ブラシの変形例２を示し、非使用時の電動歯ブラシの側面図である。

[図3B]本発明の一実施形態に係る電動歯ブラシの変形例２を示し、使用時の電動歯ブラシの側面図である。

[図4A]本発明の一実施形態に係る電動歯ブラシの変形例３を示し、非使用時

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の電動歯ブラシの側面図である。

[図4B]本発明の一実施形態に係る電動歯ブラシの変形例３を示し、使用時の電動歯ブラシの側面図である。

[図5A]本発明の一実施形態に係る電動歯ブラシの変形例４を示し、非使用時の電動歯ブラシの側面図である。

[図5B]本発明の一実施形態に係る電動歯ブラシの変形例４を示し、使用時の電動歯ブラシの側面図である。

[図6]従来の電動歯ブラシの説明図である。

発明を実施するための形態

[0021] 次に、本発明の一実施形態に係る電動歯ブラシについて、図面を参照して説明する。なお、以下に示す実施形態は本発明の電動歯ブラシにおける好適な具体例であり、技術的に好ましい種々の限定を付している場合もあるが、本発明の技術範囲は、特に本発明を限定する記載がない限り、これらの態様に限定されるものではない。また、以下に示す実施形態における構成要素は適宜、既存の構成要素等との置き換えが可能であり、かつ、他の既存の構成要素との組合せを含む様々なバリエーションが可能である。したがって、以下に示す実施形態の記載をもって、特許請求の範囲に記載された発明の内容を限定するものではない。

[0022] 図１Ａ～Ｇは本発明の一実施形態に係る電動歯ブラシを示し、図１Ａは電動歯ブラシの断面図、図１Ｂは要部の背面図、図１Ｃ～Ｇはヘッド部断面図の変形例の拡大図である。

図１Ｃは、ヘッド部１３ｄに振動伝達部９０を、例えば公知のインサート成形法によって振動モータ１７と直に接するように、かつ、植毛プレート２２をブラシ２１側に押し圧するように凸状に突出させて設ける。その後で、ヘッド部１３ｅを接着する。振動伝達部９０とモータ１７が接しているので振動モータの振動を効率よく伝達できる。また、ヘッド部１３ｄと植毛プレート２２の嵌合強度を確実にできる。

図１Ｄは、ヘッド部１３ｄに振動伝達部９０を、例えば公知のインサート

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成形法によって振動モータ１７と直に接するように設け、振動伝達部９０は、ヘッド部１３ｄからブラシ２１側へ突出しないように設置する。振動伝達部９０とモータ１７が接しているので振動モータの振動を効率よく伝達できる。

図１Ｃ及び図１Ｄの場合、振動伝達部９０を公知のインサート成形法によって振動モータ１７と接するように設ける他、振動伝達部９０を公知のインサート成形法によってヘッド部１３ｄを成形した後、振動モータ１７をヘッド部１３ｅとで各凹部に収容して接着しても良い。また、この場合、振動モータ１７を含むヘッド部１３ｅを公知のインサート成形法によって成形した後に、振動伝達部９０を含むヘッド部１３ｄと接着しても良い。

図１Ｅは、ヘッド部１３ｄとヘッド部１３ｅで振動モータ１７を挟み込んで、水分が浸入しないように接着する。ヘッド部１３ｄには予め振動伝達部９０を、例えば公知のインサート成形法によって設けることもできる。その時に、振動伝達部９０を植毛プレート２２をブラシ２１側に押し圧するように凸状に突出させて設けることで、振動モータの振動を効率よく伝達し、ヘッド部１３ｄと植毛プレート２２の嵌合強度を確実にできる。

図１Ｆは、ヘッド部１３ｄとヘッド部１３ｅで振動モータ１７を挟み込んで、水分が浸入しないように接着する。ヘッド部１３ｄには予め振動伝達部９０を、例えば公知のインサート成形法によって設けることもでき、振動伝達部９０は、ヘッド部１３ｄからブラシ２１側へ突出しないように設置する。振動伝達部９０とモータ１７が近接しているので振動モータの振動を効率よく伝達できる。

図１Ｇは、ヘッド部１３ｄとヘッド部１３ｅで振動モータ１７を挟み込んで、水分が浸入しないように接着する。その際、振動モータ１７のヘッド部１３ｄ側において、植毛プレート２２をブラシ２１側に押し圧するように突出状に凸状部（振動伝達部に相当する）を設けることで、振動モータの振動を効率よく伝達し、ヘッド部１３ｄと植毛プレート２２の嵌合強度を確実にできる。

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[0023] 図１Ａ～Ｇに示すように、電動歯ブラシ１０は、使用者が握持操作する操作部１１と、操作部１１に装着されたネック部１２と、ネック部１２の先端に設けられたヘッド部１３と、を備えている。

[0024] 操作部１１は、樹脂製の円筒状の取っ手１４と、この取っ手１４の内部に設けられている電池、例えば、交換式の単４型（単３型、単５型等でも良い）又は充電式の電池である電源１５と、電源１５の駆動を操作するスイッチ部１６と、を備えている。なお、電源１５に充電式電池を用いた場合には、公知の充電部が後端に設けられる。したがって、従来技術で説明したような、操作部１１に電動モータや偏芯錘（伝達機構を含む）を設けない構成としていることから、操作部１１の小型化（直径の短径化及び長さの短縮化）に貢献することができ、携帯性を向上することが可能となる。この際、操作部１１は、詳細には図示しないが、例えば、取っ手１４を軸線方向に沿って相対的にスライド変位可能な内外二層構造とし、その外側を延長部として操作部１１の後端に向けてスライド変位させることで操作部１１の長さを可変することができる。また、その延長部にスイッチ部１６を連携させることも可能であり、取っ手１４の長／短間の可変操作と同時にスイッチをＯＮ／ＯＦＦさせることができる。操作部１１の材質は、一般に電動歯ブラシに使用される材料、例えばＡＢＳ樹脂等が用いられるが、それらに限定されない。

[0025] ネック部１２は、取っ手１４と同じ材料で、先端側、すなわち、ヘッド部１３に向けて先細りに形成されている。この際、先細りを取っ手１４の直径の中心と同軸とするか変位させるかは任意である。また、材質や色合いを取っ手１４と異ならせても良い。

ネック部１２の先端にはヘッド部１３が形成されており、そのヘッド部の底面側にはコイン型の振動モータ（以下、単に振動モータということがある）１７が設けられている。さらに、ネック部１２の内部には、電源１５と振動モータ１７とを電気的に接続する配線１８，１９が配策されている。この配線１８，１９は、配線コードでも良いしネック部１２を射出形成する際にインサート成形したプレート状のものでも良いし、これらを併用したもので

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も良い。すなわち、電源１５から振動モータ１７への給電を確保することができれば、その構造は特に限定されるものではない。したがって、ネック部１２は、例えば、配線コードが貫通する筒状の中空体であっても良いし、少なくともヘッド部１３の先細り部分を中実体（非中空体）としてもよい。また、ネック部１２そのものを弾性体で形成してネック部１２の全体を振動吸収部と兼用しても良い。本実施形態においては、ネック部１２の中途部には、振動吸収体２０が介在され、これによりネック部１２が分割形成されている。したがって、この振動吸収体２０よりも取っ手１４側（根元側）のネック部１２ａは中空体から構成されて配線１８，１９にコードを用い、振動吸収体２０よりもヘッド部１３側（先端側）のネック部１２ｂは中実体から構成されて配線１８，１９はインサート成形としている。

[0026] 振動吸収体２０は、振動モータ１７の振動をネック部１２と操作部１１との間で、少なくとも操作部１１に伝達し難くする振動吸収性を備えているものであれば、特に限定されるものではない。ネック部１２は、振動吸収体２０から根元側のネック部１２ａに唾液等が入り込まないように、防水性が確保されている。また、電源１５からネック部１２の内部を経由して振動モータ１７に接続される配線１８，１９はこの振動吸収体２０を貫通しているが、適宜接点構造を採用して電気的な接続関係は確保されている。本実施の形態においては、振動吸収体２０は、エラストマー（例えば、オレフィン系やスチレン系）やシリコン（シリコンゴムを含む）等が用いられている。

[0027] ヘッド部１３は二つの部分からなり、一方の植毛プレートが形成されたヘッド部の上面側を構成する部分をヘッド部１３ｄ、他方のヘッド部の底面側を構成する部分をヘッド部１３ｅとする。上面側とは、ヘッド部のブラシが植設された側の方向を指し、底面側とは、ヘッド部のベース部（１３ａ）側の方向のことを指す。

ヘッド部１３ｄの上面側、すなわち、ヘッド部１３ｄの植毛プレート２２に面する側には植毛プレート２２と嵌合する凸部１３ｂが形成される。凸部１３ｂと対面する植毛プレート２２厚さは、１．５ｍｍ以上３．０ｍｍ以下

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、好ましくは２．０ｍｍ以上２．５ｍｍ以下である。

ヘッド部１３ｅには振動モータ１７が配置される凹部１３ｃが形成され、ヘッド部１３ｄにも対応する位置に凹部が形成されて振動モータ１７を収納、固定し、各ヘッド部１３ｄおよび１３ｅを、例えば超音波接着などにより水密に密着して一体化している。植毛プレート２２が嵌め込まれるヘッド部１３ｄの凸部１３ｂは振動モータが配置されている周りを取り巻くように形成されている。さらに振動伝達部９０はヘッド部１３ｄに備えられ、ヘッド部１３ｄの凸部１３ｂに配置されている。

振動伝達部９０は図１Ｃ及び図１Ｄに示すように、例えば公知のインサート成形法によって振動モータ１７と接することもできる。また、図１Ｅ及び図１Ｆに示すように例えば公知のインサート成形法によって１３ｄに設け、振動モータ１７と振動伝達部９０が接しない様に配置することもできる。さらに、図１Ｇに示すように植毛プレート２２をブラシ２１側に押し圧するように凸状部を設けることで振動伝達部とする場合もある。

図１Ｃ及び図１Ｄの場合、振動伝達部９０と振動モータ１７を含むヘッド部１３ｄを成形後、ヘッド部１３ｅを接着する。振動伝達部９０とモータ１７が接するので振動モータの振動を効率よく伝達することができる。

或は、振動伝達部９０を公知のインサート成形法によってヘッド部１３ｄを成形した後、振動モータ１７をヘッド部１３ｅとで各凹部に収容して接着しても良い。

また、この場合、振動モータ１７を含むヘッド部１３ｅを公知のインサート成形法によって成形した後に、振動伝達部９０を含むヘッド部１３ｄと接着しても良い。

図１Ｅ及び図１Ｆの場合、振動伝達部９０を含むヘッド部１３ｄとヘッド部１３ｅで振動モータ１７を挟み込んで、水分が浸入しないように接着する。

図１Ｇの場合、ヘッド部１３ｄとヘッド部１３ｅで振動モータを挟み込んで、水分が浸入しないように接着する。

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図１Ｃ、図１Ｅにおいて振動伝達部９０を植毛プレート２２をブラシ側に押し圧するように凸状に設けることもでき、この場合、ヘッド部１３ｄと植毛プレート２２の勘合強度を確実にできる。

植毛プレート２２には、適宜の硬さや太さの歯磨き用のブラシ２１が植毛されている。植毛プレート２２の材質は、植毛強度の確保ができるよう、強度の高いＰＯＭ、ＰＢＴ、ＰＴＴ等が好ましく用いられる。尚、植毛プレート２２とブラシ２１を植毛部という。

植毛プレート２２は、スライド式で固定しても、アンダーカットで固定してもよい。

ヘッド部１３の材質は、一般に電動歯ブラシに使用される材料、例えばＰＯＭ樹脂等が用いられるが、それらに限定されない。

[0028] 植毛プレートに植毛される刷毛の材質は特に限定しないが、例えば、ポリアミド（例：６－１２ナイロン、６－１０ナイロン）、ポリエステル（例：ポリエチレンテレフタレート、ポリブチレンテレフタレート、ポリトリメチレンテレフタレート）、ポリオレフィン（例：ポリプロピレン）、エラストマー（例：オレフィン系、スチレン系）などの合成樹脂材料を用いることができる。

また、刷毛の毛先形状については、毛先を丸めたもの、毛先に向かうに従って徐々に外径が細くなるテーパー状のもの、さらに、ヘラ状、球状、先割れ状などの形状とすることができる。

刷毛の毛丈は、大人用で８ｍｍ以上１３ｍｍ以下、子供用で６ｍｍ以上９ｍｍ以下とすることが好ましく、選択された刷毛の直径が小さければ口腔内の使用性や使用感の点から刷毛の毛丈も短くなることが好ましい。また、使用感や、刷掃感、清掃効果、耐久性など考慮して、太さの異なる複数本の刷毛を任意に組み合わせて用いてもよい。また、毛先のプロファイルについては何ら制限されるものはない。

[0029] スイッチ部１６は、操作部１１の後端に設けた公知の回転式のほか、操作部１１の側面に設けた公知のスライド式でも良い。なお、スライド式とした

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場合には不測にスライドが変位してＯＮにならないようにロック機構を設けることも可能である。

[0030] 振動モータ１７は、いわゆる偏芯モータであり、例えば、コイン型の容器内に駆動部と駆動部の回転軸に設けられた半円形の回転子とが備えられ、回転軸を回転させた際に振動モータ１７の重心が偏ることで全体が振動するものが挙げられる。振動モータ１７は、例えば、厚み１．５ｍｍ以上３．０ｍｍ以下、好ましくは２．０ｍｍ以上２．５ｍｍ以下、直径φ８．０ｍｍ以上１２．０ｍｍ以下、好ましくはφ１０ｍｍ以上１２ｍｍ以下、程度のものが用いられる。

このような振動モータ１７を用いることで、電動歯ブラシ１０をコンパクトかつ軽量なものにでき、使用性を向上できる。加えて、振動モータ１７は、ブラシ２１をその径方向に振動できるため、ブラシ２１の可動領域を大きくして、歯磨き効果をより高められる。

さらに、振動モータ１７は、リニアモータ等に比べて消費電力が小さいため、単３～５型の小さい電池１本で十分に駆動でき、かつ頻繁に交換する必要がない。このため、操作部をコンパクト化するのに好適である。

なお、振動モータ１７には、例えば、その振動数を７５００ｒｐｍ／ｍｉｎ以上２００００ｒｐｍ／ｍｉｎ以下に確保することができれば、その大きさは上述したものよりも小さくても良い。

[0031] 振動伝達部９０は、ヘッド部１３ｄに備えられ、ヘッド部１３ｄの凸部１３ｂに配置される。

振動伝達部９０は図１Ｃ及び図１Ｄに示すように、例えば公知のインサート成形法によって振動モータ１７と接することもできるし、図１Ｅ及び図１Ｆに示すように例えば公知のインサート成形法によって振動モータ１７と接せず１３ｄに設けることもできる。また、図１Ｇに示すように植毛プレート２２をブラシ２１側に押し圧するように凸状部を設けることで振動伝達部とする場合もある。

振動伝達部９０では、振動数を増幅させることや、振動の方向性を特異的

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に定めること、さらには振幅を変化させることができるものでもよく、植毛プレート２２とヘッド部の勘合部分の振動ロスを減少するためにヘッド部１３ｄの振動モータ１７の配置部位置の上部にブラシ２１方向に向けて突出した凸部をヘッド部１３ｄと一体に設けた構造として勘合状態を確実にし、振動ロスを減少するようにしても良い。振動数の増幅、または振動の方向性を制御できるもの、さらには振幅を変化できるものであれば、特にその材質には限定されない。

また、振動モータ１７は、図１Ｂに示すように、ヘッド部１３の幅（例えば、８．５ｍｍ以上１３．０ｍｍ以下）よりも小径なものを用い、ヘッド部１３からはみ出さないようにするのが好ましい。

市販の振動モータ１７としては、例えば、ＬＥ１０Ｅ０Ｈ（φ１０ｍｍ、厚み２．０ｍｍ、質量＝約１ｇ、回転数９０００ｒｐｍ、レキシンジャパン株式会社製）等が挙げられる。

[0032] 振動モータ１７は、ヘッド部１３に嵌め込み又は埋め込みすることによって、その振動を伝達機構等を介することなく直接ヘッド部１３を振動させることができる。したがって、口腔内の歯磨き操作を行う際には、その振動が直接伝わるため、確実に振動による歯磨き効果を確保することができる。また、振動を直接伝達することにより、適用する振動モータ１７の小型化や回転数の少ない安価なものを用いることができる。なお、振動モータ１７は、使用時には口腔内にあることから、超音波接着による密閉構造や、パッキン等による防水性の確保、振動モータ１７の外表面に防水コーティング処理を施す、インサート成形、溶着等の公知の手段を用いて防水性又は密閉性を確保するのが好ましい。

ヘッド部１３ｄとヘッド部１３ｅは振動モータ１７を内蔵するように貼り合わせることで、振動モータ１７の露出を防ぐことができる。そのヘッド部１３ｅには振動モータ１７が配置される凹部１３ｃが形成され、ヘッド部１３ｄにも対応する位置に凹部が形成されて振動モータ１７を収納、固定する。各ヘッド部１３ｄおよびヘッド部１３ｅは、例えば超音波接着などにより

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水密に密着して一体化している。ヘッド部１３ｄおよびヘッド部１３ｅの材質は、振動に耐えうるよう、強度の高いＰＯＭ、ＰＢＴ、ＰＰ等が好ましく用いられる。

振動モータ１７の固定の仕方としては、モータのがたつきをなくす為に、隙間を埋める為の弾性材料を用いることができる。また、振動モータ１７を固定する為の、凸部が数か所存在していてもよい。

前記弾性材料としては、シリコーンゴム、エポキシ樹脂、アクリル樹脂、中でもシリコーンゴムがこのましい。

[0033] ところで、上記実施の形態においては、ヘッド部１３の底面側に振動モータ１７を配置することにより、操作部１１及びネック部１２のコンパクト化を実現し、操作部１１の小径化のみならず、その長さも短くすることができた。ただし、使用時には利用者が把持操作するための長さが短くなってしまうため、以下の実施例に示すような仕様とした。

[0034] （実施例１）

ヘッド部にコイン型振動モータを有する上記形態の電動歯ブラシを用いる。

図２Ａ及びＢは、電動歯ブラシの操作性やコンパクト化を向上するための変形例１を示し、図２Ａは非使用時の電動歯ブラシの断面図、図２Ｂは使用時の電動歯ブラシの断面図である。なお、図２Ａ及びＢにおいて、上記実施の形態と同一の構成には一部の図示を省略するとともに、同一の符号を付してその説明を省略する。

[0035] 図２Ａ及びＢに示すように、操作部１１の後端にインロー方式で着脱可能な有底円筒形状のキャップ２４を延長部として設け、不使用時にはキャップ２４を操作部１１の先端側に嵌め込むことでヘッド部１３とネック部１２とを覆うことができ、使用時には操作部１１の後端側にキャップ２４を嵌め込むことで操作部１１の長さを延長することができる。即ち、本実施形態の延長部は、不使用時にはネック部１２とヘッド部１３とを覆った状態で操作部１１の先端側と係合し、使用時には操作部１１の後端側と係合するキャップ

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２４とされている。このような構成の電動歯ブラシによれば、不使用時にはヘッド部のブラシの衛生を確保し得て、使用時には置き場を考慮することなく操作部の一部として利用することができる。

なお、ネック部１２の先細りは、キャップ２４による操作部１１への嵌め込みとカバー機能とを考慮すると、操作部１１の中心よりも一方側（ヘッド部の裏面側）に変位している。

[0036] ここで、延長部は、電動歯ブラシ１０としての全長が、不使用時、すなわち、図２Ａの形態において１１０ｍｍ以上１５０ｍｍ以下の長さとすれば、例えば、女性が外出時に持ち運ぶ化粧ポーチ等にも容易に入れ易くすることができる。また、延長部は、電動歯ブラシ１０としての全長が、使用時において、すなわち、図２Ｂの形態において、１７０ｍｍ以上１８０ｍｍ以下とすることができれば、操作性を確保することができる。このとき、キャップ２４と操作部１１のラップ代Ｄ４は５ｍｍ以上５０ｍｍ以下とする。

[0037] したがって、キャップ２４を延長部として用いた場合、操作部１１の先端側及び後端側とのキャップ２４とのラップ代Ｄ１は５ｍｍ以上１０ｍｍ以下、キャップ２４の全長Ｄ２は６５ｍｍ以上８０ｍｍ以下、ネック部１２とヘッド部１３とを合わせた長さＤ３はキャップ２４の長さＤ２とラップ代Ｄ１とを考慮したうえで６０ｍｍ以上７０ｍｍ以下程度とすれば、操作部１１の長さを５０ｍｍ以上７０ｍｍ以下で確保することができ、電源１５（単５型電池：長さ３０．２ｍｍ、単４型電池：長さ４４．５ｍｍ、単３型電池：長さ５０．５ｍｍ）及びスイッチ部１６の収納スペースは容易に確保することができる。

[0038]（実施例２）

ヘッド部にコイン型振動モータを有する上記形態の電動歯ブラシを用いる。

図３Ａ及びＢは、このようなコンパクト化を向上するための変形例２を示し、図３Ａは非使用時の電動歯ブラシの側面図、図３Ｂは使用時の電動歯ブラシの側面図である。なお、図３Ａ及びＢにおいて、上記実施の形態と同一

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の構成には一部の図示を省略するとともに、同一の符号を付してその説明を省略する。

[0039] 図３Ａ及びＢに示すように、操作部３１は、上述した操作部１１よりも長くされ、不使用時、すなわち、図３Ａの形態において、ネック部１２及びヘッド部１３が隠れる長さ１２０ｍｍ以上１５５ｍｍ以下とされている。また、操作部３１は、電源１５よりも先端側にネック部１２とヘッド部１３とが収納可能となっており、根元側のネック部１２ａには、電源１５の先端側が収納可能な空間部１２ｃが形成されている。さらに、操作部３１には、ネック部１２をヘッド部１３と一体に操作部３１から出没させることができるように、スライド操作用のノブ３２が設けられている。使用時、すなわち図３Ｂの形態において、１７０ｍｍ以上１８０ｍｍ以下とすることができれば、操作部３１は、使用時に歯磨き操作がし易い長さを確保するとともに、不使用時にはネック部１２とヘッド部１３とを収納してコンパクト化に貢献することができる。このとき、操作部３１とネック部１２のラップ代Ｄ５は５ｍｍ以上５０ｍｍ以下とする。

[0040] （実施例３）

ヘッド部にコイン型振動モータを有する上記形態の電動歯ブラシを用いる。

図４Ａ及びＢは、このようなコンパクト化を向上するための変形例３を示し、図４Ａは不使用時の電動歯ブラシの側面図、図４Ｂは使用時の電動歯ブラシの側面図である。なお、図４Ａ及びＢにおいて、上記実施の形態と同一の構成には一部の図示を省略するとともに、同一の符号を付してその説明を省略する。

[0041] 図４Ａ及びＢに示すように、操作部４１は、上述した操作部１１よりも長くされ、不使用時において、すなわち、図４Ａの形態において、ネック部１２及びヘッド部１３が隠れる長さ６５ｍｍ以上８０ｍｍ以下とされている。また、操作部４１は、電源１５よりも先端側にネック部１２とヘッド部１３とが収納可能となっており、根元側のネック部１２ａには、電源１５の先端

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側が収納可能な空間部１２ｃが形成されている。さらに、操作部４１は、ネック部１２をヘッド部１３と一体に操作部４１から突出することができるように、基端側操作部４３と先端側操作部４２とで分割され、その間にはネック部１２をヘッド部１３と一体に操作部４１から出没させることができるように、回転操作用のノブ４４が設けられている。この場合の出没機構としては、例えば、ネック部１２を基端側操作部４３に対し相対回転しないように支持するとともにネック部１２と先端側操作部４２とを螺旋溝、螺旋突条で係合させ、基端側操作部４３を把持固定した上で先端側操作部４２及びノブ４４を回転させることによって上記の出没が可能となる。使用時、すなわち図４Ｂの形態において、１７０ｍｍ以上１８０ｍｍ以下とすることができれば、操作部４１は、使用時に歯磨き操作がし易い長さを確保するとともに、不使用時にはネック部１２とヘッド部１３とを収納してコンパクト化に貢献することができる。このとき、操作部４１とネック部１２のラップ代Ｄ６は５ｍｍ以上５０ｍｍ以下とする。

[0042]（実施例４）

ヘッド部にコイン型振動モータを有する上記形態の電動歯ブラシを用いる。

図５Ａ及びＢは、このようなコンパクト化を向上するための変形例４を示し、図５Ａは不使用時の電動歯ブラシの側面図、図５Ｂは使用時の電動歯ブラシの側面図である。なお、図５Ａ及びＢにおいて、上記実施の形態と同一の構成には一部の図示を省略するとともに、同一の符号を付してその説明を省略する。

[0043] 図５Ａ及びＢに示すように、操作部５１は、上述した操作部１１よりも長くされ、不使用時において、すなわち図５Ａの形態において、ネック部１２及びヘッド部１３をピン５２を中心として折り畳むことにより、これらが隠れる長さ１００ｍｍ以上１２０ｍｍ以下とされている。また、操作部５１は、電源１５及びスイッチ部１６を配置するとともにネック部１２とヘッド部１３とが収納可能となるように断面略Ｕ字状に形成されている。また、使用

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時、すなわち図５Ｂの形態において、１７０ｍｍ以上１８０ｍｍ以下とすることができれば、操作部５１は、使用時に歯磨き操作がし易い長さを確保するとともに、不使用時にはネック部１２とヘッド部１３とを収納してコンパクト化に貢献することができる。

[0044] このように、本発明の電動歯ブラシ１０にあっては、ヘッド部、ネック部、及び操作部からなる電動歯ブラシであって、前記ヘッド部の底面側にはコイン型振動モータを、前記ヘッド部の上面側には着脱自在の植毛プレートを有し、前記操作部には電池とスイッチ部を収容し、前記電池からの給電によって作動する前記コイン型振動モータにより、歯ブラシが振動することを特徴とする。このような構成の電動歯ブラシによれば、口腔内での歯磨き操作性を確保しつつヘッド部を確実に振動させることができ、しかも、小型化及び軽量化を実現し得て、携帯性を向上することができ、且つ、経済的である。

加えて、コイン型の振動モータを採用しているため、ブラシ２１を前記コイン型振動モータの径方向に振動させて、歯磨き効果を高められる。

さらにコイン型の振動モータは、消費電力が小さいため、単３～５型の小さい電池１本で十分に駆動でき、かつ頻繁に交換する必要がない。

[0045] また、本発明の電動歯ブラシ１０にあっては、ヘッド部１３と操作部との間に振動モータ１７の駆動に伴う振動が操作部１１に伝達することを緩和する振動吸収体２０と、を備えていることにより、操作部１１に伝わる振動を緩和することができ、操作部１１を握持した使用者の手に振動が伝わる不快感を軽減することができる。

[0046] さらに、本発明の電動歯ブラシ１０にあっては、操作部１１の全長が不使用時には短くかつ使用時には長くなる延長部（例えば、キャップ２４）を備えていることにより、使用時の操作性を確保しつつ、不使用時のコンパクト化をより一層向上することができる。この際、延長部を不使用時にはネック部１２とヘッド部１３とを覆った状態で操作部１１の先端側と係合し、使用時には操作部１１の後端側と係合するキャップとすれば、不使用時にはヘッ

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ド部１３のブラシ２１の衛生を確保し得て、使用時には置き場を考慮することなく操作部１１の一部として利用することができる。

[0047] さらに、本発明の電動歯ブラシ１０にあっては、振動モータ１７の直径はヘッド部１３の幅よりも小径であることにより、ヘッド部１３のコンパクト化に貢献することができるうえ、口腔内での歯磨き操作性を向上することができる。

[0048] また、本発明の電動歯ブラシ１０において、振動伝達部９０は、ヘッド部１３ｄに備えられる。

振動伝達部９０は図１Ｃ及び図１Ｄに示すように、例えば公知のインサート成形法によって振動モータ１７と接することもできるし、図１Ｅ及び図１Ｆに示すように例えば公知のインサート成形法によってヘッド部１３ｄに設けることもできる。また、図１Ｇに示すように植毛プレート２２をブラシ２１側に押し圧するように凸状部を設けることで振動伝達部とする場合もある。

振動伝達部９０では、振動数を増幅させることや、振動の方向性を特異的に定めること、さらには振幅を変化させることができ、振動数の増幅、振動の方向性を制御できるもの、さらには振幅を変化させることができるものであれば、特にその材質には限定しない。

また、振動伝達部９０は、植毛プレート２２とヘッド部の勘合構造の振動ロスを減少するために、ヘッド部１３ｄの振動モータ１７の配置部位置の上部にブラシ２１方向に向けて突出した凸部をヘッド部１３ｄと一体に設けた構造として勘合状態を確実にし、振動ロスを減少するようにしても良い。

[0049] さらに、本発明の電動歯ブラシ１０にあっては、駆動部、すなわち、コイン型モータをヘッド部に搭載し、植毛部（植毛プレート、刷毛）のみを交換可能なカセット式にすることで、駆動部を捨てる必要がなく、かつネック部の強度を確保しつつ、口腔内操作性に優れた電動歯ブラシを提供する事ができる。

[0050] 上述の実施形態では、振動吸収体が根元側のネック部寄りに設けられてい

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るが、本発明はこれに限定されず、振動吸収体は、ヘッド部と、使用者が把持する位置との間の何れの位置に設けられていてもよい。

また、振動吸収体は、二次成形によって、ネック部の一部をエラストマーで被覆した被覆体であってもよい。

[0051] 上述の実施形態では、ヘッド部１３ｄ及び１３ｅを貼り合せて振動モータを配置させるが、本発明はこれに限定されず、ヘッド部のベース部の裏面に開口する凹部が形成され、この凹部にベース部の裏側から振動モータが挿入され、凹部の開口面を蓋体で水密に封止する構成とされていてもよい。凹部の開口面を水密に封止する構成としては、蓋体の周縁にゴムパッキンを設けるなど、従来公知の構成を採用できる。

[0052] （比較例１）

モータの取付位置が操作部にあり、全長が１８０ｍｍ程度の電動歯ブラシ（デンターシステマ　音波アシストブラシ、ライオン株式会社）を用いた。

（比較例２）

モータの取付位置が操作部のブラシ取付軸にあり、全長が１６０ｍｍ程度の電動歯ブラシ（ポケットドルツ、パナソニック株式会社）を用いた。

[0053] （評価方法）

外出時に歯磨きを行う女性１６名に、実施例１及び比較例１～２の電動歯ブラシを持ち歩いてもらい、その使用性・使用感評価を行った。

[0054] [表1]

	携帯時のサイズのよさ	使用時のサイズのよさ	ヘッド部に伝わる振動のよさ	手に伝わる振動の不快感のなさ	口腔内操作性	総合評価
実施例1	A	A	A	A	A	A
比較例1	C	A	B	B	A	B
比較例2	B	B	B	B	C	B

Ａ：よいと回答した人が１２～１６名

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Ｂ：よいと回答した人が７～１１名

Ｃ：よいと回答した人が０～６名

[0055] 表１に示すように、本発明を適用した実施例１は、携帯時のサイズのよさ、使用時のサイズのよさ、ヘッド部に伝わる振動のよさ、手に伝わる振動の不快感のなさ、口腔内操作性のいずれも「Ａ」であった。

一方、比較例１の電動歯ブラシは、ネック部が細くできている為、口腔内操作性及び使用時のサイズのよさは優れていた。しかし、電動歯ブラシのサイズが小さくならないため、携帯には不便である。

比較例２の電動歯ブラシは、女性の化粧ポーチにかろうじて収納できる大きさであるが、斜めにしなければ入らないという意見も多く、よりコンパクト化が望まれている。また、ネックが太くて口腔内操作性が悪い。

産業上の利用可能性

[0056] 本発明の電動歯ブラシは、駆動部（コイン型モータ）をヘッド部に搭載し、植毛部（植毛プレート、刷毛）のみを交換可能なカセット式にすることで、駆動部を捨てる必要がなく、かつネック部の強度を確保しつつ、口腔内操作性に優れた電動歯ブラシを提供する事ができる。また、使用性を損なうことなく、小型で携帯性に優れ、確実に振動をヘッド部に与えることができる。

符号の説明

[0057] １０　電動歯ブラシ

１１　操作部

１２　ネック部

１２ａ　ネック部（根元側）

１２ｂ　ネック部（先端側）

１３　ヘッド部

１３ａ　ヘッド部１３のベース部

１３ｂ　ヘッド部１３ｄの凸部

１３ｃ　ヘッド部１３ｅの凹部

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１３ｄ　ヘッド部（上面側）

１３ｅ　ヘッド部（底面側）

１４　取っ手

１５　電源

１６　スイッチ部

１７　振動モータ

１８　配線

１９　配線

２０　振動吸収体（振動吸収部）

２１　ブラシ

２２　植毛プレート

２３　パッキン

２４　キャップ

９０　振動伝達部

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請求の範囲

［請求項1］ ヘッド部、ネック部、及び操作部からなる電動歯ブラシであって、

前記ヘッド部の底面側にはコイン型振動モータを、前記ヘッド部の上面側には着脱自在の植毛プレートを有し、

前記操作部には電池とスイッチ部を収容し、前記電池からの給電によって作動する前記コイン型振動モータにより、歯ブラシが振動することを特徴とする電動歯ブラシ。

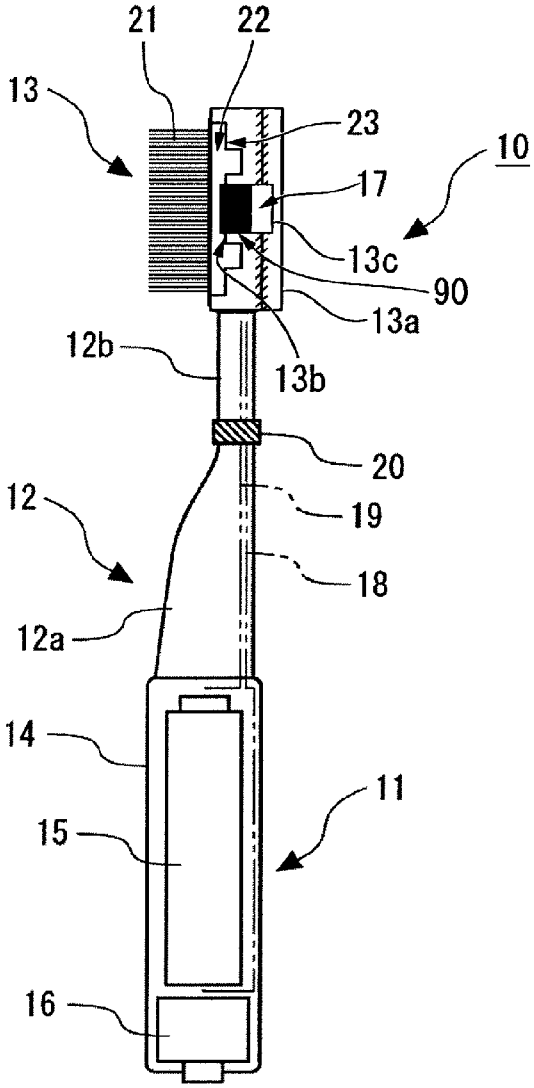
［請求項2］ ネック部に振動を遮断する部材を介在させることを特徴とする請求項１に記載の電動歯ブラシ。

［請求項3］ スライド式／繰り出し式／折りたたみ式／キャップ付け替え式の方法で使用時にはハンドルが延びる機構を備えた請求項１に記載の電動歯ブラシ。

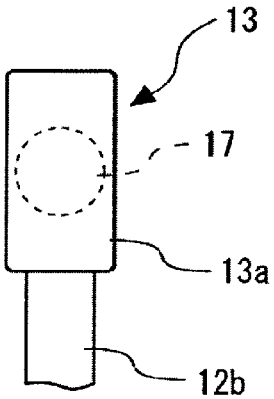
［請求項4］ 前記コイン型振動モータ上面に振動伝達部を備えた請求項１記載の電動歯ブラシ。

Petitioner Therabody Ex-1013, 0094

[図1A]

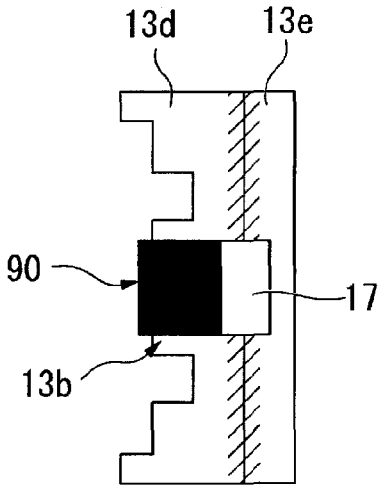


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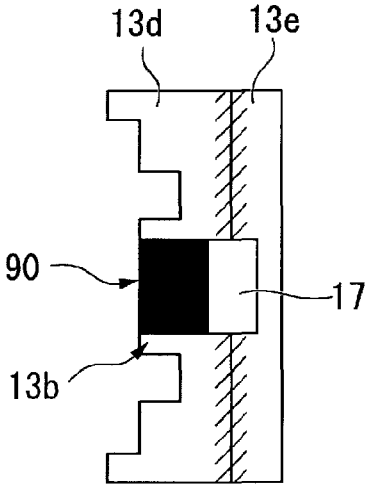


Petitioner Therabody Ex-1013, 0095

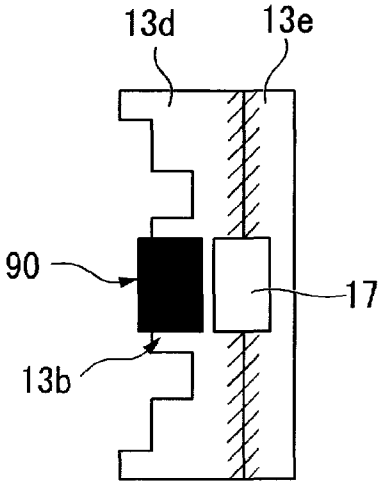
[図1C]



[図1D]

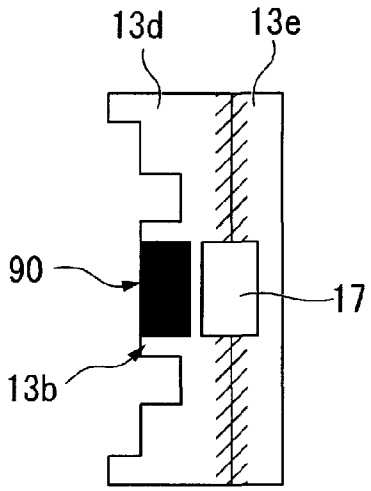


[図1E]

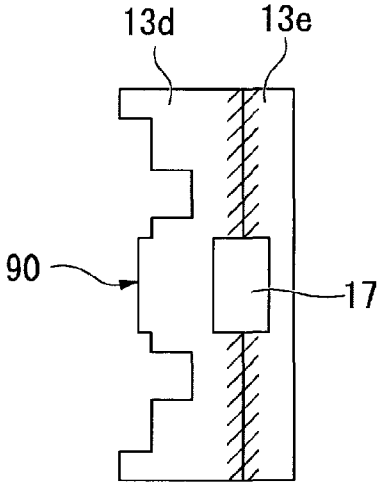


Petitioner Therabody Ex-1013, 0096

[図1F]

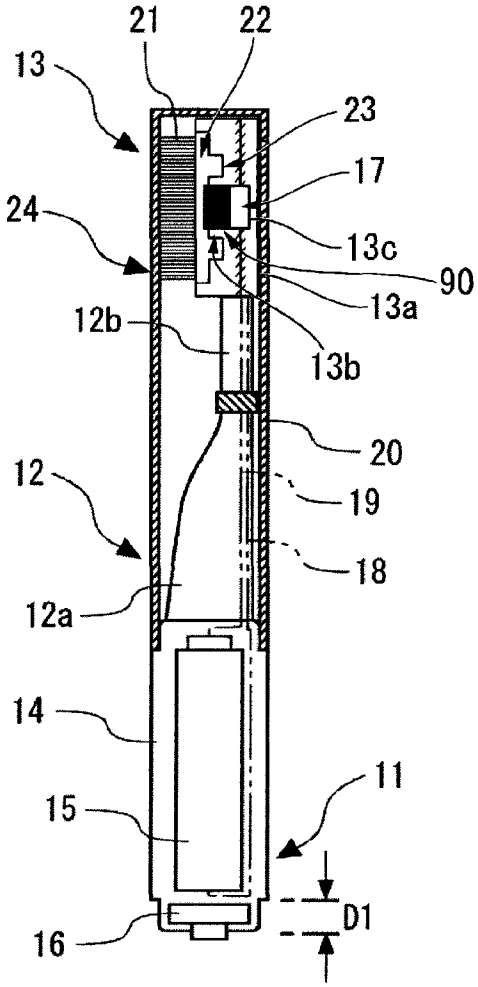


[図1G]



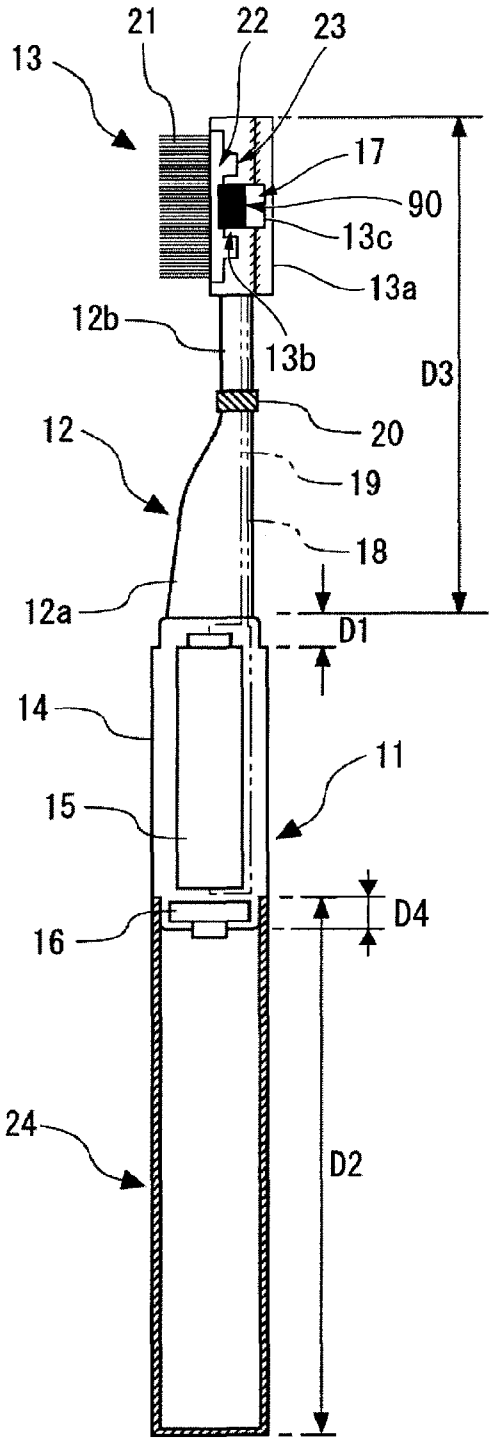
Petitioner Therabody Ex-1013, 0097

[図2A]



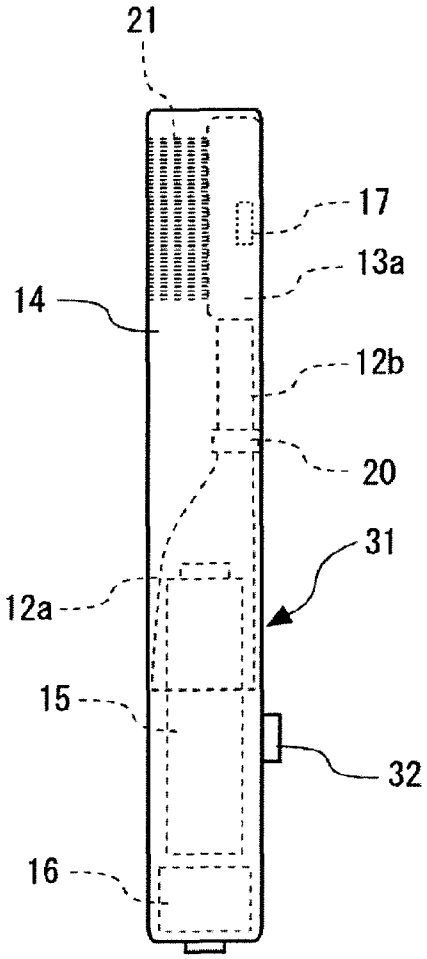
Petitioner Therabody Ex-1013, 0098

[図2B]



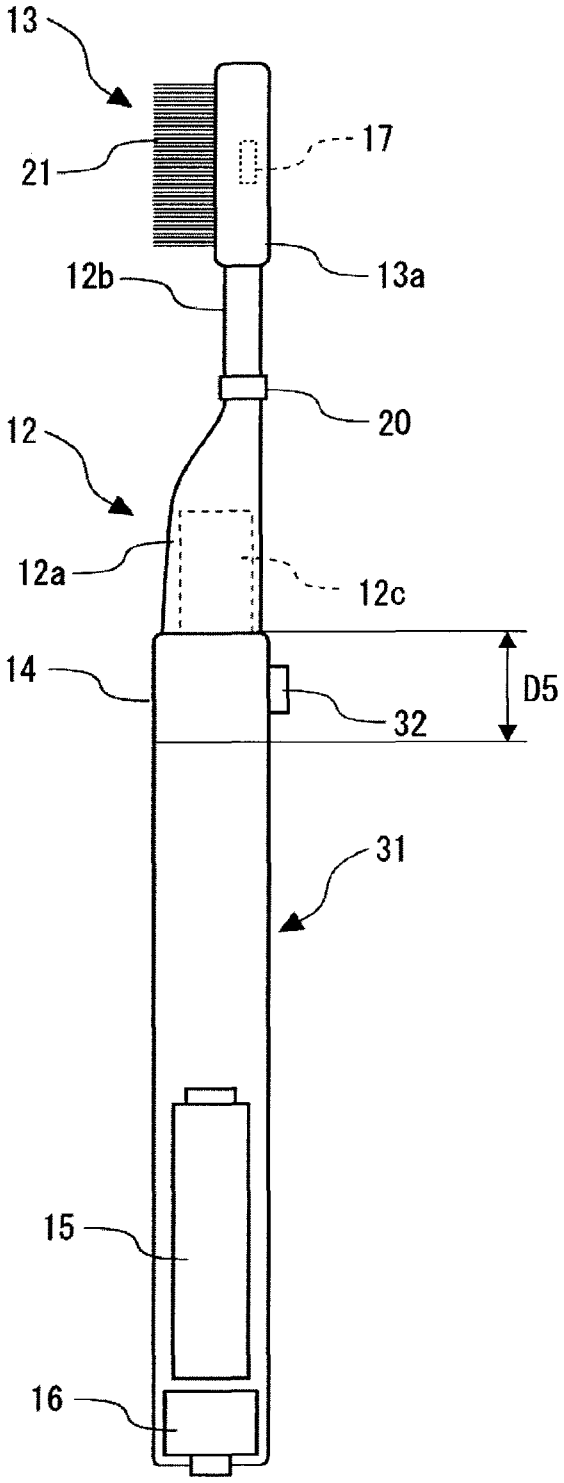
Petitioner Therabody Ex-1013, 0099

[図3A]



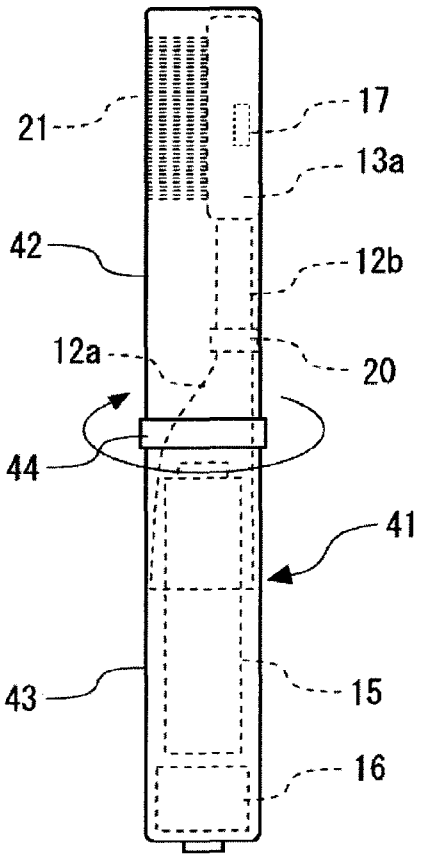
Petitioner Therabody Ex-1013, 0100

[図3B]



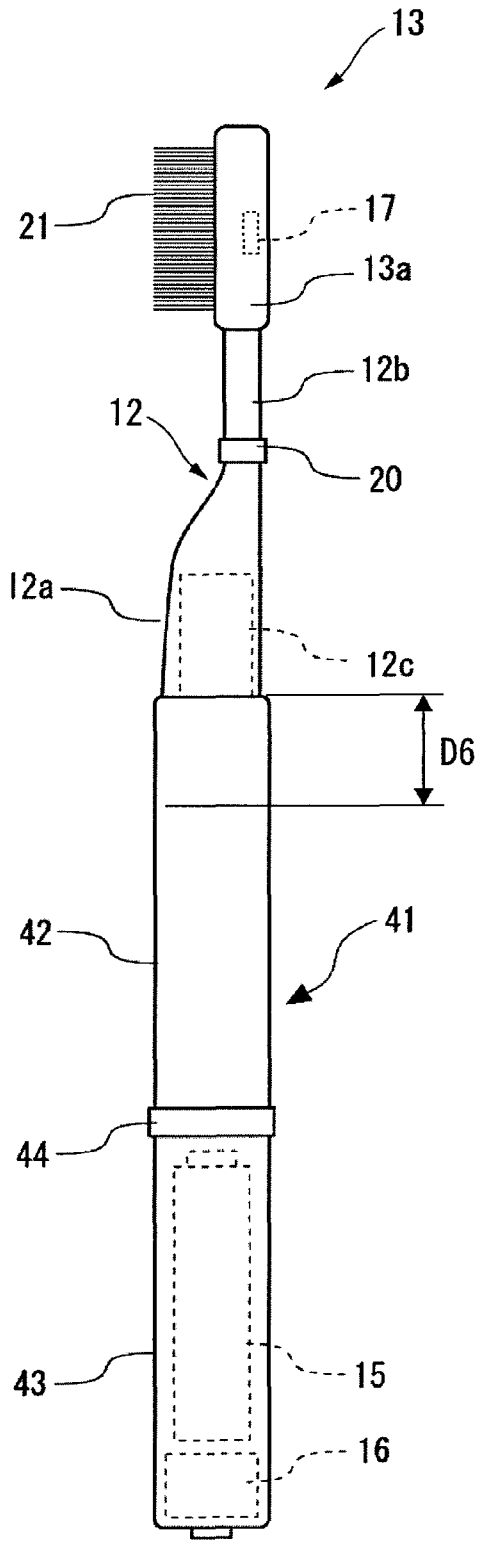
Petitioner Therabody Ex-1013, 0101

[図4A]



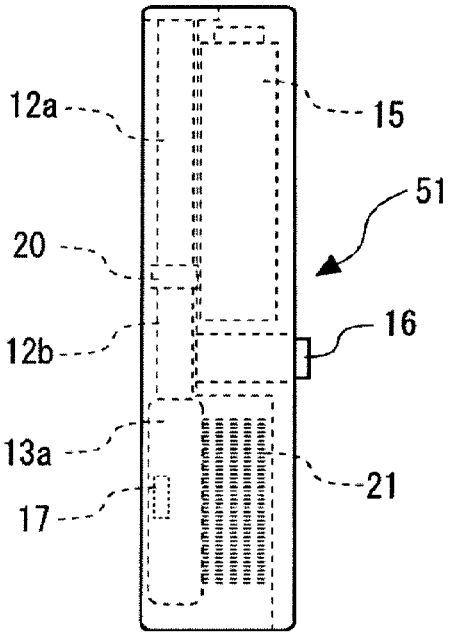
Petitioner Therabody Ex-1013, 0102

[図4B]



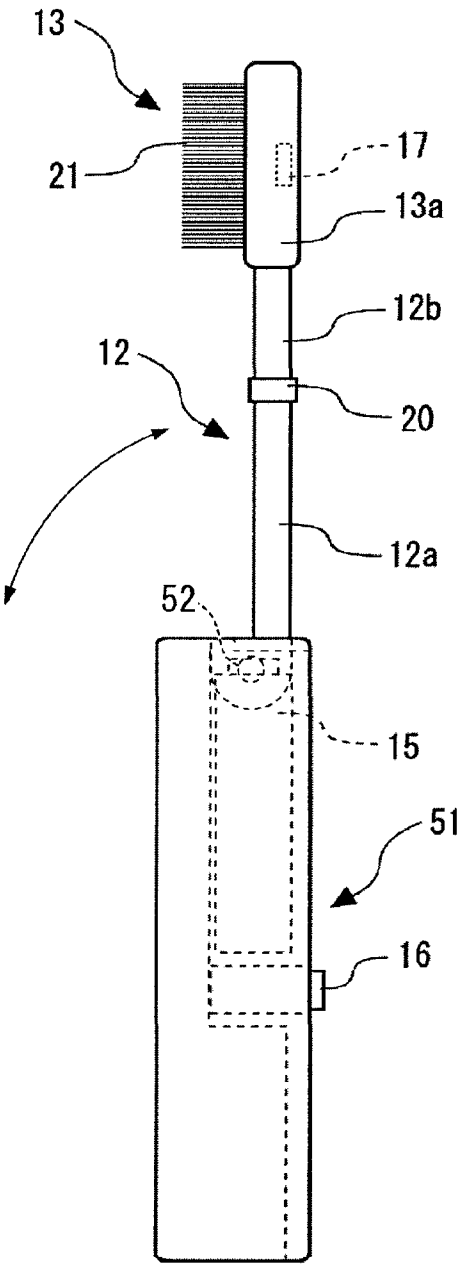
Petitioner Therabody Ex-1013, 0103

[図5A]



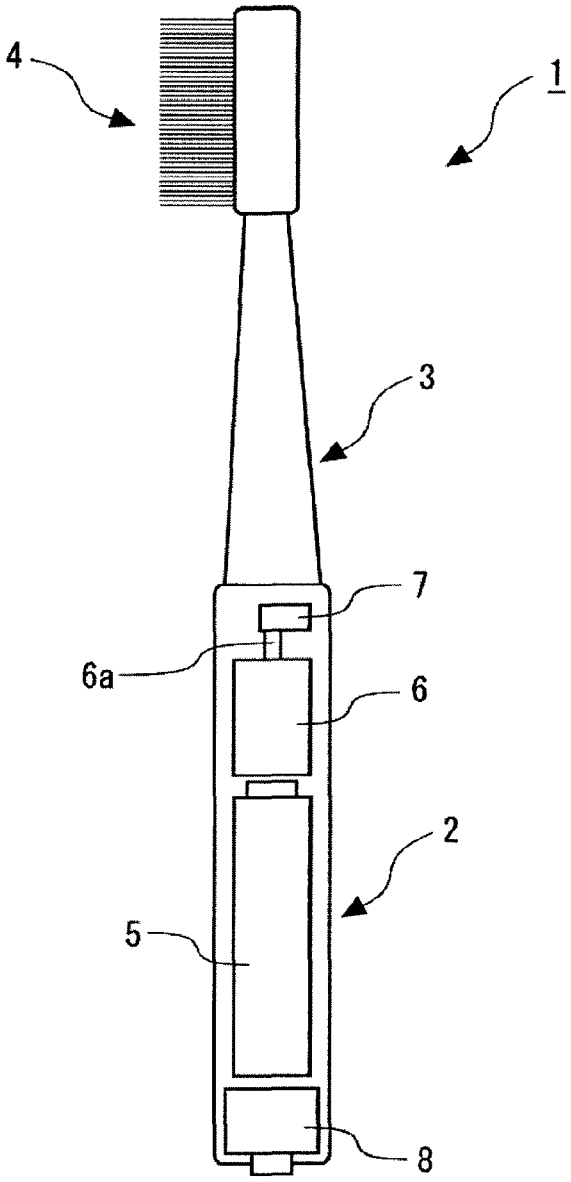
Petitioner Therabody Ex-1013, 0104

[図5B]



Petitioner Therabody Ex-1013, 0105

[図6]



Petitioner Therabody Ex-1013, 0106

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/058294

A. CLASSIFICATION OF SUBJECT MATTER
A61C17/22(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61C17/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2009-106355 A (Lion Corp.), 21 May 2009 (21.05.2009), paragraphs [0021] to [0026]; fig. 1 (Family: none)	1-4
Y	US 2011/0247153 A1 (Byeon), 13 October 2011 (13.10.2011), paragraphs [0031] to [0032]; fig. 1, 4 & KR 10-0999270 B1 & CN 102210614 A	1-4
Y	US 2006/0156496 A1 (Hafliger et al.), 20 July 2006 (20.07.2006), paragraph [0034]; fig. 4 to 5d & EP 1221906 A & WO 2001/028452 A1 & DE 299019053 U & AU 770483 B & AT 353601 T & CN 1379643 A & ES 2338237 T	1-4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June, 2013 (13.06.13)	25 June, 2013 (25.06.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

MassagerPriorArt0000758

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/058294

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2003-093415 A (Topland Corp.), 02 April 2003 (02.04.2003), claim 3 (Family: none)	2
Y	JP 2-139533 U (Lion Corp.), 21 November 1990 (21.11.1990), fig. 1 to 5 (Family: none)	3

MassagerPriorArt0000759

Petitioner Therabody Ex-1013, 0108

国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２０１３／０５８２９４

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　A61C17/22(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　A61C17/22

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２０１３年
日本国実用新案登録公報	１９９６－２０１３年
日本国登録実用新案公報	１９９４－２０１３年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
Y	JP 2009-106355 A (ライオン株式会社) 2009.05.21, 段落[0021]－[0026]、図１(ファミリーなし)	1-4
Y	US 2011/0247153 A1 (Byeon) 2011.10.13, 段落[0031]－[0032]、第1, 4図 & KR 10-0999270 B1 & CN 102210614 A	1-4
Y	US 2006/0156496 A1 (Hafliger et al.) 2006.07.20, 段落[0034], 第4-5d図 & EP 1221906 A & WO 2001/028452 A1 & DE 299019053 U & AU 770483 B & AT 353601 T & CN 1379643 A & ES 2338237 T	1-4
Y	JP 2003-093415 A (株式会社トップランド) 2003.04.02, 請求項３(ファミリーなし)	2

☑　Ｃ欄の続きにも文献が列挙されている。　　☐　パテントファミリーに関する別紙を参照。

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「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
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国際調査を完了した日 １３．０６．２０１３	国際調査報告の発送日 ２５．０６．２０１３
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　３Ｒ　２３３０ 鈴木　誠 電話番号　０３－３５８１－１１０１　内線　３３８６

様式ＰＣＴ／ＩＳＡ／２１０（第２ページ）（２００９年７月）

MassagerPriorArt0000760

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Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
Y	JP 2-139533 U（ライオン株式会社）1990.11.21，第1-5図（ファミリーなし）	3

MassagerPriorArt0000761

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Handheld electronic device

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bibliography | scope of patents | detailed instructions | symbol description

number

application date 2012/02/24

COMMUNIQUÉ IPC *H05K 7/00*(2006.01)

THE CURRENT IPC *H05K 7/00*(2006.01)

applicant Xinquan Computer Co., Ltd. 6F-2, No. 268 Liancheng Road, Zhonghe District, New Taipei City (Republic of China);
SHIN CHUAN COMPUTER CO., LTD 6F-2, NO. 268, LIANCHENG RD., ZHONGHE DISTRICT, NEW TAIPEI CITY, TAIWAN (TW)

current patentee XINQUAN COMPUTER CO., LTD.; SHIN CHUAN COMPUTER CO., LTD

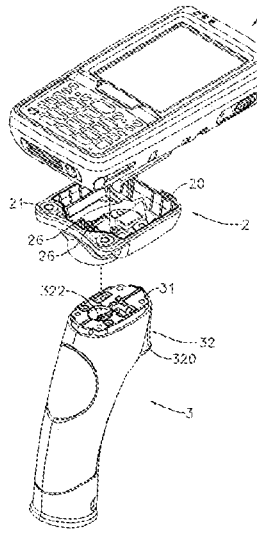
inventor Tu Zhongyuan (Republic of China); TU, CHUNG YUAN (TW)

agent forest fire spring

summary a handheld electronic device that allows a variety of handheld electronic devices to use the same (universal) grip by improving the structure of the grip connection of the handheld electronic device. the handheld electronic device comprises a device body, a battery cover and a grip, the device body has a battery capacity, the battery capacity is a concave body formed on the back of the device body, for setting the battery, the battery cover closes the battery capacity. the grip locks securely to the battery cover. therefore, the battery cover of the handheld electronic device can be unified according to the different models of the connected grip specifications.

scope of patents

diagrams all schemas



第 2 圖

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TOP

Petitioner Therabody Ex-1013, 0111

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(10) International Publication Number
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A61H 1/00 (2006.01)

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(22) International Filing Date: 24 July 2008 (24.07.2008)

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60/951,704 24 July 2007 (24.07.2007) US

(71) Applicant *(for all designated States except US)*: **ACTIVATOR METHODS INTERNATIONAL, LIMITED** [US/US]; 2950 North Seventh Street, Ste. 200, Phoenex, AZ 85014 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **TSAI, Stephen, C.** [US/US]; 340 East Commonwealth Avenue, Fullerton, CA 92832 (US). **FUHR, Arlan, W.** [US/US]; 2950 North Seventh Street, Ste. 200, Phoenix, AZ 85014 (US).

(74) Agent: **DAUGHERTY, Raye, Lynn**; Greenberg Traurig, LLP, 2450 Colorado Avenue, Ste. 400E, Santa Monica, CA 90404 (US).

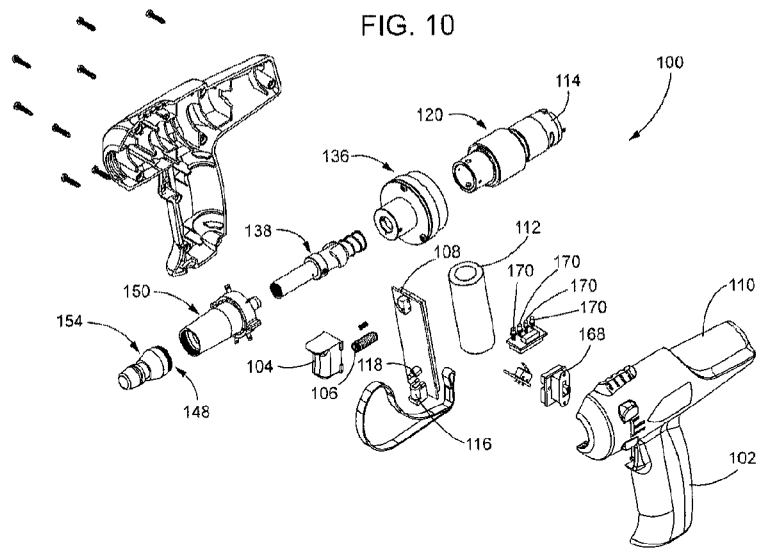
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) Title: PORTABLE CHIROPRACTIC ADJUSTOR

FIG. 10



(57) Abstract: A portable battery power operated chiropractic adjustor, manipulator or thruster for applying an adjustment energy to a patient through a plunger having a resilient or cushioned head with the energy applied to the plunger being supplied by non-manual sources and the impulse is adjustable or tunable along with having annunciators or indicators for preload and readiness to operate. The power source may be an internal rechargeable battery or removable rechargeable battery pack and the adjustor is DC motor operated to impart selectively single or multiple thrusts.

WO 2009/014727 A1

MassagerPriorArt0002162

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PORTABLE CHIROPRACTIC ADJUSTOR

FIELD OF INVENTION

[0001] The present invention relates generally to a portable chiropractic adjustor for use in chiropractic adjustment of musculoskeletal structures. More, particularly, this invention concerns an improved power operated chiropractic-adjusting device for use in spinal manipulative therapy to apply impact forces or thrusts to a human body.

BACKGROUND

[0002] The chiropractic art is generally concerned with adjusting misaligned body structures by manually manipulating the various joints in the human body. Of more specific interest in the art, however, is the spinal column which is comprised of several interconnected musculoskeletal structures or vertebrae. Unlike other, less critical body structures, the spinal column must be treated or manipulated with extreme caution because of its link with the central nervous system.

[0003] The human spine is susceptible to many different pathologic abnormalities including misalignment, miscellaneous trauma and pain, and degeneration as a result of age or disease. By employing various physical therapy techniques, though, a chiropractor, or one skilled in the chiropractic art, may be able to successfully treat a pathologic spine. Successful treatment will not only relieve any pain or discomfort that the patient might be suffering, but will also improve the overall quality of life of that patient.

[0004] One common spinal-adjustment technique involves applying thrusts or forces to the afflicted region of the spine. In particular, this technique involves either "mobilizing" the spine (i.e. passively moving the spine with relatively slow cyclic or oscillatory motion), or "manipulating" the spine (i.e. applying an impulsive thrust or force in a well-defined direction to a specific region of the spine). Depending on professional affiliations, this technique is referred to as chiropractic adjustment, osteopathic manipulation, orthopedic manual therapy, and/or spinal manipulative therapy.

[0005] There are several well-known procedures or techniques for "manipulating" or administering impulsive thrusts to a spine. One technique involves applying one or more rapid thumb thrusts to misaligned or afflicted vertebrae. Thumb thrusts, however, tend to be both imprecise in magnitude and location and tiresome to administer. Another technique

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involves using a manually operated chiropractic-adjusting instrument. For instance, U.S. Pat. No. 4,116,235, issued to Fuhr et al. ("Fuhr"); Fuhr U.S. Pat. No. 6,702,836; Fuhr U.S. Pat. No. 6,379,375; Keller et al. U.S. Pat. No. 5,626,615; Keller et al. U.S. Pat. No. 5,656,017; and U.S. Pat. No. 4,498,464, issued to Morgan, Jr., disclose such instruments.

[0006] Throughout the years it has also been known that power driven devices at times can offer benefits or advantages in use over the manually operated devices. Particularly, there is a current need for a compact, lightweight device that is portable and yet can be easily and repetitively operated by a person with a lower degree of hand strength.

[0007] Electric solenoid operated adjustors such as ones described in Evans U.S. Pat. No. 4,841,955 issued in 1989 or Adelman U.S. Pat. No. 4,682,490, issued in 1987, can provide adjusting and controllability benefits over manual devices. However, using an electrical appliance operating at conventional voltages close to the body can be potentially hazardous and even prohibited by governmental regulatory agency rules or regulations and power supply cords can get in the way.

[0008] Thus, numerous efforts have been made to develop a power operated thrusters with all of the desired features and benefits required for safe and varied usage of such devices. Examples of such an approach in pneumatic operated thrusters is shown in U.S. Pat. No. 4,716,890, issued in 1988 to Bichel.

[0009] While the Bichel thruster as described did seek to overcome disadvantages presented in prior art devices, it still did not provide certain features and advantages required to achieve wide spread acceptance and use by chiropractic practitioners.

[0010] By way of example, it may be noted that such prior devices including Bichel are capable of only delivering a single thrust or stroke, provide only manual adjustability of stroke lengths; provide force adjustment by changing stroke length and change air pressure only at the compressor or supply source. In addition they involve complicated multiple parts designs which make them more costly to manufacture and more difficult and costly to maintain or use. A pneumatic thruster of Frye U.S. Pat. No. 6,503,211 has solved some of the problems and objections of the field.

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SUMMARY OF THE INVENTION

[0011] The present invention may provide a portable chiropractic adjustor instrument comprising a DC motor driven plunger. The instrument may be relatively light weight and have a substantially long life rechargeable battery.

[0012] The present invention may provide an improved power operated chiropractic instrument that is "tunable" or settable as to load, amplitude, and frequency within a user selected range of natural frequency.

[0013] The present invention may provide a portable device with annunciators or indicators of settings such as preload and readiness to operate.

[0014] The present invention may provide a self contained power source for the adjusting instrument which is long lasting and yet can be rechargeable or replaceable.

[0015] These together with other features of the invention are more fully hereinafter described, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

[0016] It will be appreciated that the foregoing and subsequent descriptions are considered as illustrative only of aspects and features of the invention. Thus, it is not desired to limit the invention to the exact construction and operation shown and described, and, accordingly, all suitable modifications and equivalents may be utilized, falling within the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a top plan view of an embodiment of a portable chiropractic adjustor of the present invention;

[0018] FIG. 2 is a right elevational side view of the portable chiropractic adjuster shown in FIG. 1;

[0019] FIG. 3 is a left elevational side view of the portable chiropractic adjuster shown in FIG. 1;

[0020] FIG. 4 is a bottom view of the portable chiropractic adjuster shown in FIG. 1;

[0021] FIG. 5 is a front elevational view of the portable chiropractic adjuster shown in FIG. 1;

[0022] FIG. 6 is a rear elevational view of the portable chiropractic adjuster shown in FIG. 1;

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[0023] FIG. 7 is a partial cross-sectional view taken through line 7-7 of the portable chiropractic adjuster shown in FIG. 1;

[0024] FIG. 8 is another cross-sectional view taken through line 7-7 of the portable chiropractic adjuster shown in FIG. 1;

[0025] FIG. 9 is a cross-sectional view taken through line 9-9 of FIG. 2 of the portable chiropractic adjuster shown in FIG. 1;

[0026] FIG. 10 is an exploded view of the portable chiropractic adjuster shown in FIG. 1;

[0027] FIG. 11 is an exploded view of a motor and gear mechanism for the portable chiropractic adjuster shown in FIG. 1;

[0028] FIG. 12 is an exploded view of a heat dissipating mechanism for the portable chiropractic adjuster shown in FIG. 1;

[0029] FIG. 13 is an exploded view of a thrust transfer mechanism for the portable chiropractic adjuster shown in FIG. 1;

[0030] FIG. 14 is an exploded view of a barrel portion for the portable chiropractic adjuster shown in FIG. 1;

[0031] FIG. 15 is an exploded view of a plunger mechanism for the portable chiropractic adjuster shown in FIG. 1; and

[0032] FIG. 16 is a simplified diagram illustrating a control board in communication with components of the portable chiropractic adjuster shown in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0033] Turning to FIGS. 1-16, there is shown another embodiment of a portable chiropractic adjustor instrument 100. Referring to FIGS. 1-6, the portable chiropractic instrument 100 may comprise a structure, including a housing, that is relatively convenient for an operator to hold, adjust, and operate. The instrument may have an ergonomic handle 102 which is comfortable and convenient to grip. The portable chiropractic instrument 100 may also have a trigger mechanism 104 that likewise comfortably receives an operators finger for firing the instrument. As shown in FIG. 8, the trigger 104 may be coupled to a spring 106 which biases the trigger 104 in the non-engaged position. The trigger 104 may be in contact with a switch 108 that is depressed when the trigger 104 is depressed to operate the instrument 100.

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[0034] Turning to FIGS. 7-15, suitable internal components of the portable chiropractic instrument 100 are shown in detail. The instrument 100 may utilize a battery 112 such that the such that the portability of the instrument 100 is enhanced by not requiring an unwieldy power cord for usage. Furthermore, in order to offer further enhanced portability along with a reasonable battery usage life, the instrument may utilize a DC motor 114 which is significantly more energy efficient than solenoid driven devices. In addition, a DC motor 114 may generally be constructed such that it weighs less than a solenoid for supplying a comparable amount of force such that the instrument 100 may be made lighter, and thus, easier for an operator to hold over an extended period of time than a solenoid driven instrument. The battery 112 may be disposed in the handle 102 and the motor 114 may be disposed in the housing 110 such that it is in line with a plunger mechanism 154 (described in further detail below).

[0035] In some embodiments, the battery 112 may be generally disposed within the housing 110 such that it is not generally removable by the operator. In other embodiments, the battery 112 may be removable and replaceable by the operator. The battery 112 may be any suitable battery for driving a DC motor 114 with long usage and recharge characteristics. The battery 112 may be rechargeable such that the battery 112 may be reused after charging.

[0036] The instrument 100 may comprise a charging port 116, such as shown in FIGS. 7 and 8, for receiving an adaptor to recharge the battery 112. In some embodiments where the battery112 is removable, the battery 112 may be removed for charging in a free standing charger and may be replaced with a spare charged battery when one battery 112 is being charged. The instrument 100 may also comprise a charge indicator 118, such as an LED light shown in FIGS. 7, 8, and 10, that may inform an operator when the battery 112 is charging, when the battery 112 has been charged, and/or when the battery 112 is nearly discharged. It will be appreciated that any suitable form of battery 112 indicator may be used, the instrument 100 may utilize any suitable number of battery indicators, and the battery indicator(s) may be used to indicate any suitable battery condition. In some embodiments, the battery 112 may be a lithium-ion rechargeable battery.

[0037] Referring to FIGS. 7-11, the motor 114 may be in contact with a gear mechanism 120 that may comprise a plurality of gears 122 for assisting with the transfer of force from the motor 114 to further components of the instrument 100. In some embodiments, the gear mechanism 120 may comprise a gear housing 124 having gear teeth 126 on an internal surface of the gear housing 124. The gear mechanism 120 may comprise one or more sets of

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planetary gears 128. A pinion gear plate 130 may be disposed between sets of planetary gears 128 to transfer motion. The gear mechanism 120 may also comprise a head portion 132 having one or more camming actuators, such as protrusions 134.

[0038] Referring to FIGS. 7-10 and 12, the instrument may comprise a heat dissipation structure 136 for dissipating heat within the instrument 100. In some embodiments, the heat dissipation structure 136 may operate as a heat sink to draw heat away from one or more components within the instrument 100. The heat dissipation structure 136 may at least partially surround a portion of the thrust transfer mechanism 138 (described below).

[0039] Turning to FIGS. 7-10 and 13, the instrument 100 may comprise a thrust transfer mechanism 138. The thrust transfer mechanism 138 may comprise a suitable structure(s) for contacting the gear mechanism and converting the rotational forces conveyed by the motor 114 to the gear mechanism 120 into an axial force directed away from the motor 114 and toward a patient. For example, the thrust transfer mechanism 138 may operate as a camming structure and may comprise one or more ramping structures 140, with grooves 142 therebetween, coupled to a ramping component 144. The protrusions 134 of the head portion 132 of the gear mechanism 120 may ride along these ramping structures 140. The ramping component 144 may be biased away from the motor by one or more springs 146.

[0040] As the head portion 132 of the gear mechanism 120 is rotated, the protrusions 134 ride up the ramping structures 140 which forces the ramping component 144 to move toward the motor 114 and compress the one or more springs 146. As the ends of the ramping structures 140 are reached, the protrusions 134 reach the grooves 142 and the spring force propels the ramping component 144 forward. In this way, the rotational forces of the motor 114 have been converted into an axial force.

[0041] Referring to FIGS. 1-5, 7-10, and 14, the instrument 100 may comprise a forward end 148 having a barrel portion 150 coupled to the housing 110. The barrel portion 150 may comprise a plurality of components for receiving a force from the thrust transfer mechanism 138 and conveying the force to a plunger mechanism 154 (described below). For example, the barrel portion 150 may comprise a hammer 152 for receiving and carrying forward the force created by the spring force propelling the ramping component 144 forward when the trigger 104 has been engaged.

[0042] Referring to FIGS. 1-5 and 7-10, and 15, the forward end 148 may further have a plunger mechanism 154. The plunger mechanism 154 may have a suitable structure for asserting a force on a patient. Furthermore, the plunger mechanism 154 may have a suitable

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structure for allowing an operator to assert a preload force on a patient before firing the instrument 100.

[0043] The plunger mechanism 154 may comprise a plunger 156, a plunger housing 158, a spring 160, a force transfer pin 162, and an o-ring 164. When assembled, the spring 160 may be disposed around the force transfer pin162 and both the spring 160 and the force transfer pin 162 may be at least partially disposed within the plunger housing 158. The plunger housing 158 may be coupled to the barrel portion 150. A tip 166 may be disposed at an end of the plunger 156 for contact with the patient. The tip 166 may be cushioned. The plunger 156 may be mounted such that the plunger 156 may be at least partially received by the plunger housing 158. The plunger 156 can be interchangeable with various single or dual style forms.

[0044] The plunger 156 may be movable with respect to the plunger housing 158 when a force is asserted against the tip 166. The plunger 156 may be coupled to a suitable structure, such as the spring 160 disposed against the force transfer pin 162, which applies an increasing amount of force to resist the inward movement of the plunger 156 as the plunger 156 is pushed further into the plunger housing 158. This permits an operator of the instrument 100 to apply a preload force prior to engaging the trigger 104. Therefore, the plunger mechanism 154 may have a structure such that as the instrument 100 is pressed against the patient and as the plunger 156 moves further into the plunger housing 158, the amount of preload force increases.

[0045] In addition, the force transfer pin 162 receives the force transmitted through the barrel portion 150 when the trigger 104 is engaged and directs the force onto the patient via the plunger 156 and plunger tip 166. This force is carried by the hammer 152 through the barrel portion 150 to the force transfer pin 162. The o-ring 164 provides a cushioning contact between the force transfer pin 162 and the hammer 152 to reduce the noise that would otherwise result from the impact of these two components and also reduce the wear on these components. The amount of preload force that is applied to the force transfer pin 162 may affect the distance that the force transfer pin 162 travels when the trigger 104 is engaged.

[0046] Referring to FIGS. 2 and 10, the instrument 100 may comprise a suitable mechanism for turning the instrument 100 on and off and setting the instrument 100 to any suitable operating mode. For example, the instrument 100 may comprise a switch 168 that is movable between any two or more suitable positions to place the instrument 100 into a desired operating mode.

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[0047] In one embodiment, the switch 168 may be movable between an off mode, a single thrust operating mode, and a multiple thrust operating mode. In the single thrust operating mode, the instrument 100 may apply a single thrust for each activation of the trigger 104. In comparison, the multiple thrust setting may apply multiple thrusts for each activation of the trigger 104. In some embodiments, the instrument 100 may continue to apply thrusts until such time as the trigger 104 is released. In other embodiments, the instrument 100 may apply a predetermined or operator set number of thrusts. It will be appreciated, however, that the switch 168 may be used to place the instrument 100 into any suitable operating mode and the switch 168 may be movable between any suitable number of operating modes.

[0048] An annunciation structure may be disposed on the instrument to provide feedback to the operator as to such things as preload settings, loading status, readiness, force settings, and even values of impulse frequency or amplitude. It will be appreciated that the annunciation structure may be any suitable structure in any suitable quantity. As shown in FIGS. 1, 7, and 8, the housing may comprise a plurality of indicators 170, such as LED lights, that indicate the thrust setting. The instrument 100 may have any suitable number of indicators 170 representing any suitable number of thrust settings. In some embodiments, the LED lights could change colors, such as from red to yellow to green, for example, for preload status. In some embodiments, the annunciation structure may be an LCD display and/or an audio annunciator. An LCD display could be graphic, alpha numeric, and/or pictorial.

[0049] By way of example and not limitation, as shown in FIGS. 1, 7, and 8, the instrument may have indicators 170 that notify the operator when certain predetermined amounts of preload force have been asserted on the patient based on information provide by the one or more preload force sensors disposed within the housing 110. As the amount of preload force applied reaches a first predetermined amount, the first indicator will notify the operator. As the amount of preload force is increased to a second predetermined amount, the second indicator will notify the operator. Further indicators may be provided to indicate when further increased amounts of preload force have been reached. In this way, the operator may accurately apply a desired amount of preload force before engaging the trigger 104. In one example embodiment, the respective indicators 170 may notify an operator when 19 pounds, 34 pounds, 38 pounds, and/or 55 pounds of preload force have been applied. In another example embodiment, respective indicators 170 may notify an operator when 75 Newtons, 125 Newtons, 175 Newtons, and/or 250 Newtons of preload force have been

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applied. It will be appreciated that any suitable number of indicators 170 may indicate any suitable levels of preload force.

[0050] The motor 114 may be in contact with a gear mechanism 120 for driving the thrust of the tip 166 in response the engagement of the trigger 104. When the trigger switch 108 is depressed, power from the battery 112 may be provided to the motor 114. Depending on whether the instrument 100 is set for single thrust operation or multiple thrust operation, the motor 114 may be driven for only a relatively short period of time, the motor 114 may be driven for a desired longer period of time to provide a predetermined number of thrusts, or the motor 114 may be driven until the trigger 104 is released. The motor 114 may drive the gear mechanism 120, which in turn, may apply a force on the thrust transfer mechanism 138. The thrust transfer mechanism 138 may convert the rotational force of the gear mechanism 120 into an axial force that may be transmitted through the instrument to the plunger 156 and on the patient.

[0051] As shown in FIG. 16, a control board may be disposed within the instrument that may be used to communicate with such features as the battery 112, motor 114, annunciaton structure(s) (such as 170), thrust setting switch(es) 168, microsensors 176, preload sensor(s) 174, and any other suitable structures, for operation of the portable chiropractic instrument 100. The circuitry of the instrument 100 may also contain microprocessor devices for data storage such as number and duration of thrusts, for example, and the data collected can be downloadable to a computer having diagnostic software and/or a patient database.

[0052] All references, including publications, patent applications, and patents, cited herein are hereby incorporated by reference to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

[0053] The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods

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described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

[0054] Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

What is claimed is:

1. A portable chiropractic adjustor for applying an adjustment energy to a patient, the portable chiropractic adjustor comprising:

a plunger mechanism having a plunger and a plunger tip;

a housing having a thrust transfer structure for transferring an axial thrust force through the housing to the plunger mechanism, a camming structure, and a handle having a trigger;

a DC motor disposed within the housing for rotatably driving the camming structure in response to the trigger being engaged; and

a cam actuator for converting the rotational drive of the camming structure to the axial thrust force applied to the thrust transfer structure.

2. The portable chiropractic adjustor of claim 1 wherein the DC motor is battery operated.

3. The portable chiropractic adjustor of claim 2 wherein the battery is rechargeable.

4. The portable chiropractic adjustor of claim 1 wherein the plunger mechanism has a spring in contact with the plunger for an application of a preload force.

5. The portable chiropractic adjustor of claim 1 further comprising an annunciator.

6. The portable chiropractic adjustor of claim 5 wherein the annunciator indicates an amount of preload force applied.

7. The portable chiropractic adjustor of claim 1 further comprising a switch for changing the portable chiropractic adjustor between a single thrust operation mode and a multiple thrust operation mode.

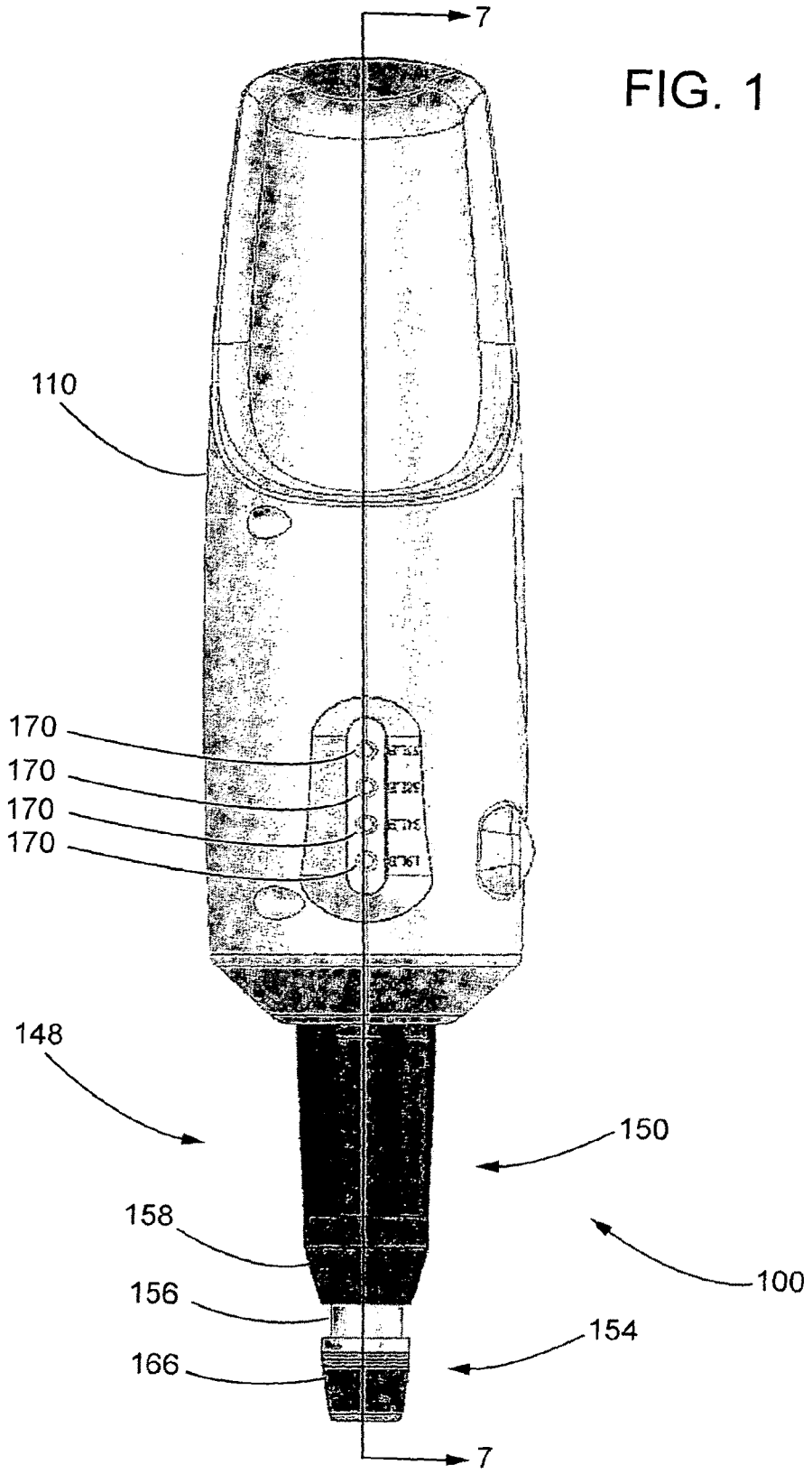
8. The portable chiropractic adjustor of claim 1 wherein the camming structure comprises a ramp for contacting the cam actuator.

9. The portable chiropractic adjustor of claim 8 wherein the camming structure comprises a groove for receiving the cam actuator.

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10. The portable chiropractic adjustor of claim 1 wherein the camming structure is in contact with a spring.

FIG. 1



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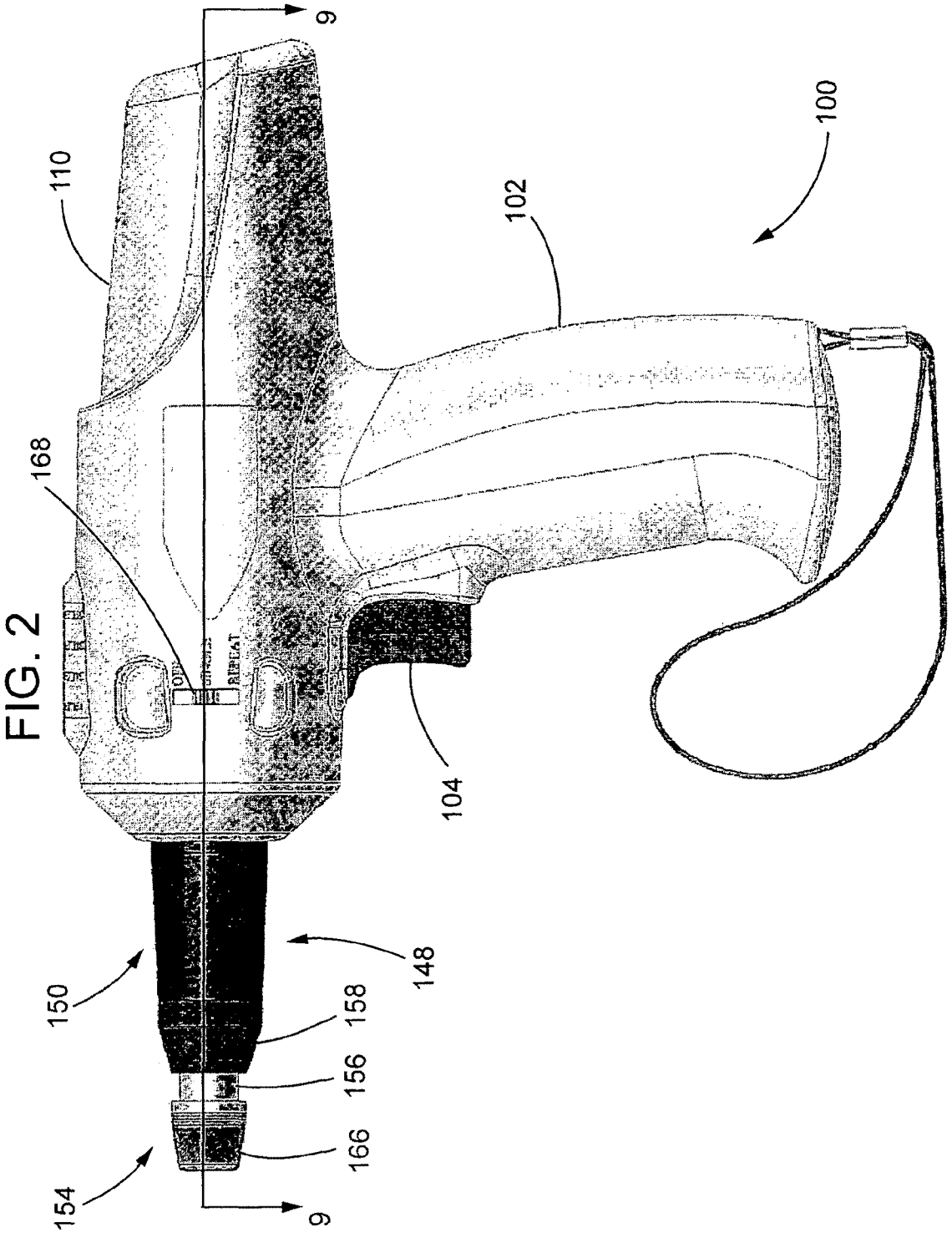


FIG. 2

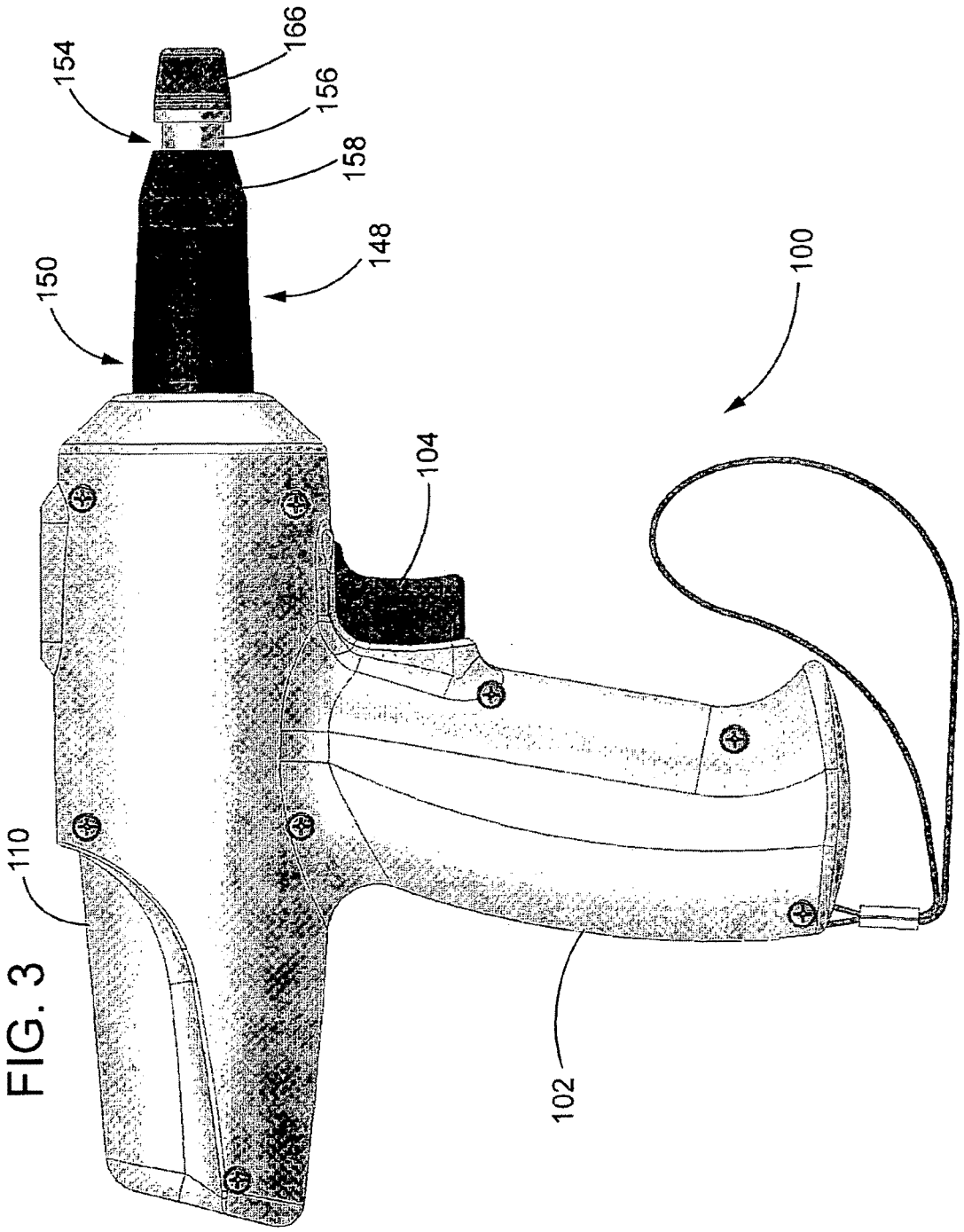
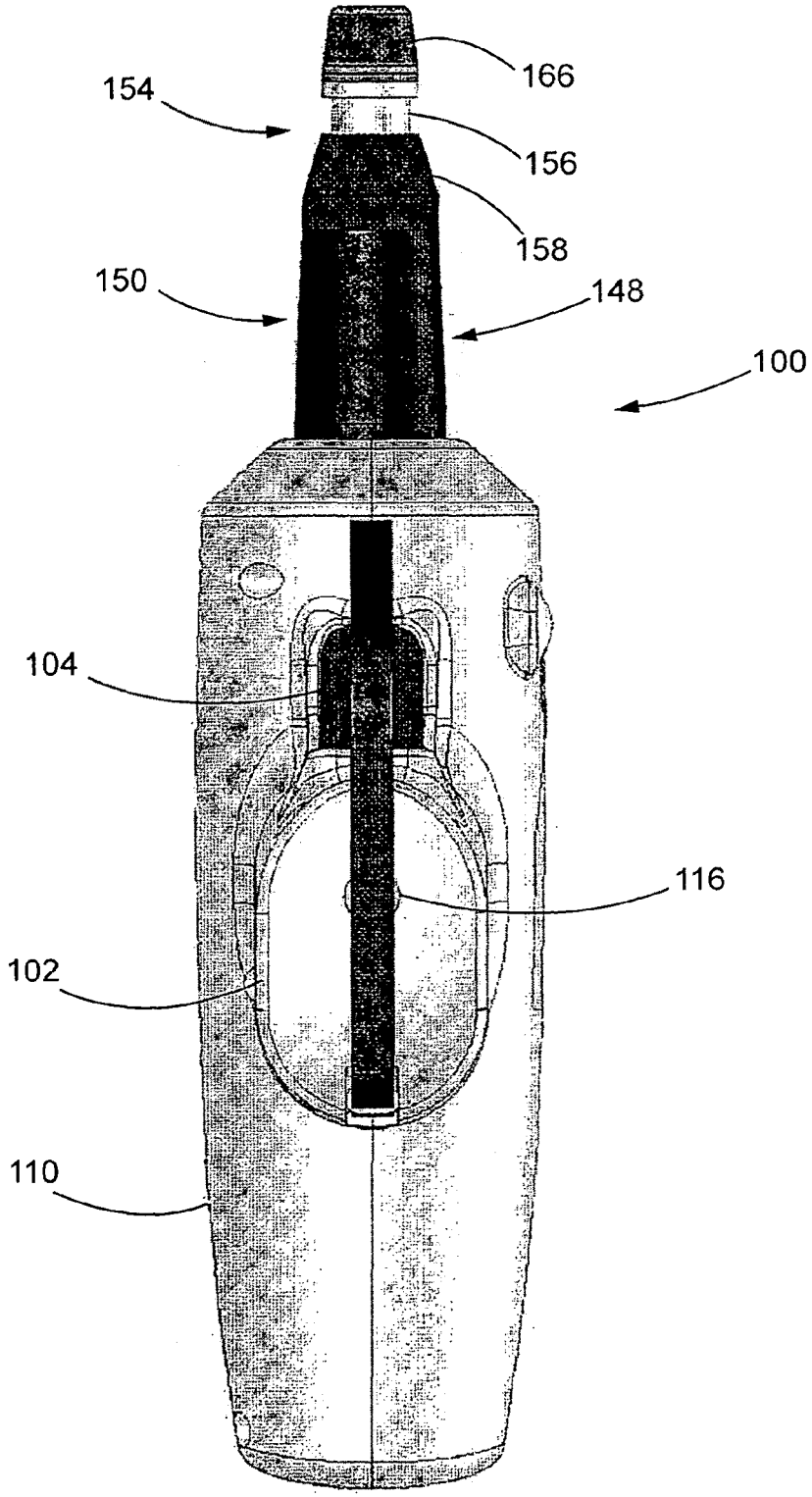


FIG. 3

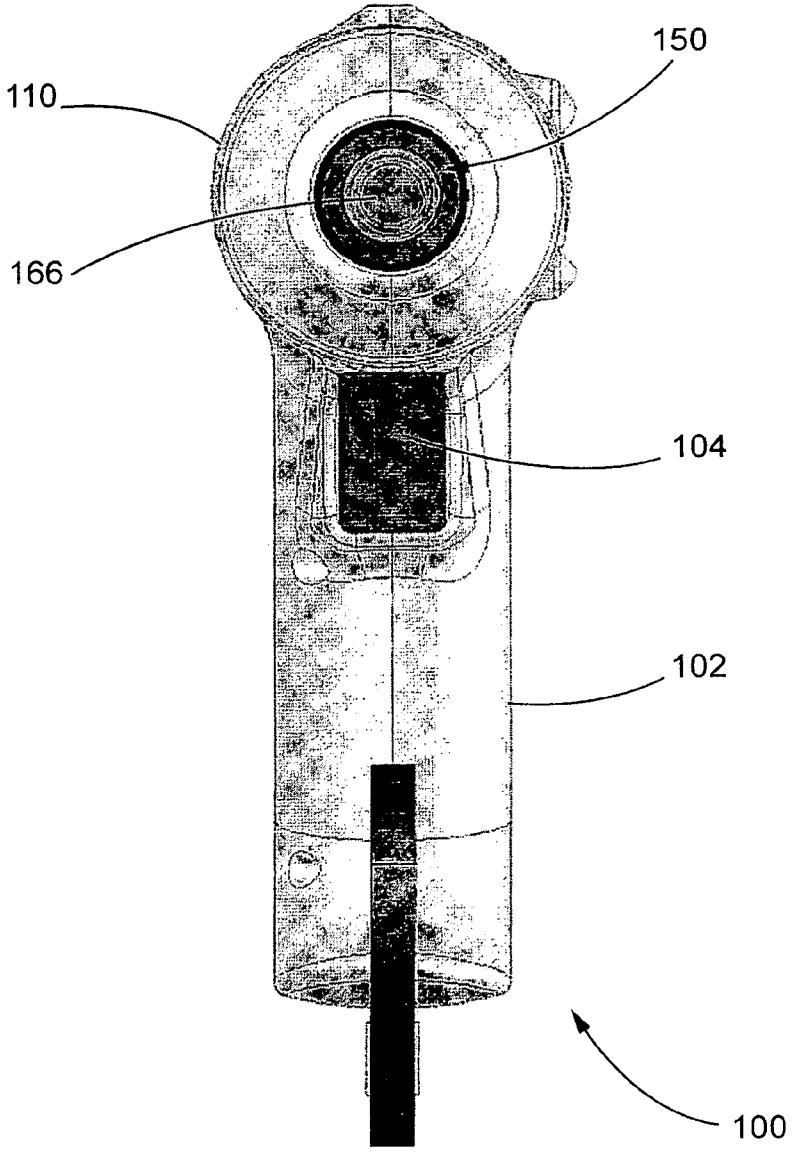
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FIG. 4



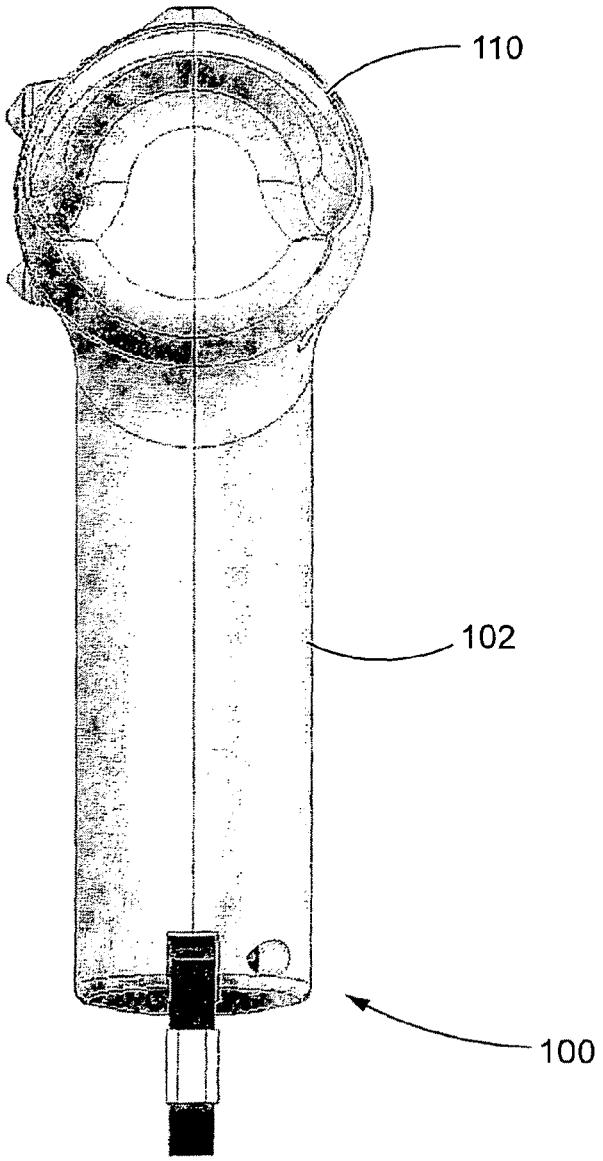
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FIG. 5



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FIG. 6



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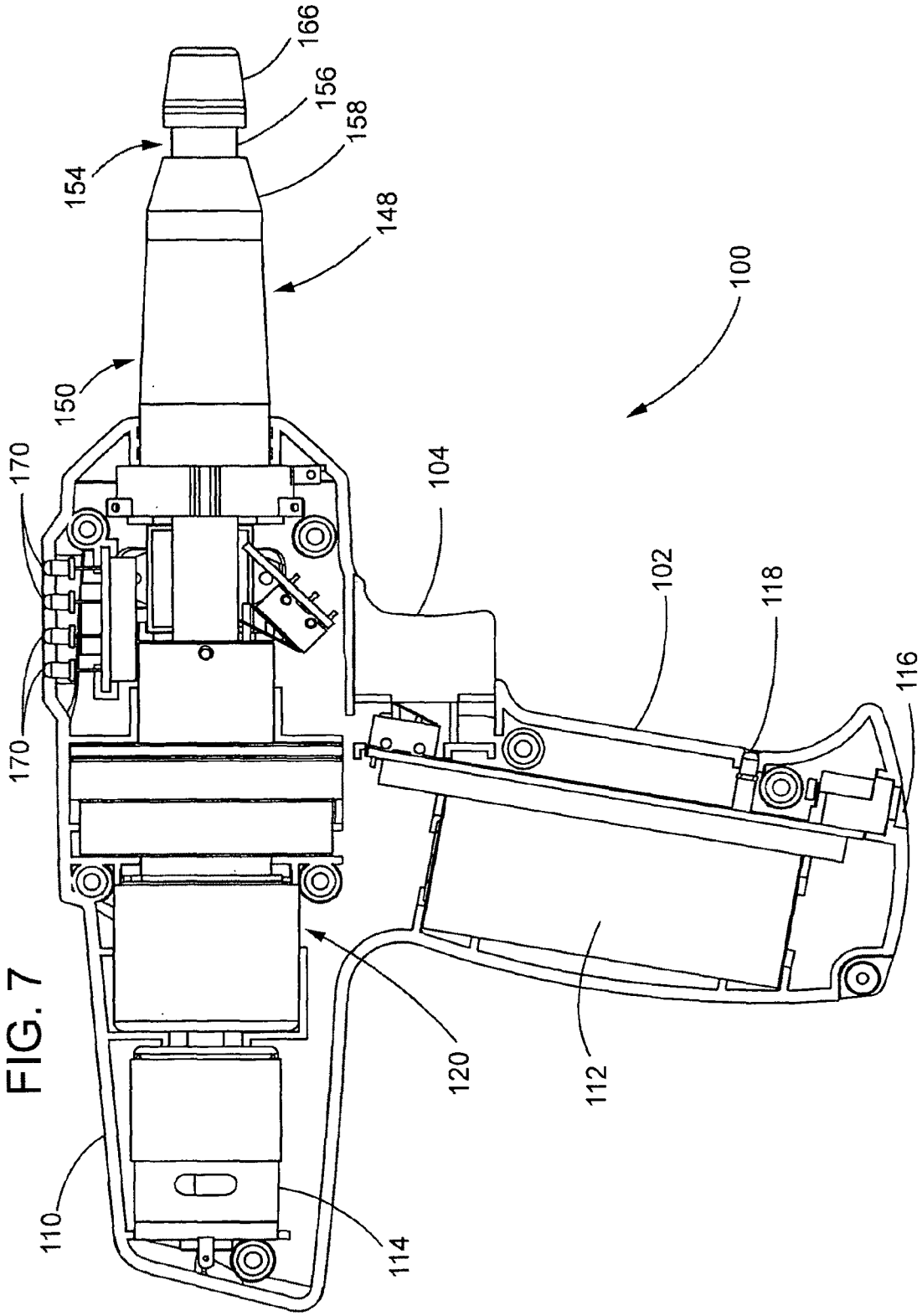


FIG. 7

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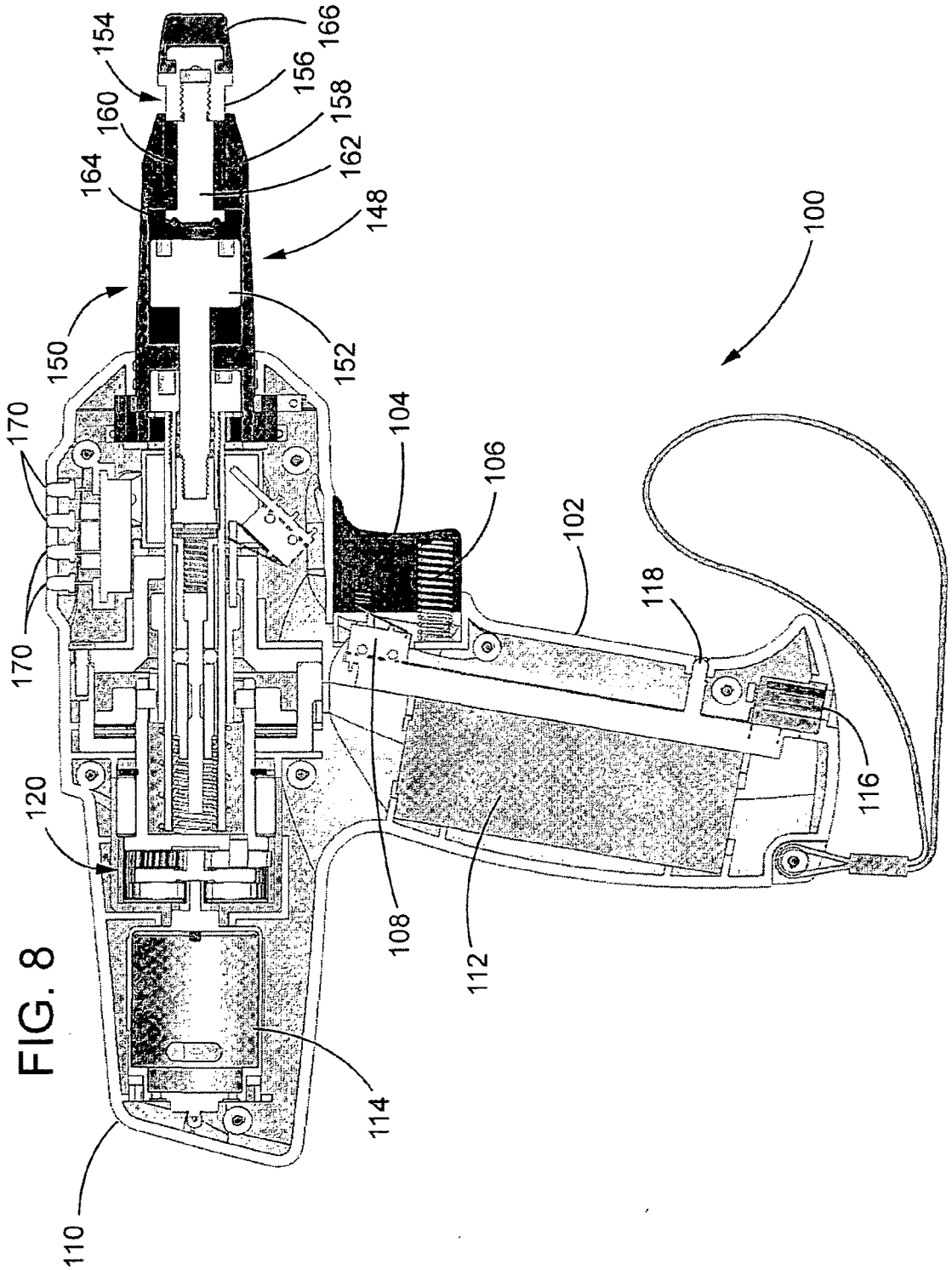
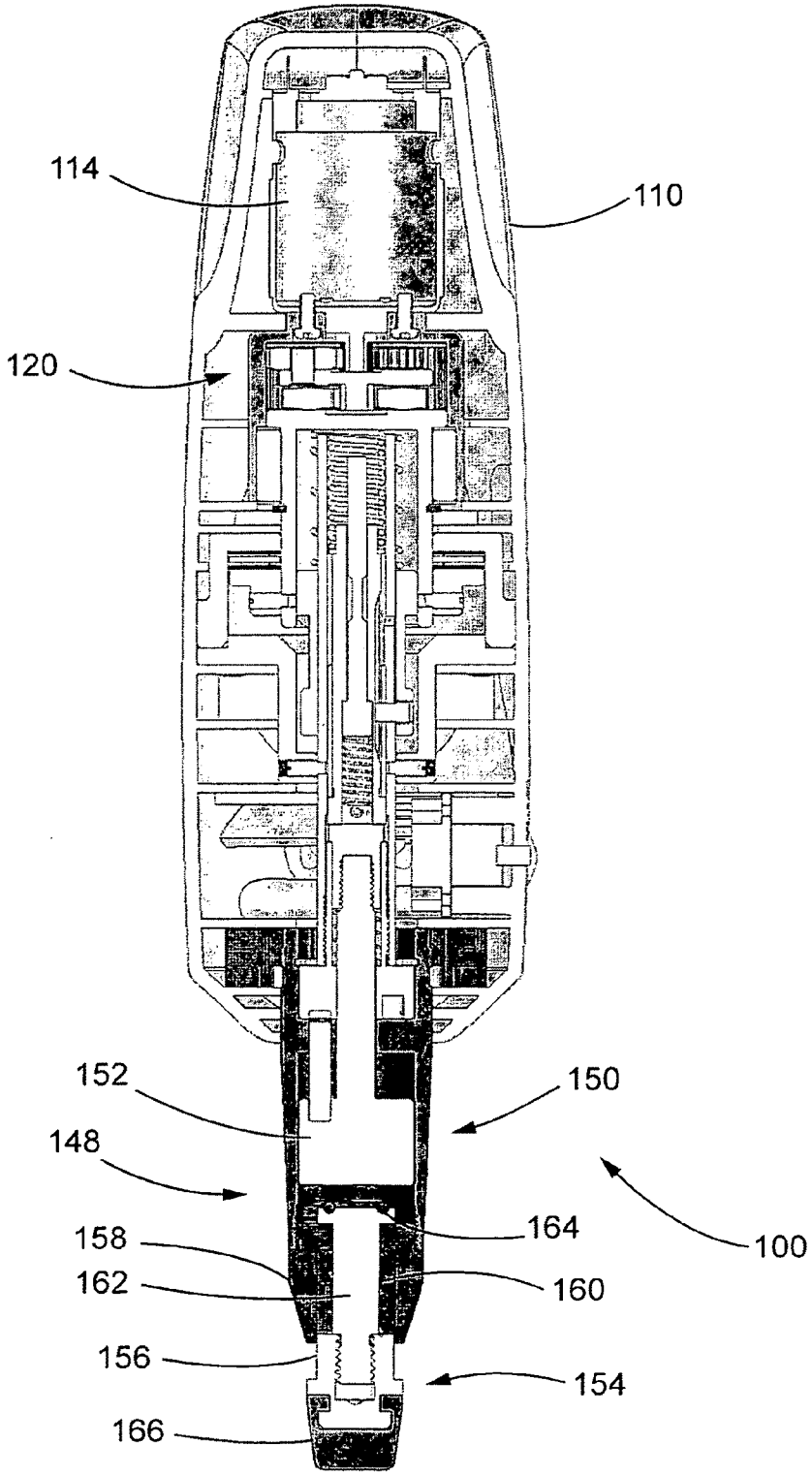


FIG. 8

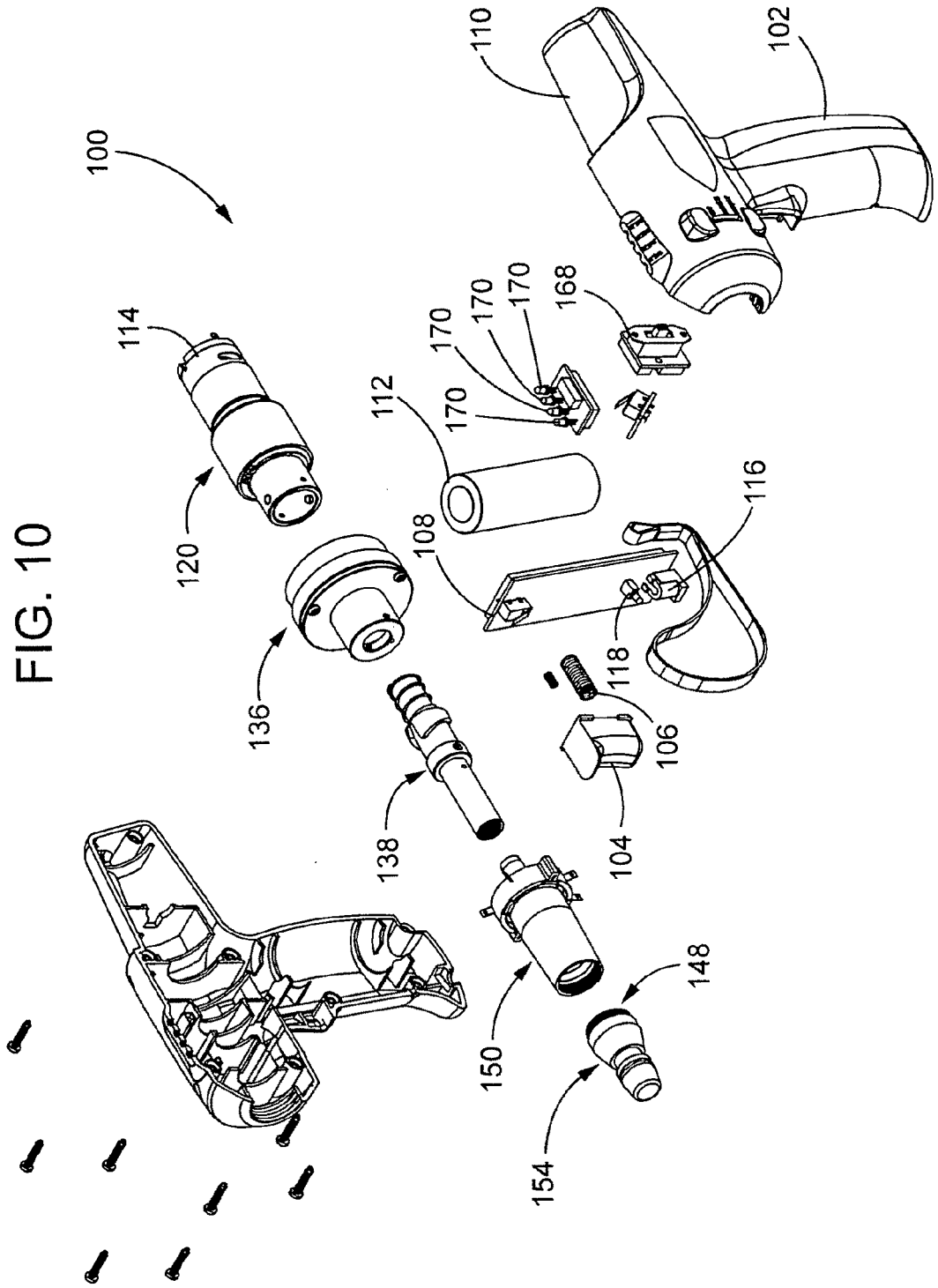
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FIG. 9



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FIG. 10



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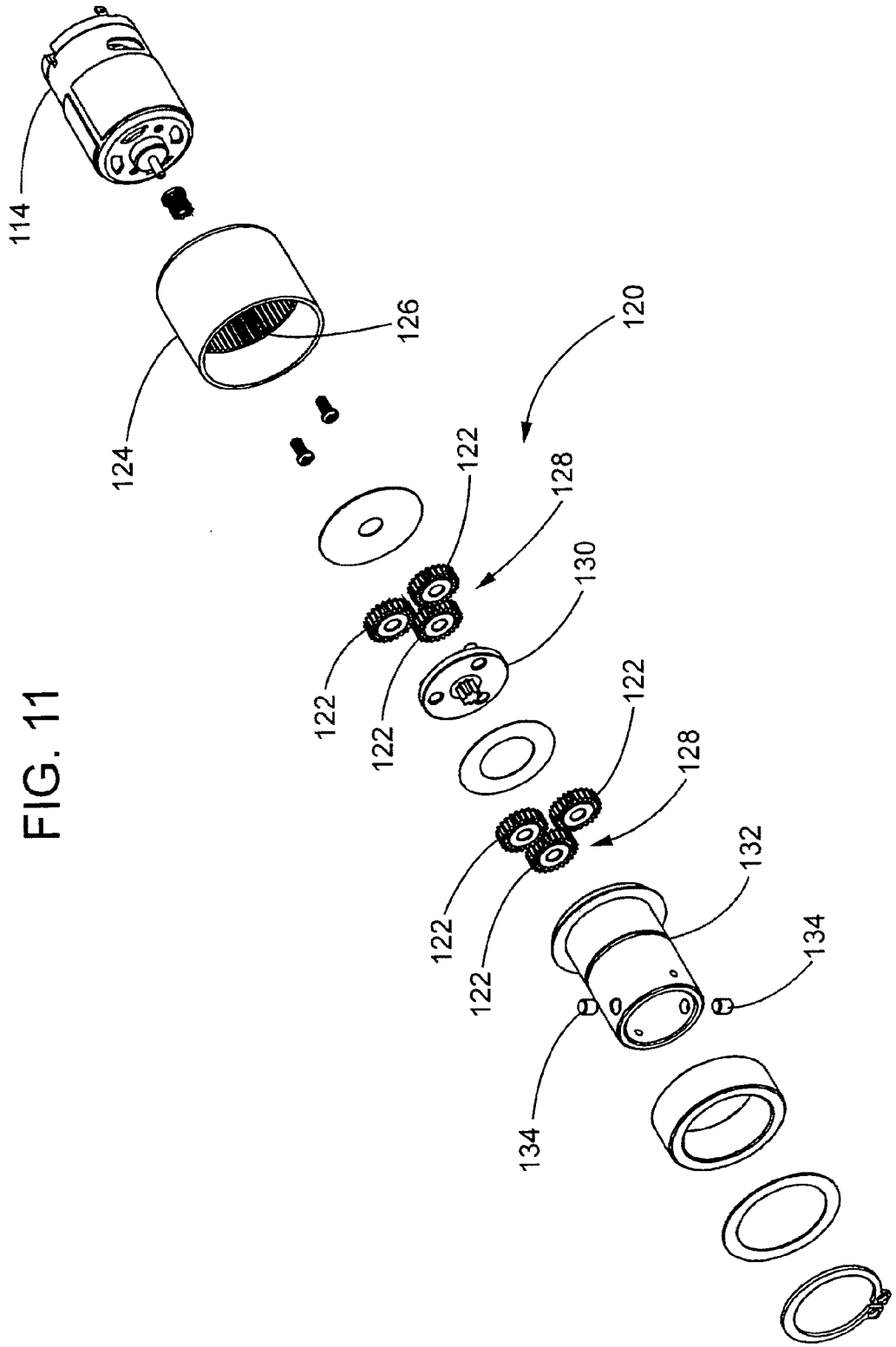


FIG. 11

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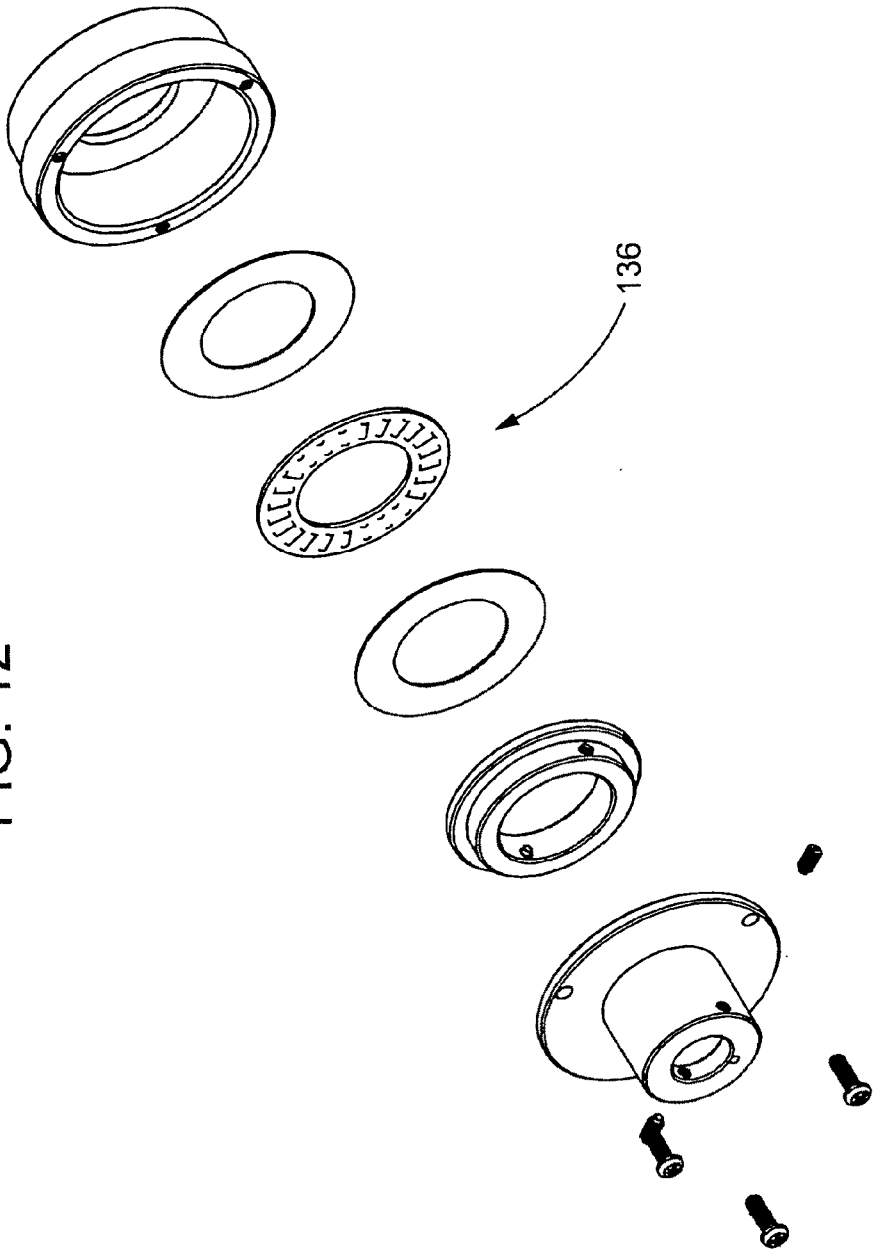


FIG. 12

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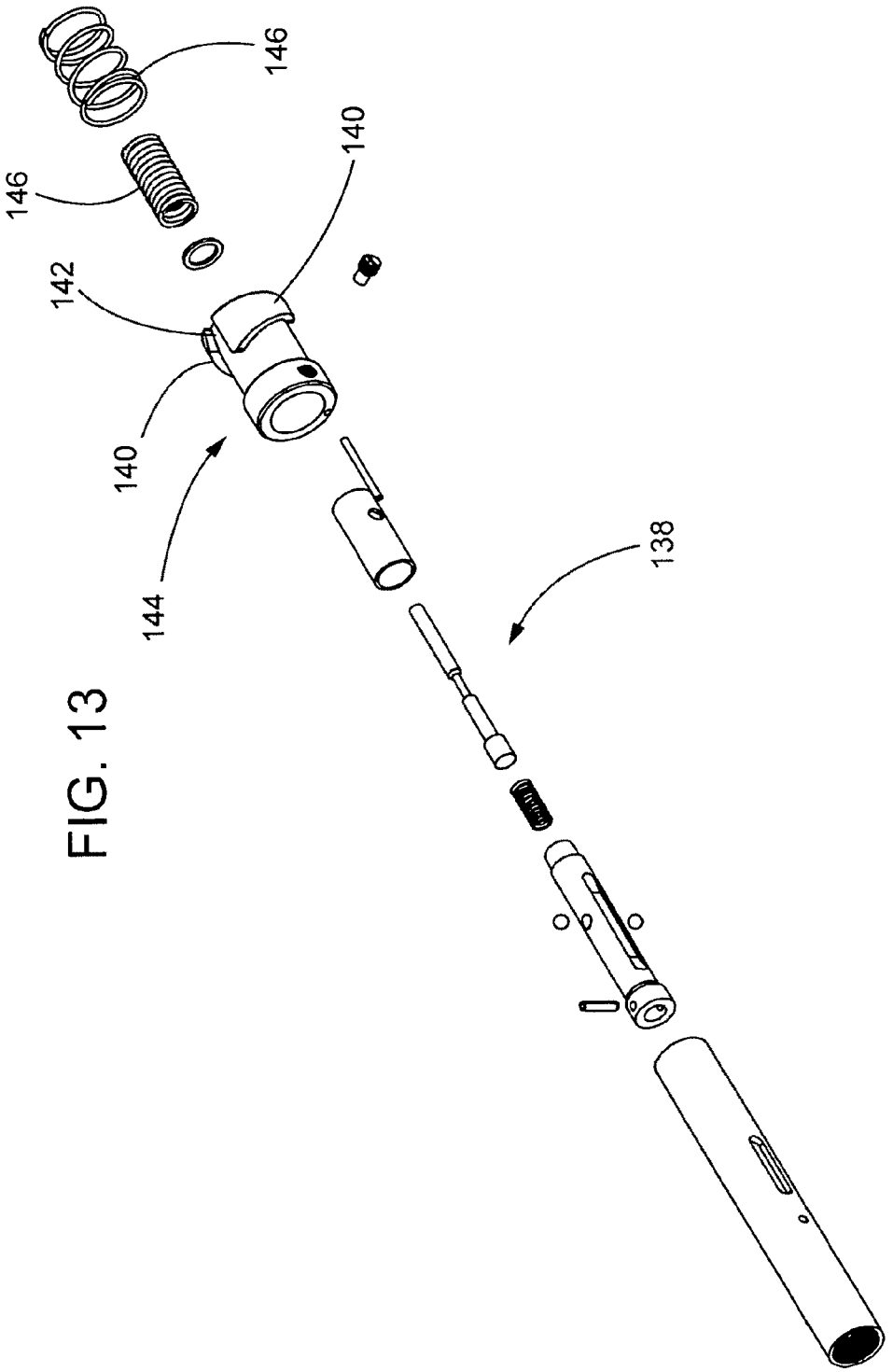


FIG. 13

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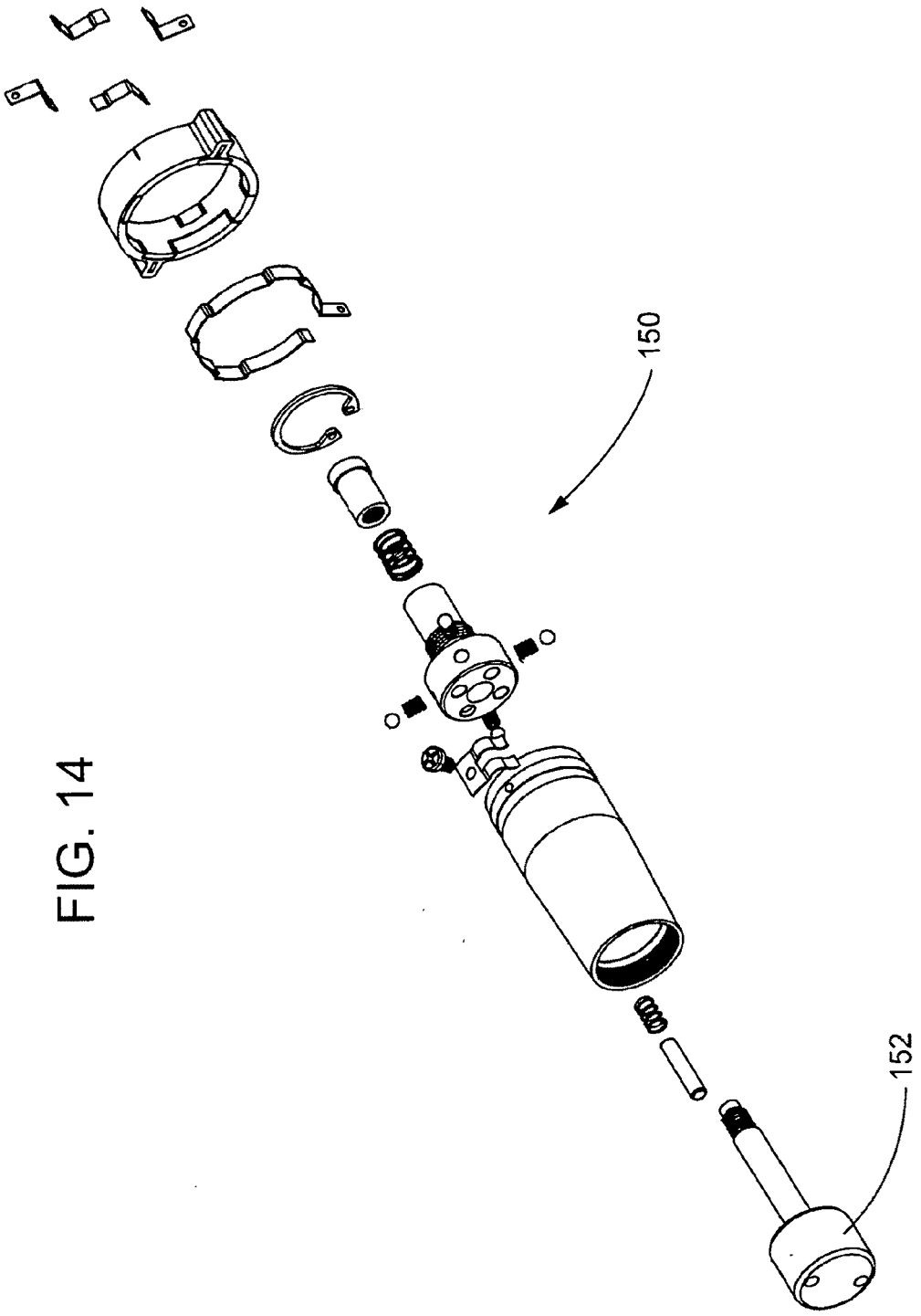
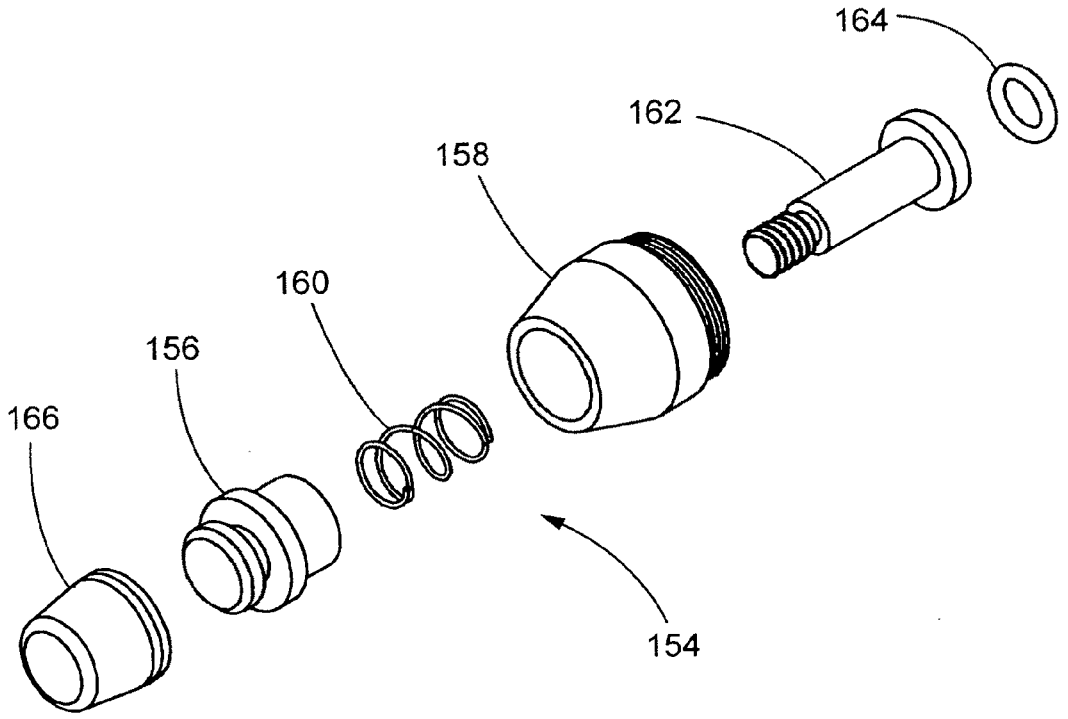


FIG. 14

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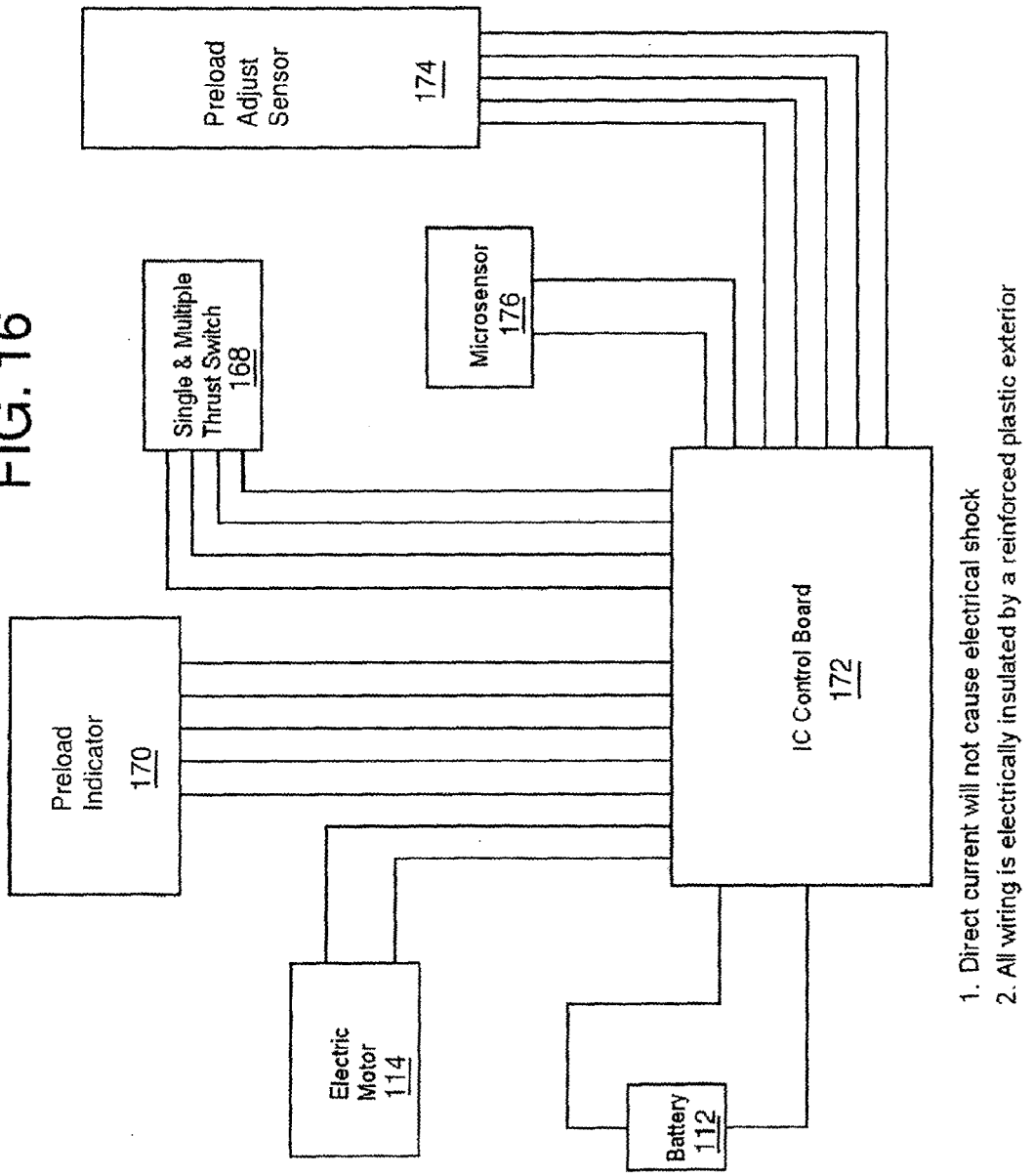
FIG. 15



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FIG. 16



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/008982

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61H 1/00 (2008.04)
USPC - 606/239
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - A61H 1/00, 5/00, 23/02, 39/04 (2008.04)
USPC - 601/46, 67, 68, 97, 101, 107, 108; 606/237-239

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 6,228,042 B1 (DUNGAN) 08 May 2001 (08.05.2001) entire document	1, 2, 4, 7-10 --- 3, 5, 6
Y	US 2006/0293711 A1 (KELLER et al) 28 December 2006 (28.12.2006) entire document	3, 5, 6
A	GB 2 275 196 A (CIRONE) 24 August 1994 (24.08.1994) entire document	1-10
A	US 2003/0195443 A1 (MILLER) 16 October 2003 (16.10.2003) entire document	1-10
A	US 2,078,159 A (REDDING) 20 April 1937 (20.04.1937) entire document	1-10

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 October 2008	27 OCT 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2005)

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(19) World Intellectual Property Organization
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(54) **Title:** MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH SELECTIVE APPLICATION OF ENERGY BASED ON BUTTON DISPLACEMENT, INTENSITY, OR LOCAL TISSUE CHARACTERIZATION

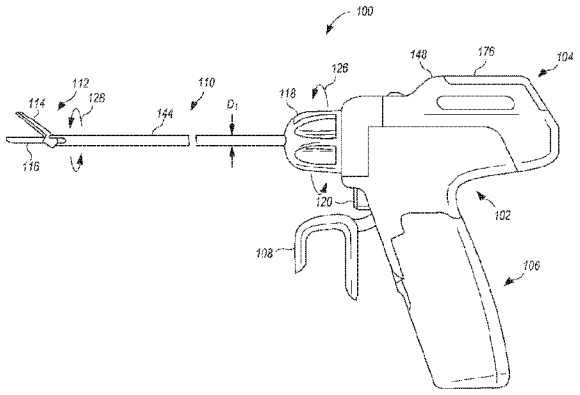


FIG. 1

(57) **Abstract:** A surgical instrument comprises a controller configured to control application of RF or ultrasonic energy at a low level when displacement or intensity of a button is above a first threshold but below a second threshold higher than the first threshold, and control application of RF or ultrasonic energy at a high level when the displacement or intensity exceeds the second threshold. In another aspect, a surgical instrument comprises a first sensor configured to measure a tissue characteristic at a first location, a second sensor configured to measure the tissue characteristic at a second location, and a controller configured to, based at least in part on the measured tissue characteristic at the first location and the second location, control application of RF or ultrasonic energy.

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MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH SELECTIVE APPLICATION OF ENERGY BASED ON BUTTON DISPLACEMENT, INTENSITY, OR LOCAL TISSUE CHARACTERIZATION

PRIORITY

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 62/279,635 filed January 15, 2016 and U.S. Provisional Application Serial No. 62/330,669, filed May 2, 2016, the contents of each of these provisional applications is incorporated herein by reference in their entirety.

BACKGROUND

[0002] The present disclosure is related generally to surgical instruments and associated surgical techniques. More particularly, the present disclosure is related to ultrasonic and electrosurgical systems that allow surgeons to perform cutting and coagulation and to adapt and customize such procedures based on the type of tissue being treated.

[0003] Ultrasonic surgical instruments are finding increasingly widespread applications in surgical procedures by virtue of the unique performance characteristics of such instruments. Depending upon specific instrument configurations and operational parameters, ultrasonic surgical instruments can provide simultaneous or near-simultaneous cutting of tissue and hemostasis by coagulation, desirably minimizing patient trauma. The cutting action is typically realized by an-end effector, or blade tip, at the distal end of the instrument, which transmits ultrasonic energy to tissue brought into contact with the end effector. Ultrasonic instruments of this nature can be configured for open surgical use, laparoscopic, or endoscopic surgical procedures including robotic-assisted procedures.

[0004] Some surgical instruments utilize ultrasonic energy for both precise cutting and controlled coagulation. Ultrasonic energy cuts and coagulates by vibrating a blade in contact with tissue. Vibrating at high frequencies (e.g., 55,500 times per second), the ultrasonic blade denatures protein in the tissue to form a sticky coagulum. Pressure exerted on tissue with the blade surface collapses blood vessels and allows the coagulum to form a hemostatic seal. The precision of cutting and coagulation is controlled by the surgeon's technique and adjusting the power level, blade edge, tissue traction, and blade pressure.

[0005] Electrosurgical instruments for applying electrical energy to tissue in order to treat and/or destroy the tissue are also finding increasingly widespread applications in surgical procedures. An electrosurgical instrument typically includes a hand piece, an instrument having

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a distally-mounted end effector *(e.g.,* one or more electrodes). The end effector can be positioned against the tissue such that electrical current is introduced into the tissue. Electrosurgical instruments can be configured for bipolar or monopolar operation. During bipolar operation, current is introduced into and returned from the tissue by active and return electrodes, respectively, of the end effector. During monopolar operation, current is introduced into the tissue by an active electrode of the end effector and returned through a return electrode *(e.g.,* a grounding pad) separately located on a patient's body. Heat generated by the current flowing through the tissue may form hemostatic seals within the tissue and/or between tissues and thus may be particularly useful for sealing blood vessels, for example. The end effector of an electrosurgical instrument also may include a cutting member that is movable relative to the tissue and the electrodes to transect the tissue.

[0006] Electrical energy applied by an electrosurgical instrument can be transmitted to the instrument by a generator in communication with the hand piece. The electrical energy may be in the form of radio frequency ("RF") energy. RF energy is a form of electrical energy that may be in the frequency range of 200 kilohertz (kHz) to 1 megahertz (MHz). In application, an electrosurgical instrument can transmit low frequency RF energy through tissue, which causes ionic agitation, or friction, in effect resistive heating, thereby increasing the temperature of the tissue. Because a sharp boundary is created between the affected tissue and the surrounding tissue, surgeons can operate with a high level of precision and control, without sacrificing un-targeted adjacent tissue. The low operating temperatures of RF energy is useful for removing, shrinking, or sculpting soft tissue while simultaneously sealing blood vessels. RF energy works particularly well on connective tissue, which is primarily comprised of collagen and shrinks when contacted by heat.

[0007] The RF energy may be in a frequency range described in EN 60601-2-2:2009+A1 1:201 1, Definition 201 .3.21 8 - HIGH FREQUENCY. For example, the frequency in monopolar RF applications may be typically restricted to less than 5MHz. However, in bipolar RF applications, the frequency can be almost anything. Frequencies above 200 kHz can be typically used for monopolar applications in order to avoid the unwanted stimulation of nerves and muscles that would result from the use of low frequency current. Lower frequencies may be used for bipolar applications if the risk analysis shows the possibility of neuromuscular stimulation has been mitigated to an acceptable level. Normally, frequencies above 5 MHz are not used in order to minimize the problems associated with high frequency leakage currents.

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Higher frequencies may, however, be used in the case of bipolar applications. It is generally recognized that 10 mA is the lower threshold of thermal effects on tissue.

[0008] A challenge of using these medical devices is the inability to fully control and customize the functions of the surgical instruments. It would be desirable to provide a surgical instrument that overcomes some of the deficiencies of current instruments.

SUMMARY

[0009] In one aspect, the present disclosure provides a surgical instrument comprising: a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position; a handle assembly coupled to a proximal end of the shaft, the handle assembly comprising a button configured to be displaced when pressed by a user; a battery assembly coupled to the handle assembly; a sensor configured to measure a displacement or intensity of the button; a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue; an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and a controller configured to: control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy at a low level when the displacement or intensity measured by the sensor is above a first threshold but below a second threshold higher than the first threshold, and control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy at a high level when the displacement or intensity measured by the sensor is above the second threshold.

[0010] In another aspect, the present disclosure provides a surgical instrument comprising: a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position; a handle assembly coupled to a proximal end of the shaft, the handle assembly comprising a button configured to be displaced when pressed by a user; a battery assembly coupled to the handle assembly; a sensor configured to measure a displacement or intensity of the button; a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue; an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and a controller configured to: control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy when the displacement or intensity

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measured by the sensor is above a first threshold but below a second threshold higher than the first threshold, and control the RF energy output to apply RF energy and control the ultrasonic energy output to apply ultrasonic energy when the displacement or intensity measured by the sensor is above the second threshold.

[0011] In another aspect, the present disclosure provides a surgical instrument comprising: a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position, wherein the first or second jaw comprising: a first sensor configured to measure a tissue characteristic at a first location, and a second sensor configured to measure the tissue characteristic at a second location; a handle assembly coupled to a proximal end of the shaft; a battery assembly coupled to the handle assembly; a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue; an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and a controller configured to, based at least in part on the measured tissue characteristic at the first location and the second location, control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy.

[0012] In addition to the foregoing, various other method and/or system and/or program product aspects are set forth and described in the teachings such as text (e.g., claims and/or detailed description) and/or drawings of the present disclosure.

[0013] The foregoing is a summary and thus may contain simplifications, generalizations, inclusions, and/or omissions of detail; consequently, those skilled in the art will appreciate that the summary is illustrative only and is NOT intended to be in any way limiting. Other aspects, features, and advantages of the devices and/or processes and/or other subject matter described herein will become apparent in the teachings set forth herein.

[0014] In one or more various aspects, related systems include but are not limited to circuitry and/or programming for effecting herein-referenced method aspects; the circuitry and/or programming can be virtually any combination of hardware, software, and/or firmware configured to affect the herein-referenced method aspects depending upon the design choices of the system designer. In addition to the foregoing, various other method and/or system aspects are set forth and described in the teachings such as text (e.g., claims and/or detailed description) and/or drawings of the present disclosure.

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[0015] Further, it is understood that any one or more of the following-described forms, expressions of forms, examples, can be combined with any one or more of the other following-described forms, expressions of forms, and examples.

[0016] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, and features described above, further aspects, and features will become apparent by reference to the drawings and the following detailed description.

FIGURES

[0017] The novel features of the various aspects described herein are set forth with particularity in the appended claims. The various aspects, however, both as to organization and methods of operation may be better understood by reference to the following description, taken in conjunction with the accompanying drawings as follows:

[0018] FIG. 1 is a diagram of a modular battery powered handheld ultrasonic surgical instrument, according to an aspect of the present disclosure.

[0019] FIG. 2 is an exploded view of the surgical instrument shown in FIG. 1, according to an aspect of the present disclosure.

[0020] FIG. 3 is an exploded view of a modular shaft assembly of the surgical instrument shown in FIG. 1, according to aspect of the present disclosure.

[0021] FIG. **4** is a perspective transparent view of the ultrasonic transducer/generator assembly of the surgical instrument shown in FIG. 1, according to aspect of the present disclosure.

[0022] FIG. 5 is an end view of the ultrasonic transducer/generator assembly, according to aspect of the present disclosure.

[0023] FIG. 6 is a perspective view of the ultrasonic transducer/generator assembly with the top housing portion removed to expose the ultrasonic generator, according to aspect of the present disclosure.

[0024] FIG. 7 is a sectional view of the of the ultrasonic transducer/generator assembly, according to aspect of the present disclosure.

[0025] FIG. 8 is an elevation view of an ultrasonic transducer/generator assembly that is configured to operate at 31 kHz resonant frequency, according to one aspect of the present disclosure.

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[0026] FIG. **9** is an elevation view of an ultrasonic transducer/generator assembly that is configured to operate at 55 kHz resonant frequency, according to one aspect of the present disclosure.

[0027] FIGS. 10A and 10B illustrate a shifting assembly that selectively rotates the ultrasonic transmission waveguide with respect to the ultrasonic transducer and urges them towards one another, according to one aspect of the present disclosure.

[0028] FIG. 11 is a schematic diagram of one aspect of an ultrasonic drive circuit shown in FIG. 4 suitable for driving an ultrasonic transducer, according to one aspect of the present disclosure.

[0029] FIG. 12 is a schematic diagram of the transformer coupled to the ultrasonic drive circuit shown in FIG. 11, according to one aspect of the present disclosure.

[0030] FIG. 13 is a schematic diagram of the transformer shown in FIG. 12 coupled to a test circuit, according to one aspect of the present disclosure.

[0031] FIG. 14 is a schematic diagram of a control circuit, according to one aspect f the present disclosure.

[0032] FIG. 15 shows a simplified block circuit diagram illustrating another electrical circuit contained within a modular ultrasonic surgical instrument, according to one aspect of the present disclosure.

[0033] FIG. 16 shows a battery assembly for use with the surgical instrument, according to one aspect of the present disclosure.

[0034] FIG. 17 shows a disposable battery assembly for use with the surgical instrument, according to one aspect of the present disclosure.

[0035] FIG. 18 shows a reusable battery assembly for use with the surgical instrument, according to one aspect of the present disclosure.

[0036] FIG. **19** is an elevated perspective view of a battery assembly with both halves of the housing shell removed exposing battery cells coupled to multiple circuit boards which are coupled to the multi-lead battery terminal in accordance with one aspect of the present disclosure.

[0037] FIG. 20 illustrates a battery test circuit, according to one aspect of the present disclosure.

[0038] FIG. 21 illustrates a supplemental power source circuit to maintain a minimum output voltage, according to one aspect of the present disclosure.

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[0039] FIG. 22 illustrates a switch mode power supply circuit for supplying energy to the surgical instrument, according to one aspect of the present disclosure.

[0040] FIG. 23 illustrates a discrete version of the switching regulator shown in FIG. 22 for supplying energy to the surgical instrument, according to one aspect of the present disclosure.

[0041] FIG. 24 illustrates a linear power supply circuit for supplying energy to the surgical instrument, according to one aspect of the present disclosure.

[0042] FIG. 25 is an elevational exploded view of modular handheld ultrasonic surgical instrument showing the left shell half removed from a handle assembly exposing a device identifier communicatively coupled to the multi-lead handle terminal assembly in accordance with one aspect of the present disclosure.

[0043] FIG. 26 is a detail view of a trigger portion and switch of the ultrasonic surgical instrument shown in FIG. 25, according to one aspect of the present disclosure.

[0044] FIG. 27 is a fragmentary, enlarged perspective view of an end effector from a distal end with a jaw member in an open position, according to one aspect of the present disclosure.

[0045] FIG. 28 illustrates a modular shaft assembly and end effector portions of the surgical instrument, according to one aspect of the present disclosure.

[0046] FIG. 29 is a detail view of an inner tube/spring assembly, according to one aspect of the present disclosure.

[0047] FIG. 30 illustrates a modular battery powered handheld combination ultrasonic/electrosurgical instrument, according to one aspect of the present disclosure.

[0048] FIG. 31 is an exploded view of the surgical instrument shown in FIG. 30, according to one aspect of the present disclosure.

[0049] FIG. 32 is a partial perspective view of a modular battery powered handheld combination ultrasonic/RF surgical instrument, according to one aspect of the present disclosure.

[0050] FIG. 33 illustrates a nozzle portion of the surgical instruments described in connection with FIGS. 30-32, according to one aspect of the present disclosure.

[0051] FIG. 34 is a schematic diagram of one aspect of a drive circuit configured for driving a high-frequency current (RF), according to one aspect of the present disclosure.

[0052] FIG. 35 is a schematic diagram of the transformer coupled to the RF drive circuit shown in FIG. 34, according to one aspect of the present disclosure.

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[0053] FIG. 36 is a schematic diagram of a circuit comprising separate power sources for high power energy/drive circuits and low power circuits, according to one aspect of the resent disclosure.

[0054] FIG. 37 illustrates a control circuit that allows a dual generator system to switch between the RF generator and the ultrasonic generator energy modalities for the surgical instrument shown in FIGS. 30 and 31.

[0055] FIG. 38 is a sectional view of an end effector, according to one aspect of the present disclosure.

[0056] FIG. 39 is a sectional view of an end effector, according to one aspect of the present disclosure.

[0057] FIG. 40 is a partial longitudinal sectional side view showing a distal jaw section in a closed state, according to one aspect of the present disclosure.

[0058] FIG. 41 is a partial longitudinal sectional side view showing the distal jaw section in an open state, according to one aspect of the present disclosure.

[0059] FIG. 42 is a partial longitudinal sectional side view showing a jaw member, according to one aspect of the present disclosure.

[0060] FIG. 43 is a cross-sectional view showing the distal jaw section in a normal state, according to one aspect of the present disclosure.

[0061] FIG. 44 is a cross-sectional view showing the distal jaw section in a worn state, according to one aspect of the present disclosure.

[0062] FIG. 45 illustrates a modular battery powered handheld electrosurgical instrument with distal articulation, according to one aspect of the present disclosure.

[0063] FIG. 46 is an exploded view of the surgical instrument shown in FIG. 45, according to one aspect of the present disclosure.

[0064] FIG. 47 is a perspective view of the surgical instrument shown in FIGS. 45 and 46 with a display located on the handle assembly, according to one aspect of the present disclosure.

[0065] FIG. 48 is a perspective view of the instrument shown in FIGS. 45 and 46 without a display located on the handle assembly, according to one aspect of the present disclosure.

[0066] FIG. 49 is a motor assembly that can be used with the surgical instrument to drive the knife, according to one aspect of the present disclosure.

[0067] FIG. 50 is diagram of a motor drive circuit, according to one aspect of the present disclosure.

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[0068] FIG. 51 illustrates a rotary drive mechanism to drive distal head rotation, articulation, and jaw closure, according to one aspect of the present disclosure.

[0069] FIG. 52 is an enlarged, left perspective view of an end effector assembly with the jaw members shown in an open configuration, according to one aspect of the present disclosure.

[0070] FIG. 53 is an enlarged, right side view of the end effector assembly of FIG. 52, according to one aspect of the present disclosure.

[0071] FIG. 54 illustrates a modular battery powered handheld electrosurgical instrument with distal articulation, according to one aspect of the present disclosure.

[0072] FIG. 55 is an exploded view of the surgical instrument shown in FIG. 54, according to one aspect of the present disclosure.

[0073] FIG. 56 is an enlarged area detail view of an articulation section illustrated in FIG. 54 including electrical connections, according to one aspect of the present disclosure.

[0074] FIG. 57 is an enlarged area detail view articulation section illustrated in FIG. 56 including electrical connections, according to one aspect of the present disclosure.

[0075] FIG. 58 illustrates a perspective view of components of the shaft assembly, end effector, and cutting member of the surgical instrument of FIG. 54, according to one aspect of the present disclosure.

[0076] FIG. 59 illustrates the articulation section in a second stage of articulation, according to one aspect of the present disclosure.

[0077] FIG. 60 illustrates a perspective view of the end effector of the device of FIGS. 54-59 in an open configuration, according to one aspect of the present disclosure.

[0078] FIG. 61 illustrates a cross-sectional end view of the end effector of FIG. 60 in a closed configuration and with the blade in a distal position, according to one aspect to the present disclosure.

[0079] FIG. 62 illustrates the components of a control circuit of the surgical instrument, according to one aspect of the present disclosure.

[0080] FIG. 63 is a system diagram of a segmented circuit comprising a plurality of independently operated circuit segments, according to one aspect of the present disclosure. FIG. 63 is a diagram of one form of a direct digital synthesis circuit.

[0081] FIG. 64 illustrates a diagram of one aspect of a surgical instrument comprising a feedback system for use with any one of the surgical instruments described herein in connection with FIGS. 1-61, which may include or implement many of the features described herein

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[0082] FIG. 65 illustrates one aspect of a fundamental architecture for a digital synthesis circuit such as a direct digital synthesis (DDS) circuit configured to generate a plurality of wave shapes for the electrical signal waveform for use in any of the surgical instruments described herein in connection with FIGS. 1-61, according to one aspect of the present disclosure.

[0083] FIG. 66 illustrates one aspect of direct digital synthesis (DDS) circuit configured to generate a plurality of wave shapes for the electrical signal waveform for use in any of the surgical instruments described herein in connection with FIGS. 1-61, according to one aspect of the present disclosure.

[0084] FIG. 67 illustrates one cycle of a discrete time digital electrical signal waveform, according to one aspect of the present disclosure of an analog waveform (shown superimposed over a discrete time digital electrical signal waveform for comparison purposes), according to one aspect of the present disclosure.

[0085] FIG. 68A illustrates a circuit comprising a controller comprising one or more processors coupled to at least one memory circuit for use in any of the surgical instruments described herein in connection with FIGS. 1-61 , according to one aspect of the present disclosure.

[0086] FIG. 68B illustrates a circuit comprising a finite state machine comprising a combinational logic circuit configured to implement any of the algorithms, processes, or techniques described herein, according to one aspect of the present disclosure.

[0087] FIG. 68C illustrates a circuit comprising a finite state machine comprising a sequential logic circuit configured to implement any of the algorithms, processes, or techniques described herein, according to one aspect of the present disclosure.

[0088] FIG. 69 is a circuit diagram of various components of a surgical instrument with motor control functions, according to one aspect of the present disclosure.

[0089] FIG. 70 illustrates a handle assembly with a removable service panel removed to shown internal components of the handle assembly, according to one aspect of the present disclosure.

[0090] FIG. 71 is a graphical representation of determining wait time based on tissue thickness, according to aspects of the present disclosure.

[0091] FIG. 72 is a force versus time graph for thin, medium, and thick tissue types, according to aspects of the present disclosure.

[0092] FIG. 73 is a graph of motor current versus time for different tissue types, according to aspects of the present disclosure.

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[0093] FIG. 74 is a graphical depiction of impedance bath tub, according to aspects of the present disclosure.

[0094] FIG. 75 is a graph depicting one aspect of adjustment of energy switching threshold due to the measurement of a secondary tissue parameter, according to aspects of the present disclosure.

[0095] FIG. 76 is a diagram of a process illustrating selective application of radio frequency or ultrasonic treatment energy based on measured tissue characteristics, according to aspects of the present disclosure.

[0096] FIG. 77 is a graph depicting a relationship between trigger button displacement and sensor output, according to aspects of the present disclosure.

[0097] FIG. 78 is a graph depicting an abnormal relationship between trigger button displacement and sensor output, according to aspects of the present disclosure.

[0098] FIG. 79 is a graph depicting an acceptable relationship between trigger button displacement and sensor output, according to aspects of the present disclosure.;

[0099] FIG. 80 illustrates one aspect of a left-right segmented flexible circuit, according to aspects of the present disclosure.

[0100] FIG. 81 is a cross-sectional view of one aspect of a flexible circuit comprising RF electrodes and data sensors embedded therein, according to aspects of the present disclosure.

[0101] FIG. 82 is a cross sectional view of an end effector comprising a jaw member, a flexible circuit, and a segmented electrode, according to one aspect of the present disclosure.

[0102] FIG. 83 is a detailed view of the end effector shown in FIG. 82, according to one aspect of the present disclosure.

[0103] FIG. 84A is a cross sectional view of an end effector comprising a rotatable jaw member, a flexible circuit, and an ultrasonic blade positioned in a vertical orientation relative to the jaw member with no tissue located between the jaw member and the ultrasonic blade, according to one aspect of the present disclosure.

[0104] FIG. 84B is a cross sectional view of the end effector shown in FIG. 84A with tissue located between the jaw member and the ultrasonic blade, according to one aspect of the present disclosure.

[0105] FIG. 85A is a cross sectional view of the effector shown in FIGS. 84A and 84B with the ultrasonic blade positioned in a horizontal orientation relative to the jaw member with no tissue located between the jaw member and the ultrasonic blade, according to one aspect of the present disclosure.

[0106] FIG. 85B is a cross sectional view of the end effector shown in FIG. 85A with tissue located between the jaw member and the ultrasonic blade, according to one aspect of the present disclosure.

[0107] FIG. 86 illustrates one aspect of an end effector comprising RF data sensors located on the jaw member, according to one aspect of the present disclosure.

[0108] FIG. 87 illustrates one aspect of the flexible circuit shown in FIG. 86 in which the sensors may be mounted to or formed integrally therewith, according to one aspect of the present disclosure.

[0109] FIG. 88 is a cross-sectional view of the flexible circuit shown in FIG. 87, according to one aspect of the present disclosure.

[01 10] FIG. 89 illustrates one aspect of a segmented flexible circuit configured to fixedly attach to a jaw member of an end effector, according to one aspect of the present disclosure.

[01 11] FIG. 90 illustrates one aspect of a segmented flexible circuit configured to mount to a jaw member of an end effector, according to one aspect of the present disclosure.

[0112] FIG. 91 illustrates one aspect of an end effector configured to measure a tissue gap G_T, according to one aspect of the present disclosure.

[01 13] FIG. 92 illustrates one aspect of an end effector comprising segmented flexible circuit, according to one aspect of the present disclosure.

[01 14] FIG. 93 illustrates the end effector shown in FIG. 92 with the jaw member clamping tissue between the jaw member and the ultrasonic blade, according to one aspect of the present disclosure.

[01 15] FIG. 94 illustrates graphs of energy applied by the right and left side of an end effector based on locally sensed tissue parameters, according to one aspect of the present disclosure.

[01 16] FIG. 95 is a cross-sectional view of one aspect of an end effector configured to sense force or pressure applied to tissue located between a jaw member and an ultrasonic blade, according to one aspect of the present disclosure.

[01 17] FIG. 96 is a schematic diagram of one aspect of a signal layer of a flexible circuit, according to one aspect of the present disclosure.

[0118] FIG. 97 is a schematic diagram of sensor wiring for the flexible circuit shown in FIG. 96, according to one aspect of the present disclosure.

[0119] FIG. 98A is a graphical representation of one aspect of a medical device surrounding tissue, according to one aspect of the present disclosure.

[01 20] FIG. 98B is a graphical representation of one aspect of a medical device compressing

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tissue, according to one aspect of the present disclosure.

[0121] FIG. 99A is a graphical representation of one aspect of a medical device compressing tissue, according to one aspect of the present disclosure.

[0122] FIG. 99B also depicts example forces exerted by one aspect of an end-effector of a medical device compressing tissue, according to one aspect of the present disclosure.

[0123] FIG. 100 illustrates a logic diagram of one aspect of a feedback system, according to one aspect of the present disclosure.

DESCRIPTION

[0124] This application is related to following commonly owned patent applications filed concurrently herewith, the content of each of which is incorporated herein by reference in its entirety:

[0125] Attorney Docket No. END791 1USNP/160006, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT AND METHODS THEREFOR, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0126] Attorney Docket No. END791 1USNP1/160006-1 , titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH SELECTIVE APPLICATION OF ENERGY BASED ON TISSUE CHARACTERIZATION, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0127] Attorney Docket No. END791 1USNP3/1 60006-3, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH VARIABLE MOTOR CONTROL LIMITS, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0128] Attorney Docket No. END791 1USNP4/1 60006-4, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH MOTOR CONTROL LIMIT PROFILE, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0129] Attorney Docket No. END791 1USNP5/1 60006-5, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH MOTOR CONTROL LIMITS BASED ON TISSUE CHARACTERIZATION, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0130] Attorney Docket No. END791 1USNP6/1 60006-6, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH MULTI-FUNCTION MOTOR VIA SHIFTING GEAR ASSEMBLY, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

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[0131] Attorney Docket No. END7911USNP7/160006-7, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH A PLURALITY OF CONTROL PROGRAMS, by inventor Frederick E. Shelton, IV, filed December 16, 2016.

[0132] Attorney Docket No. END7911USNP8/160006-8, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH ENERGY CONSERVATION TECHNIQUES, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0133] Attorney Docket No. END7911USNP9/160006-9, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH VOLTAGE SAG RESISTANT BATTERY PACK, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0134] Attorney Docket No. END7911USNP10/160006-10, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH MULTISTAGE GENERATOR CIRCUITS, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0135] Attorney Docket No. END7911USNP11/160006-11, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH MULTIPLE MAGNETIC POSITION SENSORS, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0136] Attorney Docket No. END7911USNP12/160006-12, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT CONTAINING ELONGATED MULTI-LAYERED SHAFT, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0137] Attorney Docket No. END7911USNP13/160006-13, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH MOTOR DRIVE, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0138] Attorney Docket No. END7911USNP14/160006-14, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH SELF-DIAGNOSING CONTROL SWITCHES FOR REUSABLE HANDLE ASSEMBLY, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0139] Attorney Docket No. END7911USNP15/160006-15, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH REUSABLE ASYMMETRIC HANDLE HOUSING, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

[0140] Attorney Docket No. END7911USNP16/160006-16, titled MODULAR BATTERY POWERED HANDHELD SURGICAL INSTRUMENT WITH CURVED END EFFECTORS HAVING ASYMMETRIC ENGAGEMENT BETWEEN JAW AND BLADE, by inventors Frederick E. Shelton, IV, et al., filed December 16, 2016.

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[0141] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols and reference characters typically identify similar components throughout the several views, unless context dictates otherwise. The illustrative aspects described in the detailed description, drawings, and claims are not meant to be limiting. Other aspects may be utilized, and other changes may be made, without departing from the scope of the subject matter presented here.

[0142] Before explaining the various aspects of the present disclosure in detail, it should be noted that the various aspects disclosed herein are not limited in their application or use to the details of construction and arrangement of parts illustrated in the accompanying drawings and description. Rather, the disclosed aspects may be positioned or incorporated in other aspects, variations and modifications thereof, and may be practiced or carried out in various ways. Accordingly, aspects disclosed herein are illustrative in nature and are not meant to limit the scope or application thereof. Furthermore, unless otherwise indicated, the terms and expressions employed herein have been chosen for the purpose of describing the aspects for the convenience of the reader and are not to limit the scope thereof. In addition, it should be understood that any one or more of the disclosed aspects, expressions of aspects, and/or examples thereof, can be combined with any one or more of the other disclosed aspects, expressions of aspects, and/or examples thereof, without limitation.

[0143] Also, in the following description, it is to be understood that terms such as front, back, inside, outside, top, bottom and the like are words of convenience and are not to be construed as limiting terms. Terminology used herein is not meant to be limiting insofar as devices described herein, or portions thereof, may be attached or utilized in other orientations. The various aspects will be described in more detail with reference to the drawings.

[0144] In various aspects, the present disclosure is directed to a mixed energy surgical instrument that utilizes both ultrasonic and RF energy modalities. The mixed energy surgical instrument my use modular shafts using that accomplish existing end-effector functions such as ultrasonic functions disclosed in U.S. Patent No. 9,107,690, which is incorporated herein by reference in its entirety, combination device functions disclosed in U.S. Patent Nos. 8,696,666 and 8,663,223, which are both incorporated herein by reference in their entireties, RF opposed electrode functions disclosed in U.S. Patent Nos. 9,028,478 and 9,113,907, which are both incorporated herein by reference in their entireties, and RF I-blade offset electrode functions as disclosed in U.S. Patent Application Publication No. 2013/0023868, which is incorporated herein by reference in its entirety.

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[0145] In various aspects, the present disclosure is directed to a modular battery powered handheld ultrasonic surgical instrument comprising a first generator, a second generator, and a control circuit for controlling the energy modality applied by the surgical instrument. The surgical instrument is configured to apply at least one energy modality that comprises an ultrasonic energy modality, a radio frequency (RF) energy modality, or a combination ultrasonic and RF energy modalities.

[0146] In another aspect, the present disclosure is directed to a modular battery powered handheld surgical instrument that can be configured for ultrasonic energy modality, RF modality, or a combination of ultrasonic and RF energy modalities. A mixed energy surgical instrument utilizes both ultrasonic and RF energy modalities. The mixed energy surgical instrument may use modular shafts that accomplish end effector functions. The energy modality may be selectable based on a measure of specific measured tissue and device parameters, such as, for example, electrical impedance, tissue impedance, electric motor current, jaw gap, tissue thickness, tissue compression, tissue type, temperature, among other parameters, or a combination thereof, to determine a suitable energy modality algorithm to employ ultrasonic vibration and/or electrosurgical high-frequency current to carry out surgical coagulation/cutting treatments on the living tissue based on the measured tissue parameters identified by the surgical instrument. Once the tissue parameters have been identified, the surgical instrument may be configured to control treatment energy applied to the tissue in a single or segmented RF electrode configuration or in an ultrasonic device, through the measurement of specific tissue/device parameters. Tissue treatment algorithms are described in commonly owned U.S. Pat. App. No. 15/177,430, titled SURGICAL INSTRUMENT WITH USER ADAPTABLE TECHNIQUES, which is herein incorporated by reference in its entirety.

[0147] In another aspect, the present disclosure is directed to a modular battery powered handheld surgical instrument having a motor and a controller, where a first limiting threshold is used on the motor for the purpose of attaching a modular assembly and a second threshold is used on the motor and is associated with a second assembly step or functionality of the surgical instrument. The surgical instrument may comprise a motor driven actuation mechanism utilizing control of motor speed or torque through measurement of motor current or parameters related to motor current, wherein motor control is adjusted via a non-linear threshold to trigger motor adjustments at different magnitudes based on position, inertia, velocity, acceleration, or a combination thereof. Motor driven actuation of a moving mechanism and a motor controller may be employed to control the motor velocity or torque. A sensor associated with physical

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properties of the moving mechanism provides feedback to the motor controller. In one aspect, the sensor is employed to adjust a predefined threshold which triggers a change in the operation of the motor controller. A motor may be utilized to drive shaft functions such as shaft rotation and jaw closure and switching that motor to also provide a torque limited waveguide attachment to a transducer. A motor control algorithm may be utilized to generate tactile feedback to a user through a motor drive train for indication of device status and/or limits of the powered actuation. A motor powered modular advanced energy based surgical instrument may comprise a series of control programs or algorithms to operate a series of different shaft modules and transducers. In one aspect, the programs or algorithms reside in a module and are uploaded to a control handle when attached. The motor driven modular battery powered handheld surgical instrument may comprise a primary rotary drive capable of being selectably coupleable to at least two independent actuation functions (first, second, both, neither) and utilize a clutch mechanism located in a distal modular elongated tube.

[0148] In another aspect, the present disclosure is directed to modular battery powered handheld surgical instrument comprising energy conservation circuits and techniques using sleep mode de-energizing of a segmented circuit with short cuts to minimize non-use power drain and differing wake-up sequence order than the order of a sleep sequence. A disposable primary cell battery pack may be utilized with a battery powered modular handheld surgical instrument. The disposable primary cell may comprise power management circuits to compensate the battery output voltage with additional voltage to offset voltage sags under load and to prevent the battery pack output voltage from sagging below a predetermined level during operation under load. The circuitry of the surgical instrument comprises radiation tolerant components and amplification of electrical signals may be divided into multiple stages. An ultrasonic transducer housing or RF housing may contain the final amplification stage and may comprise different ratios depending on an energy modality associated with the ultrasonic transducer or RF module.

[0149] In another aspect, the present disclosure is directed to a modular battery powered handheld surgical instrument comprising multiple magnetic position sensors along a length of a shaft and paired in different configurations to allow multiple sensors to detect the same magnet in order to determine three dimensional position of actuation components of the shaft from a stationary reference plane and simultaneously diagnosing any error from external sources. Control and sensing electronics may be incorporated in the shaft. A portion of the shaft control electronics may be disposed along the inside of moving shaft components and are separated

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from other shaft control electronics that are disposed along the outside of the moving shaft components. Control and sensing electronics may be situated and designed such that they act as a shaft seal in the device.

[0150] In another aspect, the present disclosure is directed to a modular battery powered handheld surgical instrument comprising self diagnosing control switches within a battery powered, modular, reusable handle. The control switches are capable of adjusting their thresholds for triggering an event as well as being able to indicate external influences on the controls or predict time till replacement needed. The reusable handle housing is configured for use with modular disposable shafts and at least one control and wiring harness. The handle is configured to asymmetrically part when opened so that the switches, wiring harness, and/or control electronics can be supportably housed in one side such that the other side is removably attached to cover the primary housing.

[0151] FIG. 1 is a diagram of a modular battery powered handheld ultrasonic surgical instrument 100, according to an aspect of the present disclosure. FIG. 2 is an exploded view of the surgical instrument 100 shown in FIG. 1, according to an aspect of the present disclosure. With reference now to FIGS. 1 and 2, the surgical instrument 100 comprises a handle assembly 102, an ultrasonic transducer/generator assembly 104, a battery assembly 106, a shaft assembly 110, and an end effector 112. The ultrasonic transducer/generator assembly 104, battery assembly 106, and shaft assembly 110 are modular components that are removably connectable to the handle assembly 102. The handle assembly 102 comprises a motor assembly 160. In addition, some aspects of the surgical instrument 100 include battery assemblies 106 that contain the ultrasonic generator and motor control circuits. The battery assembly 106 includes a first stage generator function with a final stage existing as part of the ultrasonic transducer/generator assembly 104 for driving 55 kHz and 33.1 Khz ultrasonic transducers. A different final stage generator for interchangeable use with the battery assembly 106, common generator components, and segmented circuits enable battery assembly 106 to power up sections of the drive circuits in a controlled manner and to enable checking of stages of the circuit before powering them up and enabling power management modes. In addition, general purpose controls may be provide in the handle assembly 102 with dedicated shaft assembly 110 controls located on the shafts that have those functions. For instance, an end effector 112 module may comprise distal rotation electronics, the shaft assembly 110 may comprise rotary shaft control along with articulation switches, and the handle assembly 102 may

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comprise energy activation controls and jaw member 114 trigger 108 controls to clamp and unclamp the end effector 112.

[0152] The ultrasonic transducer/generator assembly 104 comprises a housing 148, a display 176, such as a liquid crystal display (LCD), for example, an ultrasonic transducer 130, and an ultrasonic generator 162 (FIG. 4). The shaft assembly 110 comprises an outer tube 144 an ultrasonic transmission waveguide 145, and an inner tube (not shown). The end effector 112 comprises a jaw member 114 and an ultrasonic blade 116. As described hereinbelow, a motor or other mechanism operated by the trigger 108 may be employed to close the jaw member 114. The ultrasonic blade 116 is the distal end of the ultrasonic transmission waveguide 145. The jaw member 114 is pivotally rotatable to grasp tissue between the jaw member and the ultrasonic blade 116. The jaw member 114 is operably coupled to a trigger 108 such that when the trigger 108 is squeezed the jaw member 114 closes to grasp tissue and when the trigger 108 is released the jaw member 114 opens to release tissue. In a one-stage trigger configuration, the trigger 108 functions to close the jaw member 114 when the trigger 108 is squeezed and to open the jaw member 114 when the trigger 108 is released. Once the jaw member 114 is closed, the switch 120 is activated to energize the ultrasonic generator to seal and cut the tissue. In a two-stage trigger configuration, during the first stage, the trigger 108 is squeezed part of the way to close the jaw member 114 and, during the second stage, the trigger 108 is squeezed the rest of the way to energize the ultrasonic generator to seal and cut the tissue. The jaw member 114a opens by releasing the trigger 108 to release the tissue. It will be appreciated that in other aspects, the ultrasonic transducer 103 may be activated without the jaw member 114 being closed.

[0153] The battery assembly 106 is electrically connected to the handle assembly 102 by an electrical connector 132. The handle assembly 102 is provided with a switch 120. The ultrasonic blade 116 is activated by energizing the ultrasonic transducer/generator circuit by actuating the switch 120. The battery assembly 106, according to one aspect, is a rechargeable, reusable battery pack with regulated output. In some cases, as is explained below, the battery assembly 106 facilitates user-interface functions. The handle assembly 102 is a disposable unit that has bays or docks for attachment to the battery assembly 106, the ultrasonic transducer/generator assembly 104, and the shaft assembly 110. The handle assembly 102 also houses various indicators including, for example, a speaker/buzzer and activation switches. In one aspect, the battery assembly is a separate component that is inserted into the housing of the handle assembly through a door or other opening defined by the housing of the handle assembly.

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[0154] The ultrasonic transducer/generator assembly 104 is a reusable unit that produces high frequency mechanical motion at a distal output. The ultrasonic transducer/generator assembly 104 is mechanically coupled to the shaft assembly 110 and the ultrasonic blade 116 and, during operation of the device, produces movement at the distal output of the ultrasonic blade 116. In one aspect, the ultrasonic transducer/generator assembly 104 also provides a visual user interface, such as, through a red/green/blue (RGB) light-emitting diode (LED), LCD, or other display. As such, a visual indicator of the battery status is uniquely not located on the battery and is, therefore, remote from the battery.

[0155] In accordance with various aspects of the present disclosure, the three components of the surgical instrument 100, e.g., the ultrasonic transducer/generator assembly 104, the battery assembly 106, and the shaft assembly 110, are advantageously quickly disconnectable from one or more of the others. Each of the three components of the surgical instrument 100 is sterile and can be maintained wholly in a sterile field during use. Because the components of the surgical instrument 100 are separable, the surgical instrument 100 can be composed of one or more portions that are single-use items (e.g., disposable) and others that are multi-use items (e.g., sterilizable for use in multiple surgical procedures). Aspects of the components separate as part of the surgical instrument 100. In accordance with an additional aspect of the present disclosure, the handle assembly 102, battery assembly 106, and shaft assembly 110 components is equivalent in overall weight; each of the handle assembly 102, battery assembly 106, and shaft assembly 110 components is balanced so that they weigh the same or substantially the same. The handle assembly 102 overhangs the operator's hand for support, allowing the user's hand to more freely operate the controls of the surgical instrument 100 without bearing the weight. This overhang is set to be very close to the center of gravity. This combined with a triangular assembly configuration, makes the surgical instrument 100 advantageously provided with a center of balance that provides a very natural and comfortable feel to the user operating the device. That is, when held in the hand of the user, the surgical instrument 100 does not have a tendency to tip forward or backward or side-to-side, but remains relatively and dynamically balanced so that the waveguide is held parallel to the ground with very little effort from the user. Of course, the instrument can be placed in non-parallel angles to the ground just as easily.

[0156] A rotation knob 118 is operably coupled to the shaft assembly 110. Rotation of the rotation knob 118 ±360° in the direction indicated by the arrows 126 causes an outer tube 144 to rotate ±360° in the respective direction of the arrows 128. In one aspect, the rotation knob

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118 may be configured to rotate the jaw member 114 while the ultrasonic blade 116 remains stationary and a separate shaft rotation knob may be provided to rotate the outer tube 144 ±360°. In various aspects, the ultrasonic blade 116 does not have to stop at ±360° and can rotate at an angle of rotation that is greater than ±360°. The outer tube 144 may have a diameter D_1 ranging from 5mm to 10mm, for example.

[0157] The ultrasonic blade 116 is coupled to an ultrasonic transducer 130 (FIG. 2) portion of the ultrasonic transducer/generator assembly 104 by an ultrasonic transmission waveguide located within the shaft assembly 110. The ultrasonic blade 116 and the ultrasonic transmission waveguide may be formed as a unit construction from a material suitable for transmission of ultrasonic energy. Examples of such materials include Ti6Al4V (an alloy of Titanium including Aluminum and Vanadium), Aluminum, Stainless Steel, or other suitable materials. Alternately, the ultrasonic blade 116 may be separable (and of differing composition) from the ultrasonic transmission waveguide, and coupled by, for example, a stud, weld, glue, quick connect, or other suitable known methods. The length of the ultrasonic transmission waveguide may be an integral number of one-half wavelengths ($\eta\lambda/2$), for example. The ultrasonic transmission waveguide may be preferably fabricated from a solid core shaft constructed out of material suitable to propagate ultrasonic energy efficiently, such as the titanium alloy discussed above (i.e., Ti6Al4V) or any suitable aluminum alloy, or other alloys, or other materials such as sapphire, for example.

[0158] The ultrasonic transducer/generator assembly 104 also comprises electronic circuitry for driving the ultrasonic transducer 130. The ultrasonic blade 116 may be operated at a suitable vibrational frequency range may be about 20 Hz to 120 kHz and a well-suited vibrational frequency range may be about 30-100 kHz. A suitable operational vibrational frequency may be approximately 55.5 kHz, for example. The ultrasonic transducer 130 is energized by the actuating the switch 120.

[0159] It will be appreciated that the terms "proximal" and "distal" are used herein with reference to a clinician gripping the handle assembly 102. Thus, the ultrasonic blade 116 is distal with respect to the handle assembly 102, which is more proximal. It will be further appreciated that, for convenience and clarity, spatial terms such as "top" and "bottom" also are used herein with respect to the clinician gripping the handle assembly 102. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and absolute.

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[01 60] FIG. 3 is an exploded view of a modular shaft assembly 110 of the surgical instrument 100 shown in FIG. 1, according to aspect of the present disclosure. The surgical instrument 100 uses ultrasonic vibration to carry out a surgical treatment on living tissue. The shaft assembly 110 couples to the handle assembly 102 via slots 142a, 142b formed on the handle assembly 102 and tabs 134a, 134b on the shaft assembly 110. The handle assembly 102 comprises a male coupling member 136 that is received in a corresponding female coupling member in the 138 shaft assembly 110. The male coupling member 136 is operably coupled to the trigger 108 such that when the trigger 108 is squeezed the male coupling member 136 translates distally to drive a closure tube mechanism 140 that translates an outer tube portion of the shaft assembly 110 to close the jaw member 114. As previously discussed, when the trigger! 08 is released, the jaw member 114 opens. The male coupling member 136 also couples to the ultrasonic transmission waveguide 145 (FIG. 2) located within the outer tube 144 of the shaft assembly 110 and couples to the ultrasonic transducer 130 (FIG. 2), which is received within the nozzle 146 of the handle assembly 102. The shaft assembly 110 is electrically coupled to the handle assembly 102 via electrical contacts 137.

[0161] FIG. 4 is a perspective transparent view of the ultrasonic transducer/generator assembly 104 of the surgical instrument 100 shown in FIG. 1, according to aspect of the present disclosure. FIG. 5 is an end view of the ultrasonic transducer/generator assembly 104, FIG. 6 is a perspective view of the ultrasonic transducer/generator assembly 104 with the top housing portion removed to expose the ultrasonic generator 162, and FIG. 7 is a sectional view of the of the ultrasonic transducer/generator assembly 104. With reference now to FIGS. 4-7, the ultrasonic transducer/generator assembly 104 comprises an ultrasonic transducer 130, an ultrasonic generator 162 to drive the ultrasonic transducer 130, and a housing 148. A first electrical connector 158 couples the ultrasonic generator 162 to the battery assembly 106 (FIGS. 1 and 2) and a second electrical connector 161 couples the ultrasonic generator 162 to the nozzle (FIG. 3). In one aspect, a display 176 may be provided on one side of the ultrasonic transducer/generator assembly 104 housing 148.

[0162] The ultrasonic generator 162 comprises an ultrasonic driver circuit such as the electrical circuit 177 shown in FIG. 11 and, in some aspects, a second stage amplifier circuit 178. The electrical circuit 177 is configured for driving the ultrasonic transducer 130 and forms a portion of the ultrasonic generator circuit. The electrical circuit 177 comprises a transformer 166 and a blocking capacitor 168, among other components. The transformer 166 is electrically coupled to the piezoelectric elements 150a, 150b, 150c, 150d of the ultrasonic transducer 130.

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The electrical circuit 177 is electrically coupled to first electrical connector 158 via a first cable 179. The first electrical connector 158 is electrically coupled to the battery assembly 106 (FIGS. 1 and 2). The electrical circuit 177 is electrically coupled to second electrical connector 160 via a second cable 183. The second electrical connector 160 is electrically coupled to the nozzle 146 (FIG. 3). In one aspect, the second stage amplifier circuit 178 may be employed in a two stage amplification system.

[0163] The ultrasonic transducer 130, which is known as a "Langevin stack", generally includes a transduction portion comprising piezoelectric elements 150a-150d, a first resonator portion or end-bell 164, and a second resonator portion or fore-bell 152, and ancillary components. The total construction of these components is a resonator. There are other forms of transducers, such as magnetostrictive transducers, that could also be used. The ultrasonic transducer 130 is preferably an integral number of one-half system wavelengths ($\eta\lambda/2$; where V is any positive integer; e.g., n=1, 2, 3...) in length as will be described in more detail later. An acoustic assembly includes the end-bell 164, ultrasonic transducer 130, fore-bell 152, and a velocity transformer 154.

[0164] The distal end of the end-bell 164 is acoustically coupled to the proximal end of the piezoelectric element 150a, and the proximal end of the fore-bell 152 is acoustically coupled to the distal end of the piezoelectric element 150d. The fore-bell 152 and the end-bell 164 have a length determined by a number of variables, including the thickness of the transduction portion, the density and modulus of elasticity of the material used to manufacture the end-bell 164 and the fore-bell 152, and the resonant frequency of the ultrasonic transducer 130. The fore-bell 152 may be tapered inwardly from its proximal end to its distal end to amplify the ultrasonic vibration amplitude at the velocity transformer 154, or alternately may have no amplification. A suitable vibrational frequency range may be about 20 Hz to 120 kHz and a well-suited vibrational frequency range may be about 30-100 kHz. A suitable operational vibrational frequency may be approximately 55.5 kHz, for example.

[0165] The ultrasonic transducer 130 comprises several piezoelectric elements 150a-150d acoustically coupled or stacked to form the transduction portion. The piezoelectric elements 150a-150d may be fabricated from any suitable material, such as, for example, lead zirconate-titanate, lead meta-niobate, lead titanate, barium titanate, or other piezoelectric ceramic material. Electrically conductive elements 170a, 170b, 170c, 170d are inserted between the piezoelectric elements 150a-150d to electrically couple the electrical circuit 177 to the piezoelectric elements 150a-150d. The electrically conductive element 170a located between

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piezoelectric elements 150a, 150b and the electrically conductive element 170d located between piezoelectric element 150d and the fore-bell 152 are electrically coupled to the positive electrode 174a of the electrical circuit 177. The electrically conductive element 170b located between piezoelectric elements 150b, 150c and the electrically conductive element 170c located between piezoelectric elements 150c, 150d are electrically coupled to the negative electrode 174b of the electrical circuit 177. The positive and negative electrodes 174a, 174b are electrically coupled to the electrical circuit 177 by electrical conductors.

[01 66] The ultrasonic transducer 130 converts the electrical drive signal from the electrical circuit 177 into mechanical energy that results in primarily a standing acoustic wave of longitudinal vibratory motion of the ultrasonic transducer 130 and the ultrasonic blade 116 (FIGS. 1 and 3) at ultrasonic frequencies. In another aspect, the vibratory motion of the ultrasonic transducer 130 may act in a different direction. For example, the vibratory motion may comprise a local longitudinal component of a more complicated motion of the ultrasonic blade 116. When the acoustic assembly is energized, a vibratory motion in the form of a standing wave is generated through the ultrasonic transducer 130 to the ultrasonic blade 116 at a resonance and amplitude determined by various electrical and geometrical parameters. The amplitude of the vibratory motion at any point along the acoustic assembly depends upon the location along the acoustic assembly at which the vibratory motion is measured. A minimum or zero crossing in the vibratory motion standing wave is generally referred to as a node (i.e., where motion is minimal), and a local absolute value maximum or peak in the standing wave is generally referred to as an anti-node (i.e., where local motion is maximal). The distance between an anti-node and its nearest node is one-quarter wavelength ($\lambda/4$).

[0167] The wires transmit an electrical drive signal from the electrical circuit 177 to the positive electrode 170a and the negative electrode 170b. The piezoelectric elements 150a-150d are energized by the electrical signal supplied from the electrical circuit 177 in response to an actuator, such as the switch 120, for example, to produce an acoustic standing wave in the acoustic assembly. The electrical signal causes disturbances in the piezoelectric elements 150a-150d in the form of repeated small displacements resulting in large alternating compression and tension forces within the material. The repeated small displacements cause the piezoelectric elements 150a-150d to expand and contract in a continuous manner along the axis of the voltage gradient, producing longitudinal waves of ultrasonic energy. The ultrasonic energy is transmitted through the acoustic assembly to the ultrasonic blade 116 (FIGS. 1 and 3)

via a transmission component or an ultrasonic transmission waveguide through the shaft assembly 110 (FIGS. 1-3).

[01 68] In order for the acoustic assembly to deliver energy to the ultrasonic blade 116 (FIGS. 1 and 3), components of the acoustic assembly are acoustically coupled to the ultrasonic blade 116. A coupling stud 156 of the ultrasonic transducer 130 is acoustically coupled to the ultrasonic transmission waveguide 145 by a threaded connection such as a stud. In one aspect, the ultrasonic transducer 130 may be acoustically coupled to the ultrasonic transmission waveguide 145 as shown in FIGS. 10A and 10B.

[0169] The components of the acoustic assembly are preferably acoustically tuned such that the length of any assembly is an integral number of one-half wavelengths ($\eta\lambda/2$), where the wavelength λ is the wavelength of a pre-selected or operating longitudinal vibration drive frequency f_d of the acoustic assembly. It is also contemplated that the acoustic assembly may incorporate any suitable arrangement of acoustic elements.

[0170] The ultrasonic blade 116 (FIGS. 1 and 3) may have a length that is an integral multiple of one-half system wavelengths ($\eta\lambda/2$). A distal end of the ultrasonic blade 116 may be disposed near an antinode in order to provide the maximum longitudinal excursion of the distal end. When the ultrasonic transducer 130 is energized, the distal end of the ultrasonic blade 116 may be configured to move in the range of, for example, approximately 10 to 500 microns peak-to-peak, and preferably in the range of about 30 to 150 microns, and in some aspects closer to 100 microns, at a predetermined vibrational frequency of 55 kHz, for example.

[0171] FIG. 8 is an elevation view of an ultrasonic transducer/generator assembly 104 that is configured to operate at 31 kHz resonant frequency, according to one aspect of the present disclosure. FIG. 9 is an elevation view of an ultrasonic transducer/generator assembly 104' that is configured to operate at 55 kHz resonant frequency, according to one aspect of the present disclosure. As can be seen, the ultrasonic transducer/generator assemblies 104, 104', the housings 148 are the same size in order to fit into the nozzle 146 of the surgical instrument 100 shown in FIG. 3. Nevertheless, the individual ultrasonic transducers 130, 130' will vary in size depending on the desired resonant frequency. For example, the ultrasonic transducer 130 shown in FIG. 8 is tuned at a resonant frequency of 31 kHz is physically larger than the ultrasonic transducer 130' shown in FIG. 9, which is tuned at a resonant frequency of 55 kHz. The coupling stud 156, 156' of the ultrasonic transducer 130, 130' may be acoustically coupled to the ultrasonic transmission waveguide 145 by a threaded connection such as a stud.

[0172] FIGS. 10A and 10B illustrate a shifting assembly 200 that selectively rotates the ultrasonic transmission waveguide 145 with respect to the ultrasonic transducer 130 and urges them towards one another, according to one aspect of the present disclosure. FIG. 10A illustrates the shifting assembly 200 with the ultrasonic transmission waveguide 145 and the ultrasonic transducer 130 in a disengaged configuration and FIG. 10B illustrates the shifting assembly 200 with the ultrasonic transmission waveguide 145 and the ultrasonic transducer 130 in an engaged configuration. With reference now to both FIGS. 10A and 10B, the shifting assembly 200 is located in the handle assembly 102 of the surgical instrument 100. One or more sleeves 204 hold the ultrasonic transducer 130 in place within the housing 148. The distal end of the ultrasonic transducer 130 includes threads 202 that are engaged by a worm gear 206. As the worm gear 206 rotates the ultrasonic transducer 130 is urged in the direction indicated by the arrow 208 to thread the threaded coupling stud 156 into a threaded end of the ultrasonic transmission waveguide 145. The worm gear 206 may be driven by a motor located within the handle assembly 102 of the surgical instrument 100.

[0173] In one aspect, the shifting assembly 200 may include a torque limited motor driven attachment of the ultrasonic transmission waveguide 145 via the motor located in the handle assembly 102 that controls shaft actuation of clamping, rotation, and articulation. The shifting assembly 200 in the handle assembly 102 applies the proper torque onto the ultrasonic transmission waveguide 145 into place with a predetermined minimum torque. For instance, the handle assembly 102 may include a transducer torqueing mechanism which shifts the primary motor longitudinally uncoupling the primary drive shaft spur gear and coupling the transducer torqueing gear which rotates the shaft and nozzle therefore screwing the wave guide into the transducer.

[0174] FIG. 11 is a schematic diagram of one aspect of a electrical circuit 177 shown in FIG. 4, suitable for driving an ultrasonic transducer 130, according to one aspect of the present disclosure. The electrical circuit 177 comprises an analog multiplexer 180. The analog multiplexer 180 multiplexes various signals from the upstream channels SCL-A/SDA-A such as ultrasonic, battery, and power control circuit. A current sensor 182 is coupled in series with the return or ground leg of the power supply circuit to measure the current supplied by the power supply. A field effect transistor (FET) temperature sensor 184 provides the ambient temperature. A pulse width modulation (PWM) watchdog timer 188 automatically generates a system reset if the main program neglects to periodically service it. It is provided to automatically reset the electrical circuit 177 when it hangs or freezes because of a software or

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hardware fault. It will be appreciated that the electrical circuit 177 may be configured as an RF driver circuit for driving the ultrasonic transducer 130 or for driving RF electrodes such as the electrical circuit 702 shown in FIG. 34, for example. Accordingly, with reference now back to FIG. 11, the electrical circuit 177 can be used to drive both ultrasonic transducers and RF electrodes interchangeably. If driven simultaneously, filter circuits may be provided in the corresponding first stage circuits 5504 to select either the ultrasonic waveform or the RF waveform. Such filtering techniques are described in commonly owned U.S. Pat. App. No. 15/265,293, titled TECHNIQUES FOR CIRCUIT TOPOLOGIES FOR COMBINED GENERATOR, which is herein incorporated by reference in its entirety.

[0175] A drive circuit 186 provides left and right ultrasonic energy outputs. A digital signal the represents the signal waveform is provided to the SCL-A/SDA-A inputs of the analog multiplexer 180 from a control circuit, such as the control circuit 210 (FIG. 14). A digital-to-analog converter 190 (DAC) converts the digital input to an analog output to drive a PWM circuit 192 coupled to an oscillator 194. The PWM circuit 192 provides a first signal to a first gate drive circuit 196a coupled to a first transistor output stage 198a to drive a first ultrasonic (Left) energy output. The PWM circuit 192 also provides a second signal to a second gate drive circuit 196b coupled to a second transistor output stage 198b to drive a second ultrasonic (Right) energy output. A voltage sensor 199 is coupled between the Ultrasonic Left/Right output terminals to measure the output voltage. The drive circuit 186, the first and second drive circuits 196a, 196b, and the first and second transistor output stages 198a, 198b define a first stage amplifier circuit. In operation, the control circuit 210 (FIG. 14) generates a digital waveform 1800 (FIG. 67) employing circuits such as direct digital synthesis (DDS) circuits 1500, 1600 (FIGS. 65 and 66). The DAC 190 receives the digital waveform 1800 and converts it into an analog waveform, which is received and amplified by the first stage amplifier circuit.

[0176] FIG. 12 is a schematic diagram of the transformer 166 coupled to the electrical circuit 177 shown in FIG. 11, according to one aspect of the present disclosure. The Ultrasonic Left/Right input terminals (primary winding) of the transformer 166 are electrically coupled to the Ultrasonic Left/Right output terminals of the electrical circuit 177. The secondary winding of the transformer 166 are coupled to the positive and negative electrodes 174a, 174b. The positive and negative electrodes 174a, 174b of the transformer 166 are coupled to the positive terminal 170a (Stack 1) and the negative terminal 170b (Stack 2) of the ultrasonic transducer 130 (FIG. 4). In one aspect, the transformer 166 has a turns-ratio of n1:n2 of 1:50.

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[0177] FIG. 13 is a schematic diagram of the transformer 166 shown in FIG. 12 coupled to a test circuit 165, according to one aspect of the present disclosure. The test circuit 165 is coupled to the positive and negative electrodes 174a, 174b. A switch 167 is placed in series with an inductor/capacitor/resistor (LCR)load that simulates the load of an ultrasonic transducer.

[0178] FIG. 14 is a schematic diagram of a control circuit 210, according to one aspect f the present disclosure. The control circuit 210 is located within a housing of the battery assembly 106. The battery assembly 106 is the energy source for a variety of local power supplies 215. The control circuit comprises a main processor 214 coupled via an interface master 218 to various downstream circuits by way of outputs SCL-A/SDA-A, SCL-B/SDA-B, SCL-C/SDA-C, for example. In one aspect, the interface master 218 is a general purpose serial interface such as an I^2C serial interface. The main processor 214 also is configured to drive switches 224 through general purposes input output 220 (GPIO), a display 226 (e.g., and LCD display), and various indicators 228 trough GPIO 222. A watchdog processor 216 is provided to control the main processor 214. A switch 230 is provided in series with the battery 211 to activate the control circuit 212 upon insertion of the battery assembly 106 into the handle assembly 102 (FIGS. 1-3).

[0179] In one aspect, the main processor 214 is coupled to the electrical circuit 177 (FIGS. 4 and 11) by way of output terminals SCL-A/SDA-A. The main processor 214 comprises a memory for storing tables of digitized drive signals or waveforms that are transmitted to the electrical circuit 177 for driving the ultrasonic transducer 130 (FIGS. 4-8), for example. In other aspects, the main processor 214 may generate a digital waveform and transmit it to the electrical circuit 177 or may store the digital waveform for later transmission to the electrical circuit 177. The main processor 214 also may provide RF drive by way of output terminals SCL-B/SDA-B and various sensors (e.g., Hall-effect sensors, magnetorheological fluid (MRF) sensors, etc.) by way of output terminals SCL-C/SDA-C. In one aspect, the main processor 214 is configured to sense the presence of ultrasonic drive circuitry and/or RF drive circuitry to enable appropriate software and user interface functionality.

[0180] In one aspect, the main processor 214 may be an LM 4F230H5QR, available from Texas Instruments, for example. In at least one example, the Texas Instruments LM4F230H5QR is an ARM Cortex-M4F Processor Core comprising on-chip memory of 256 KB single-cycle flash memory, or other non-volatile memory, up to 40 MHz, a prefetch buffer to improve performance above 40 MHz, a 32 KB single-cycle serial random access memory (SRAM), internal read-only memory (ROM) loaded with StellarisWare® software, 2 KB

electrically erasable programmable read-only memory (EEPROM), one or more pulse width modulation (PWM) modules, one or more quadrature encoder inputs (QED analog, one or more 12-bit Analog-to-Digital Converters (ADC) with 12 analog input channels, among other features that are readily available for the product datasheet. Other processors may be readily substituted and, accordingly, the present disclosure should not be limited in this context.

[0181] FIG. 15 shows a simplified block circuit diagram illustrating another electrical circuit 300 contained within a modular ultrasonic surgical instrument 334, according to one aspect of the present disclosure. The electrical circuit 300 includes a processor 302, a clock 330, a memory 326, a power supply 304 (e.g., a battery), a switch 306, such as a metal-oxide semiconductor field effect transistor (MOSFET) power switch, a drive circuit 308 (PLL), a transformer 310, a signal smoothing circuit 312 (also referred to as a matching circuit and can be, e.g., a tank circuit), a sensing circuit 314, a transducer 130, and a shaft assembly 110 comprising an ultrasonic transmission waveguide that terminates at an ultrasonic blade 116, which may be referred to herein simply as the waveguide.

[0182] One feature of the present disclosure that severs dependency on high voltage (120 VAC) input power (a characteristic of general ultrasonic cutting devices) is the utilization of low-voltage switching throughout the wave-forming process and the amplification of the driving signal only directly before the transformer stage. For this reason, in one aspect of the present disclosure, power is derived from only a battery, or a group of batteries, small enough to fit either within the handle assembly 102 (FIGS. 1-3). State-of-the-art battery technology provides powerful batteries of a few centimeters in height and width and a few millimeters in depth. By combining the features of the present disclosure to provide a self-contained and self-powered ultrasonic device, a reduction in manufacturing cost may be achieved.

[0183] The output of the power supply 304 is fed to and powers the processor 302. The processor 302 receives and outputs signals and, as will be described below, functions according to custom logic or in accordance with computer programs that are executed by the processor 302. The electrical circuit 300 can also include a memory 326, preferably, random access memory (RAM), that stores computer-readable instructions and data.

[0184] The output of the power supply 304 also is directed to a switch 306 having a duty cycle controlled by the processor 302. By controlling the on-time for the switch 306, the processor 302 is able to dictate the total amount of power that is ultimately delivered to the transducer 316. In one aspect, the switch 306 is a MOSFET, although other switches and switching configurations are adaptable as well. The output of the switch 306 is fed to a drive circuit 308 that contains, for

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example, a phase detecting phase-locked loop (PLL) and/or a low-pass filter and/or a voltage-controlled oscillator. The output of the switch 306 is sampled by the processor 302 to determine the voltage and current of the output signal (V IN and I IN, respectively). These values are used in a feedback architecture to adjust the pulse width modulation of the switch 306. For instance, the duty cycle of the switch 306 can vary from about 20% to about 80%, depending on the desired and actual output from the switch 306.

[0185] The drive circuit 308, which receives the signal from the switch 306, includes an oscillatory circuit that turns the output of the switch 306 into an electrical signal having an ultrasonic frequency, e.g., 55 kHz (VCO). As explained above, a smoothed-out version of this ultrasonic waveform is ultimately fed to the ultrasonic transducer 130 to produce a resonant sine wave along the ultrasonic transmission waveguide 145 (FIG. 2).

[01 86] At the output of the drive circuit 308 is a transformer 310 that is able to step up the low voltage signal(s) to a higher voltage. It is noted that upstream switching, prior to the transformer 310, is performed at low (e.g., battery driven) voltages, something that, to date, has not been possible for ultrasonic cutting and cautery devices. This is at least partially due to the fact that the device advantageously uses low on-resistance MOSFET switching devices. Low on-resistance MOSFET switches are advantageous, as they produce lower switching losses and less heat than a traditional MOSFET device and allow higher current to pass through. Therefore, the switching stage (pre-transformer) can be characterized as low voltage/high current. To ensure the lower on-resistance of the amplifier MOSFET(s), the MOSFET(s) are run, for example, at 10 V. In such a case, a separate 10 VDC power supply can be used to feed the MOSFET gate, which ensures that the MOSFET is fully on and a reasonably low on resistance is achieved. In one aspect of the present disclosure, the transformer 310 steps up the battery voltage to 120V root-mean-square (RMS). Transformers are known in the art and are, therefore, not explained here in detail.

[0187] In the circuit configurations described, circuit component degradation can negatively impact the circuit performance of the circuit. One factor that directly affects component performance is heat. Known circuits generally monitor switching temperatures (e.g., MOSFET temperatures). However, because of the technological advancements in MOSFET designs, and the corresponding reduction in size, MOSFET temperatures are no longer a valid indicator of circuit loads and heat. For this reason, according to one aspect of the present disclosure, a sensing circuit 314 senses the temperature of the transformer 310. This temperature sensing is advantageous as the transformer 310 is run at or very close to its maximum temperature during

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use of the device. Additional temperature will cause the core material, e.g., the ferrite, to break down and permanent damage can occur. The present disclosure can respond to a maximum temperature of the transformer 310 by, for example, reducing the driving power in the transformer 310, signaling the user, turning the power off, pulsing the power, or other appropriate responses.

[0188] In one aspect of the present disclosure, the processor 302 is communicatively coupled to the end effector 112, which is used to place material in physical contact with the ultrasonic blade 116, e.g., the clamping mechanism shown in FIG. 1. Sensors are provided that measure, at the end effector 112, a clamping force value (existing within a known range) and, based upon the received clamping force value, the processor 302 varies the motional voltage VM. Because high force values combined with a set motional rate can result in high blade temperatures, a temperature sensor 336 can be communicatively coupled to the processor 302, where the processor 302 is operable to receive and interpret a signal indicating a current temperature of the blade from the temperature sensor 336 and to determine a target frequency of blade movement based upon the received temperature. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the trigger 108 to measure the force applied to the trigger 108 by the user. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the switch 120 button such that displacement intensity corresponds to the force applied by the user to the switch 120 button.

[0189] According to one aspect of the present disclosure, the PLL portion of the drive circuit 308, which is coupled to the processor 302, is able to determine a frequency of waveguide movement and communicate that frequency to the processor 302. The processor 302 stores this frequency value in the memory 326 when the device is turned off. By reading the clock 330, the processor 302 is able to determine an elapsed time after the device is shut off and retrieve the last frequency of waveguide movement if the elapsed time is less than a predetermined value. The device can then start up at the last frequency, which, presumably, is the optimum frequency for the current load.

[0190] FIG. 16 shows a battery assembly 400 for use with the surgical instrument 100, according to one aspect of the present disclosure. The battery assembly 400 comprises a housing 402 sized and configured to contain various energy cells. The energy cells may include rechargeable and non-rechargeable batteries. In one aspect, the battery assembly 400 includes four Li-ion non-rechargeable batteries 404a, 404b, 404c, 404d and two nickel metal hydride (NiMH) rechargeable batteries 406a (the second battery is not shown). The housing 402

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comprises tabs 408a, 408b to removably connect the battery assembly 400 to the handle assembly 102 of the surgical instrument 100 (FIGS. 1 and 2).

[0191] FIG. 17 shows a disposable battery assembly 410 for use with the surgical instrument 100, according to one aspect of the present disclosure. In one aspect, the disposable battery assembly 410 comprises a primary cell battery pack for use with a battery powered advanced energy instrument such as the surgical instrument 100 (FIGS. 1 and 2), comprising compensating electronics with additional voltage to offset a voltage sag from the disposable battery assembly 410 to prevent the output voltage from sagging below a predetermined level during operation under load. The disposable battery assembly 410 comprises a housing 412 sized and configured to contain various energy cells. The energy cells may include rechargeable and non-rechargeable batteries. In one aspect, the disposable battery assembly 410 includes four primary Lithium-ion (Li-ion) non-rechargeable batteries 414a, 414b, 414c, 414d and two secondary NiMH or Nickel Cadmium (NiCd) rechargeable batteries 416a, 416b. The housing 412 comprises electrical contact 418 to electrically couple the disposable battery assembly 410 to the handle assembly 102 of the surgical instrument 100. In the illustrated example the electrical contact 418 comprises four metal contacts. The disposable battery assembly 410 also includes electrical circuits 419 such as the control circuit 210 (FIG. 14) and/or the electrical circuit 300 (FIG. 15). The electrical circuits 419 are radiated hardened.

[0192] In one aspect, the disposable battery assembly 410 includes batteries 414a-d, electrical circuits 419, and other componentry that is resistant to gamma or other radiation sterilization. For instance, a switching mode power supply 460 (FIG. 22) or a linear power supply 470 (FIG. 24) and an optional charge circuit may be incorporated within the housing 412 of the disposable battery assembly 410 to reduce voltage sag of the primary Li-ion batteries 414a-d and to allow the secondary NiMH batteries 416a, 416b to be used to reduce voltage sag. This guarantees full charged cells at the beginning of each surgery that are easy to introduce into the sterile field. A dual type battery assembly including primary Li-ion batteries 414a-d and secondary NiMH batteries 416a-b can be used with dedicated energy cells 416a-b to control the electronics from dedicated energy cells 414a-d that run the generator and motor control circuits. In one aspect, the system pulls from the batteries involved in driving the electronics circuits in the case that batteries involved are dropping low. In one aspect, the system would include a one way diode system that would not allow for current to flow in the opposite direction, for example, from the batteries involved in driving the energy and/or motor control circuits to the batteries involved in driving the electronic circuits. In one additional aspect, the system may comprise a

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gamma friendly charge circuit and switch mode power supply using diodes and vacuum tube components that would minimize voltage sag at a predetermined level. The switch mode power supply may be eliminated by including a minimum sag voltage that is a division of the NiMH voltages (e.g., three NiMH cells). In another aspect, a modular system can be made wherein the radiation hardened components are located in a module, making this module sterilizable by radiation sterilization. Other non-radiation hardened components are included in other modular components and connections are made between the modular components such that the componentry operate together as if the components were located together on the same circuit board. If only two cells of the secondary NiMH batteries 416a-b are desired the switch mode power supply based on diodes and vacuum tubes allows for sterilizable electronics within the disposable primary Li-ion batteries 414a-d.

[0193] FIG. 18 shows a reusable battery assembly 420 for use with the surgical instrument 100, according to one aspect of the present disclosure. The reusable battery assembly 420 comprises a housing 422 sized and configured to contain various rechargeable energy cells. The energy cells may include rechargeable batteries. In one aspect, the reusable battery assembly 420 includes five laminated NiMH rechargeable batteries 424a, 424b, 424c, 424d, 424e. The housing 422 comprises electrical contact 428 to electrically couple the reusable battery assembly 420 to the handle assembly 102 of the surgical instrument 100 (FIGS. 1 and 2). In the illustrated example, the electrical contact 428 comprises six metal contacts. The reusable battery assembly 420 also includes up to six circuit boards 429a, 429b, 429c, 429d, 429e, 429f that may include electrical circuits such as the control circuit 210 (FIG. 14) and/or the electrical circuit 300 (FIG. 15). In one aspect, the reusable battery assembly 420 comprises drive FET transistors and associated circuitry 429a-f in the housing 422 for easy swap and no need to shut down the surgical instrument 100 (FIGS. 1 and 2) to replace the reusable battery assembly 420 with energy delivery.

[0194] The reusable battery assembly 420 comprises a battery test switch 426 and up to three LED indicators 427a, 427b, 427c to determine the health of the batteries 424a-e in the reusable battery assembly 420. The first LED indicator 427a may indicate fully charged batteries 424a-e that is ready to use. The second LED indicator 427b may indicate that the battery needs to be recharged. The third LED indicator 427c may indicate that battery is not good and to dispose. The reusable battery assembly 420 health indication to allow the user to determine the specific health and capabilities of the batteries 424a-e before it is inserted and used. For instance, charge status of the rechargeable secondary cells, sag voltage, primary cell voltage are

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checked by the activation of the battery test switch 426 which could measure these in an unload state or with a predefined resistive load placed on the system. The voltages could have at least one but more preferably three thresholds to compare the resulting voltages checks to. In the case of the first indicator 427a, the batteries 424a-e indicating whether or not they are suitable to use. With three levels the reusable battery assembly 420 could display full charge, minimum charge, and some marginal but limited charge status. This battery 424a-e health monitor would be useful for either the disposable battery assembly 410 (FIG. 17) or the reusable battery assembly 420. In the case of the disposable battery assembly 410 it is a ready/damaged indicator. In the case of the reusable battery assembly 420 it could indicate life remaining, recharge capacity, even age before failure in addition to ready/not ready.

[0195] FIG. 19 is an elevated perspective view of a removable battery assembly 430 with both halves of the housing shell removed exposing battery cells coupled to multiple circuit boards which are coupled to the multi-lead battery terminal in accordance with an aspect of the present disclosure. Further, more than or less than three circuit boards is possible to provide expanded or limited functionality. As shown in FIG. 19, the multiple circuit boards 432, 434, 436 may be positioned in a stacked architecture, which provides a number of advantages. For example, due to the smaller layout size, the circuit boards have a reduced footprint within the removable battery assembly 430, thereby allowing for a smaller battery. In addition, in this configuration, is possible to easily isolate power boards from digital boards to prevent any noise originating from the power boards to cause harm to the digital boards. Also, the stacked configuration allows for direct connect features between the boards, thereby reducing the presence of wires. Furthermore, the circuit boards can be configured as part of a rigid-flex-rigid circuit to allow the rigid parts to be "fanned" into a smaller volumetric area.

[0196] According to aspects of the present disclosure, the circuit board 432, 434, 436 provides a specific function. For instance, one circuit board 432 can provide the components for carrying out the battery protection circuitry. Similarly, another circuit board 434 can provide the components for carrying out the battery controller. Another circuit board 436 can, for example, provide high power buck controller components. Finally, the battery protection circuitry can provide connection paths for coupling the battery cells 438a-n. By placing the circuit boards in a stacked configuration and separating the boards by their respective functions, the boards may be strategically placed in a specific order that best handles their individual noise and heat generation. For example, the circuit board having the high-power buck controller components produces the most heat and, therefore, it can be isolated from the other boards and placed in

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the center of the stack. In this way, the heat can be kept away from the outer surface of the device in an effort to prevent the heat from being felt by the physician or operator of the device. In addition, the battery board grounds may be configured in a star topology with the center located at the buck controller board to reduce the noise created by ground loops.

[0197] The strategically stacked circuit boards, the low thermal conductivity path from the circuit boards to the multi-lead battery terminal assembly, and a flex circuit 3516 are features that assist in preventing heat from reaching the exterior surface of the device. The battery cells and buck components are thermally connected to a flex circuit within the handle assembly 102 (FIGS. 1 and 2) so that the heat generated by the cells and buck components enter a portion away from the physician's hand. The flex circuit presents a relatively high thermal mass, due to its broad area of exposure and the advantageous conduction characteristics of the copper, which redirects, absorbs, and/or dissipates heat across a broader area thereby slowing the concentration of heat and limiting high spot temperatures on the exterior surface of the device. Other techniques may be implemented as well, including, but not limited to, larger heat wells, sinks or insulators, a metal connector cap and heavier copper content in the flex circuit or the handle assembly 102 of the device.

[0198] Another advantage of the removable battery assembly 430 is realized when Li-ion batteries are used. As previously stated, Li-ion batteries should not be charged in a parallel configuration of multiple cells. This is because, as the voltage increases in a particular cell, it begins to accept additional charge faster than the other lower-voltage cells. Therefore, the cells are monitored so that a charge to that cell can be controlled individually. When a Li-ion battery is formed from a group of cells 438a-n, a multitude of wires extending from the exterior of the device to the batteries 438a-n is needed (at least one additional wire for each battery cell beyond the first). By having a removable battery assembly 430, a battery cell 438a-n can, in one aspect, have its own exposed set of contacts and, when the removable battery assembly 430 is not present inside the handle assembly 102 (FIGS. 1 and 2), a set of contacts can be coupled to a corresponding set of contacts in an external, non-sterile, battery-charging device. In another aspect, a battery cell 438a-n can be electrically connected to the battery protection circuitry to allow the battery protection circuitry to control and regulate recharging of a cell 438a-n. The removable battery assembly 430 is provided with circuitry to prevent use of the removable battery assembly 430 past an expected term-of-life. This term is not only dictated by the cells but is also dictated by the outer surfaces, including the battery casing or shell and the upper

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contact assembly. Such circuitry will be explained in further detail below and includes, for example, a use count, a recharge count, and an absolute time from manufacture count.

[0199] FIG. 19 also shows a multi-lead battery terminal assembly 433, which is an interface that electrically couples the components within the removable battery assembly 430 to an electrical interface of the handle assembly 102 (FIGS. 1 and 2) . It is through the handle assembly 102 that the removable battery assembly 430 is able to electrically (and mechanically) couple with the ultrasonic transducer/generator assembly 104 (FIG. 4). As is explained above, the removable battery assembly 430, through the multi-lead battery terminal assembly 433, provides power to the surgical instrument 100 (FIGS. 1 and 2), as well as other functionality described herein. The multi-lead battery terminal assembly 433 includes a plurality of contacts pads 435a-n capable of separately electrically connecting a terminal within the removable battery assembly 430 to another terminal provided by a docking bay of the handle assembly 102. One example of such electrical connections coupled to the plurality of contact pads 435a-n as power and communication signal paths. In the aspect of the multi-lead battery terminal assembly 433, sixteen different contact pads 435a-n are shown. This number is merely illustrative. In an aspect, an interior side of the battery terminal assembly 433 has a well formed on the molded terminal holder that can be filled with potting materials to create a gas tight seal. The contact pads 435a-n are overmolded in the lid and extend through the potting well into the interior of the battery 430. Here a flex circuit can be used to rearrange the array of pins and provide an electrical connection to the circuit boards. In one example, a 4x4 array is converted to a 2×8 array. In one example the multi-lead battery terminal assembly 433, a plurality of contact pads 435a-n of the multi-lead battery terminal assembly 2804 include a corresponding plurality of interior contact pins 437a-n. A contact pin 437a provides a direct electrical coupling to a corresponding one of the contact pads 435a.

[0200] FIG. 20 illustrates a battery test circuit 440, according to one aspect of the present disclosure. The battery test circuit 440 includes the battery test switch 426 as described in FIG. 18. The battery test switch 426 is a switch that engages an LCR dummy load that simulates a transducer or shaft assembly electronics. As described in FIG. 18, additional indicator circuits may be coupled to the battery test circuit 440 to provide a suitable indication of the capacity of the batteries in the reusable battery assembly 420. The illustrated battery test circuit 440 may be employed in any of the battery assemblies 400, 410, 420, 430 described in connection with FIGS. 16-19, respectively.

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[0201] FIG. 21 illustrates a supplemental power source circuit 450 to maintain a minimum output voltage, according to one aspect of the present disclosure. The supplemental power source circuit 450 may be included in any of the battery assemblies 400, 410, 420, 430 described in connection with FIGS. 16-19. The supplemental power source circuit 450 prevents the output voltage V_o from sagging under high load conditions. The supplemental power source circuit 450 includes a set of four primary batteries 452a-b, 452c-d (up to n batteries may be used) that are activated when the switch 453 closes upon insertion of the battery assembly 400, 410, 420, 430 into the handle assembly 102 of the surgical instrument 100 (FIGS. 1 and 2). The primary batteries 452a-d may be Li-ion batteries such as CR123A Li-ion batteries. Under load, the primary batteries 452a-d provide the output voltage V_o while the secondary rechargeable battery 454 is charged by the battery charger 455. In one aspect, the secondary rechargeable battery 454 in a NiMH battery and the battery charger 455 is a suitable NiMH charger. When the output voltage V_0 sags or droops due to high load conditions the voltage V_x operates the switch mode power supply 456 to restore the output voltage V_0 by supplying the additional current into the load. The diode 458 is provided to prevent current from flowing into the output of the switch mode power supply 456. Accordingly, the output voltage V_b of the switch mode power supply 456 must exceed the voltage drop across the diode 458 (~0.7V) before the supplemental current can flow into the load. Optionally, a battery test switch 459 and test resistor R_{Test} may be provided to test the supplemental power source circuit 450 under load conditions. In particular, in view of FIG. 21, the battery assemblies 400, 410, 420, 430 may comprise a test circuit 457a comprising a switch 457b and a resistor 457c such that when the switch 457b is closed (e.g., via the test button 426), the resistor 457c tests whether the primary batteries 452a-d are capable of delivering the output voltage V_0. Otherwise, the resistor 457 tests whether the secondary battery 454, via operation of the switch mode power supply 456, is capable of delivering a V_b such that supplemental current passing through the diode 458 restores the output voltage V_0.

[0202] FIG. 22 illustrates a switch mode power supply circuit 460 for supplying energy to the surgical instrument 100, according to one aspect of the present disclosure. The switch mode power supply circuit 460 may be disposed within any one of the battery assemblies 400, 410, 430 described in connection with FIGS. 16, 17, and 19, respectively. In the illustrated example, the switch mode power supply circuit 460 comprises primary Li cell batteries 429a-d where the positive (+) output voltage is coupled to an input terminal V_{IN} of a switching regulator 464. It will be appreciated that any suitable number of primary cells may be employed. The switch mode power supply circuit 460 includes a remote ON/OFF switch. The input V_{IN} of the switching

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regulator 464 also includes an input filter represented by capacitor C_i. The output V_{OUT} of the switching regulator 464 is coupled to an inductor L and an output filter represented by capacitor C_0. A catch diode D is disposed between V_{OUT} and ground. A feedback signal is provided from the output filter C_0 to the FB input of the switching regulator 464. A load resistor R_L represents a load. In one aspect, the minimum load is about 200mA. In one aspect, the output voltage V_{OUT} is 3.3VDC at 800mA.

[0203] FIG. 23 illustrates a discrete version of the switching regulator 464 shown in FIG. 22 for supplying energy to the surgical instrument 100, according to one aspect of the present disclosure. The switching regulator 464 receives the input voltage from a battery assembly 400, 410, 420, 430 at the V_{IN} terminal. The signal at the ON/OFF input enables or disables the operation of the switching regulator 464 by controlling the state of the switch 471 . A feedback signal is received from the load at the FB input where is divided by a voltage divider circuit 463. The voltage from the voltage divider 463 is applied to the positive input of a fixed gain amplifier 465. The negative input of the fixed gain amplifier 465 is coupled to a bandgap reference diode 469 (e.g., 1.23V). The amplified output of the fixed gain amplifier 465 is applied to the positive input of a comparator 466. The negative input of the comparator 466 receives a 50 kHz oscillator 467 input. The output of the comparator 466 is applied to a driver 468 which drives and output transistor 461 . The output transistor 461 supplies voltage and current to the load via the VOU_T terminal.

[0204] FIG. 24 illustrates a linear power supply circuit 470 for supplying energy to the surgical instrument 100, according to one aspect of the present disclosure. The linear power supply circuit 470 may be disposed within any one of the battery assemblies 400, 410, 420, 430 described in connection with FIGS. 16, 17, 18, and 19, respectively. In the illustrated example, the linear power supply circuit 470 comprises primary Li-ion cell batteries 462a-d where the positive (+) output voltage is coupled to the V_{IN} terminal of transistor 472. The output of the transistor 472 supplies the current and voltage to the load via the V_{OUT} terminal of the linear power supply circuit 470. An input filter Q is provided at the input side and an output filter C_0 is provided at an output side. A Zener diode D_Z applies a regulated voltage to the base of the transistor 472. A bias resistor biases the Zener diode D_Z and the transistor 472.

[0205] FIG. 25 is an elevational exploded view of modular handheld ultrasonic surgical instrument 480 showing the left shell half removed from a handle assembly 482 exposing a device identifier communicatively coupled to the multi-lead handle terminal assembly in accordance with one aspect of the present disclosure. In additional aspects of the present

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disclosure, an intelligent or smart battery is used to power the modular handheld ultrasonic surgical instrument 480. However, the smart battery is not limited to the modular handheld ultrasonic surgical instrument 480 and, as will be explained, can be used in a variety of devices, which may or may not have power requirements (e.g., current and voltage) that vary from one another. The smart battery assembly 486, in accordance with one aspect of the present disclosure, is advantageously able to identify the particular device to which it is electrically coupled. It does this through encrypted or unencrypted identification methods. For instance, a smart battery assembly 486 can have a connection portion, such as connection portion 488. The handle assembly 482 can also be provided with a device identifier communicatively coupled to the multi-lead handle terminal assembly 491 and operable to communicate at least one piece of information about the handle assembly 482. This information can pertain to the number of times the handle assembly 482 has been used, the number of times an ultrasonic transducer/generator assembly 484 (presently disconnected from the handle assembly 482) has been used, the number of times a waveguide shaft assembly 490 (presently connected to the handle assembly 482) has been used, the type of the waveguide shaft assembly 490 that is presently connected to the handle assembly 482, the type or identity of the ultrasonic transducer/generator assembly 484 that is presently connected to the handle assembly 482, and/or many other characteristics. When the smart battery assembly 486 is inserted in the handle assembly 482, the connection portion 488 within the smart battery assembly 486 makes communicating contact with the device identifier of the handle assembly 482. The handle assembly 482, through hardware, software, or a combination thereof, is able to transmit information to the smart battery assembly 486 (whether by self-initiation or in response to a request from the smart battery assembly 486). This communicated identifier is received by the connection portion 488 of the smart battery assembly 486. In one aspect, once the smart battery assembly 486 receives the information, the communication portion is operable to control the output of the smart battery assembly 486 to comply with the device's specific power requirements.

[0206] In one aspect, the communication portion includes a processor 493 and a memory 497, which may be separate or a single component. The processor 493, in combination with the memory, is able to provide intelligent power management for the modular handheld ultrasonic surgical instrument 480. This aspect is particularly advantageous because an ultrasonic device, such as the modular handheld ultrasonic surgical instrument 480, has a power requirement (frequency, current, and voltage) that may be unique to the modular handheld ultrasonic

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surgical instrument 480. In fact, the modular handheld ultrasonic surgical instrument 480 may have a particular power requirement or limitation for one dimension or type of outer tube 494 and a second different power requirement for a second type of waveguide having a different dimension, shape, and/or configuration.

[0207] A smart battery assembly 486, according to one aspect of the present disclosure, therefore, allows a battery assembly to be used amongst several surgical instruments. Because the smart battery assembly 486 is able to identify to which device it is attached and is able to alter its output accordingly, the operators of various different surgical instruments utilizing the smart battery assembly 486 no longer need be concerned about which power source they are attempting to install within the electronic device being used. This is particularly advantageous in an operating environment where a battery assembly needs to be replaced or interchanged with another surgical instrument in the middle of a complex surgical procedure.

[0208] In a further aspect of the present disclosure, the smart battery assembly 486 stores in a memory 497 a record of each time a particular device is used. This record can be useful for assessing the end of a device's useful or permitted life. For instance, once a device is used 20 times, such batteries in the smart battery assembly 486 connected to the device will refuse to supply power thereto—because the device is defined as a "no longer reliable" surgical instrument. Reliability is determined based on a number of factors. One factor can be wear, which can be estimated in a number of ways including the number of times the device has been used or activated. After a certain number of uses, the parts of the device can become worn and tolerances between parts exceeded. For instance, the smart battery assembly 486 can sense the number of button pushes received by the handle assembly 482 and can determine when a maximum number of button pushes has been met or exceeded. The smart battery assembly 486 can also monitor an impedance of the button mechanism which can change, for instance, if the handle gets contaminated, for example, with saline.

[0209] This wear can lead to an unacceptable failure during a procedure. In some aspects, the smart battery assembly 486 can recognize which parts are combined together in a device and even how many uses a part has experienced. For instance, if the smart battery assembly 486 is a smart battery according to the present disclosure, it can identify the handle assembly 482, the waveguide shaft assembly 490, as well as the ultrasonic transducer/generator assembly 484, well before the user attempts use of the composite device. The memory 497 within the smart battery assembly 486 can, for example, record a time when the ultrasonic transducer/generator assembly 484 is operated, and how, when, and for how long it is operated.

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If the ultrasonic transducer/generator assembly 484 has an individual identifier, the smart battery assembly 486 can keep track of uses of the ultrasonic transducer/generator assembly 484 and refuse to supply power to that the ultrasonic transducer/generator assembly 484 once the handle assembly 482 or the ultrasonic transducer/generator assembly 484 exceeds its maximum number of uses. The ultrasonic transducer/generator assembly 484, the handle assembly 482, the waveguide shaft assembly 490, or other components can include a memory chip that records this information as well. In this way, any number of smart batteries in the smart battery assembly 486 can be used with any number of ultrasonic transducer/generator assemblies 484, staplers, vessel sealers, etc. and still be able to determine the total number of uses, or the total time of use (through use of the clock), or the total number of actuations, etc. of the ultrasonic transducer/generator assembly 484, the stapler, the vessel sealer, etc. or charge or discharge cycles. Smart functionality may reside outside the battery assembly 486 and may reside in the handle assembly 482, the ultrasonic transducer/generator assembly 484, and/or the shaft assembly 490, for example.

[0210] When counting uses of the ultrasonic transducer/generator assembly 484, to intelligently terminate the life of the ultrasonic transducer/generator assembly 484, the surgical instrument accurately distinguishes between completion of an actual use of the ultrasonic transducer/generator assembly 484 in a surgical procedure and a momentary lapse in actuation of the ultrasonic transducer/generator assembly 484 due to, for example, a battery change or a temporary delay in the surgical procedure. Therefore, as an alternative to simply counting the number of activations of the ultrasonic transducer/generator assembly 484, a real-time clock (RTC) circuit can be implemented to keep track of the amount of time the ultrasonic transducer/generator assembly 484 actually is shut down. From the length of time measured, it can be determined through appropriate logic if the shutdown was significant enough to be considered the end of one actual use or if the shutdown was too short in time to be considered the end of one use. Thus, in some applications, this method may be a more accurate determination of the useful life of the ultrasonic transducer/generator assembly 484 than a simple "activations-based" algorithm, which for example, may provide that ten "activations" occur in a surgical procedure and, therefore, ten activations should indicate that the counter is incremented by one. Generally, this type and system of internal clocking will prevent misuse of the device that is designed to deceive a simple "activations-based" algorithm and will prevent incorrect logging of a complete use in instances when there was only a simple de-mating of the

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ultrasonic transducer/generator assembly 484 or the smart battery assembly 486 that was required for legitimate reasons.

[021 1] Although the ultrasonic transducer/generator assemblies 484 of the surgical instrument 480 are reusable, in one aspect a finite number of uses may be set because the surgical instrument 480 is subjected to harsh conditions during cleaning and sterilization. More specifically, the battery pack is configured to be sterilized. Regardless of the material employed for the outer surfaces, there is a limited expected life for the actual materials used. This life is determined by various characteristics which could include, for example, the amount of times the pack has actually been sterilized, the time from which the pack was manufactured, and the number of times the pack has been recharged, to name a few. Also, the life of the battery cells themselves is limited. Software of the present disclosure incorporates inventive algorithms that verify the number of uses of the ultrasonic transducer/generator assembly 484 and smart battery assembly 486 and disables the device when this number of uses has been reached or exceeded. Analysis of the battery pack exterior in each of the possible sterilizing methods can be performed. Based on the harshest sterilization procedure, a maximum number of permitted sterilizations can be defined and that number can be stored in a memory of the smart battery assembly 486. If it is assumed that a charger is non-sterile and that the smart battery assembly 486 is to be used after it is charged, then the charge count can be defined as being equal to the number of sterilizations encountered by that particular pack.

[0212] In one aspect, the hardware in the battery pack may be to disabled to minimize or eliminate safety concerns due to continuous drain in from the battery cells after the pack has been disabled by software. A situation can exist where the battery's internal hardware is incapable of disabling the battery under certain low voltage conditions. In such a situation, in an aspect, the charger can be used to "kill" the battery. Due to the fact that the battery microcontroller is OFF while the battery is in its charger, a non-volatile, System Management Bus (SMB) based electrically erasable programmable read only memory (EEPROM) can be used to exchange information between the battery microcontroller and the charger. Thus, a serial EEPROM can be used to store information that can be written and read even when the battery microcontroller is OFF, which is very beneficial when trying to exchange information with the charger or other peripheral devices. This example EEPROM can be configured to contain enough memory registers to store at least (a) a use-count limit at which point the battery should be disabled (Battery Use Count), (b) the number of procedures the battery has undergone (Battery Procedure Count), and/or (c) a number of charges the battery has undergone (Charge

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Count), to name a few. Some of the information stored in the EEPROM, such as the Use Count Register and Charge Count Register are stored in write-protected sections of the EEPROM to prevent users from altering the information. In an aspect, the use and counters are stored with corresponding bit-inverted minor registers to detect data corruption.

[0213] Any residual voltage in the SMBus lines could damage the microcontroller and corrupt the SMBus signal. Therefore, to ensure that the SMBus lines of the battery controller 703 do not carry a voltage while the microcontroller is OFF, relays are provided between the external SMBus lines and the battery microcontroller board.

[0214] During charging of the smart battery assembly 486, an "end-of-charge" condition of the batteries within the smart battery assembly 486 is determined when, for example, the current flowing into the battery falls below a given threshold in a tapering manner when employing a constant-current/constant-voltage charging scheme. To accurately detect this "end-of-charge" condition, the battery microcontroller and buck boards are powered down and turned OFF during charging of the battery to reduce any current drain that may be caused by the boards and that may interfere with the tapering current detection. Additionally, the microcontroller and buck boards are powered down during charging to prevent any resulting corruption of the SMBus signal.

[0215] With regard to the charger, in one aspect the smart battery assembly 486 is prevented from being inserted into the charger in any way other than the correct insertion position. Accordingly, the exterior of the smart battery assembly 486 is provided with charger-holding features. A cup for holding the smart battery assembly 486 securely in the charger is configured with a contour-matching taper geometry to prevent the accidental insertion of the smart battery assembly 486 in any way other than the correct (intended) way. It is further contemplated that the presence of the smart battery assembly 486 may be detectable by the charger itself. For example, the charger may be configured to detect the presence of the SMBus transmission from the battery protection circuit, as well as resistors that are located in the protection board. In such case, the charger would be enabled to control the voltage that is exposed at the charger's pins until the smart battery assembly 486 is correctly seated or in place at the charger. This is because an exposed voltage at the charger's pins would present a hazard and a risk that an electrical short could occur across the pins and cause the charger to inadvertently begin charging.

[0216] In some aspects, the smart battery assembly 486 can communicate to the user through audio and/or visual feedback. For example, the smart battery assembly 486 can cause

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the LEDs to light in a pre-set way. In such a case, even though the microcontroller in the ultrasonic transducer/generator assembly 484 controls the LEDs, the microcontroller receives instructions to be carried out directly from the smart battery assembly 486.

[0217] In yet a further aspect of the present disclosure, the microcontroller in the ultrasonic transducer/generator assembly 484, when not in use for a predetermined period of time, goes into a sleep mode. Advantageously, when in the sleep mode, the clock speed of the microcontroller is reduced, cutting the current drain significantly. Some current continues to be consumed because the processor continues pinging waiting to sense an input. Advantageously, when the microcontroller is in this power-saving sleep mode, the microcontroller and the battery controller can directly control the LEDs. For example, a decoder circuit could be built into the ultrasonic transducer/generator assembly 484 and connected to the communication lines such that the LEDs can be controlled independently by the processor 493 while the ultrasonic transducer/generator assembly 484 microcontroller is OFF" or in a "sleep mode." This is a power-saving feature that eliminates the need for waking up the microcontroller in the ultrasonic transducer/generator assembly 484. Power is conserved by allowing the generator to be turned off while still being able to actively control the user-interface indicators.

[0218] Another aspect slows down one or more of the microcontrollers to conserve power when not in use. For example, the clock frequencies of both microcontrollers can be reduced to save power. To maintain synchronized operation, the microcontrollers coordinate the changing of their respective clock frequencies to occur at about the same time, both the reduction and, then, the subsequent increase in frequency when full speed operation is required. For example, when entering the idle mode, the clock frequencies are decreased and, when exiting the idle mode, the frequencies are increased.

[0219] In an additional aspect, the smart battery assembly 486 is able to determine the amount of usable power left within its cells and is programmed to only operate the surgical instrument to which it is attached if it determines there is enough battery power remaining to predictably operate the device throughout the anticipated procedure. For example, the smart battery assembly 486 is able to remain in a non-operational state if there is not enough power within the cells to operate the surgical instrument for 20 seconds. According to one aspect, the smart battery assembly 486 determines the amount of power remaining within the cells at the end of its most recent preceding function, e.g., a surgical cutting. In this aspect, therefore, the smart battery assembly 486 would not allow a subsequent function to be carried out if, for example, during that procedure, it determines that the cells have insufficient power.

Alternatively, if the smart battery assembly 486 determines that there is sufficient power for a subsequent procedure and goes below that threshold during the procedure, it would not interrupt the ongoing procedure and, instead, will allow it to finish and thereafter prevent additional procedures from occurring.

[0220] The following explains an advantage to maximizing use of the device with the smart battery assembly 486 of the present disclosure. In this example, a set of different devices have different ultrasonic transmission waveguides. By definition, the waveguides could have a respective maximum allowable power limit where exceeding that power limit overstresses the waveguide and eventually causes it to fracture. One waveguide from the set of waveguides will naturally have the smallest maximum power tolerance. Because prior-art batteries lack intelligent battery power management, the output of prior-art batteries must be limited by a value of the smallest maximum allowable power input for the smallest/thinnest/most-frail waveguide in the set that is envisioned to be used with the device/battery. This would be true even though larger, thicker waveguides could later be attached to that handle and, by definition, allow a greater force to be applied. This limitation is also true for maximum battery power. For example, if one battery is designed to be used in multiple devices, its maximum output power will be limited to the lowest maximum power rating of any of the devices in which it is to be used. With such a configuration, one or more devices or device configurations would not be able to maximize use of the battery because the battery does not know the particular device's specific limits.

[0221] In one aspect, the smart battery assembly 486 may be employed to intelligently circumvent the above-mentioned ultrasonic device limitations. The smart battery assembly 486 can produce one output for one device or a particular device configuration and the same smart battery assembly 486 can later produce a different output for a second device or device configuration. This universal smart battery surgical system lends itself well to the modern operating room where space and time are at a premium. By having a smart battery pack operate many different devices, the nurses can easily manage the storage, retrieval, and inventory of these packs. Advantageously, in one aspect the smart battery system according to the present disclosure may employ one type of charging station, thus increasing ease and efficiency of use and decreasing cost of surgical room charging equipment.

[0222] In addition, other surgical instruments, such as an electric stapler, may have a different power requirement than that of the modular handheld ultrasonic surgical instrument 480. In accordance with various aspects of the present disclosure, a smart battery assembly 486 can

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be used with any one of a series of surgical instruments and can be made to tailor its own power output to the particular device in which it is installed. In one aspect, this power tailoring is performed by controlling the duty cycle of a switched mode power supply, such as buck, buck-boost, boost, or other configuration, integral with or otherwise coupled to and controlled by the smart battery assembly 486. In other aspects, the smart battery assembly 486 can dynamically change its power output during device operation. For instance, in vessel sealing devices, power management provides improved tissue sealing. In these devices, large constant current values are needed. The total power output needs to be adjusted dynamically because, as the tissue is sealed, its impedance changes. Aspects of the present disclosure provide the smart battery assembly 486 with a variable maximum current limit. The current limit can vary from one application (or device) to another, based on the requirements of the application or device.

[0223] FIG. 26 is a detail view of a trigger 483 portion and switch of the ultrasonic surgical instrument 480 shown in FIG. 25, according to one aspect of the present disclosure. The trigger 483 is operably coupled to the jaw member 495 of the end effector 492. The ultrasonic blade 496 is energized by the ultrasonic transducer/generator assembly 484 upon activating the activation switch 485. Continuing now with FIG. 25 and also looking to FIG. 26, the trigger 483 and the activation switch 485 are shown as components of the handle assembly 482. The trigger 483 activates the end effector 492, which has a cooperative association with the ultrasonic blade 496 of the waveguide shaft assembly 490 to enable various kinds of contact between the end effector jaw member 495 and the ultrasonic blade 496 with tissue and/or other substances. The jaw member 495 of the end effector 492 is usually a pivoting jaw that acts to grasp or clamp onto tissue disposed between the jaw and the ultrasonic blade 496. In one aspect, an audible feedback is provided in the trigger that clicks when the trigger is fully depressed. The noise can be generated by a thin metal part that the trigger snaps over while closing. This feature adds an audible component to user feedback that informs the user that the jaw is fully compressed against the waveguide and that sufficient clamping pressure is being applied to accomplish vessel sealing. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the trigger 483 to measure the force applied to the trigger 483 by the user. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the switch 485 button such that displacement intensity corresponds to the force applied by the user to the switch 485 button.

[0224] The activation switch 485, when depressed, places the modular handheld ultrasonic surgical instrument 480 into an ultrasonic operating mode, which causes ultrasonic motion at

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the waveguide shaft assembly 490. In one aspect, depression of the activation switch 485 causes electrical contacts within a switch to close, thereby completing a circuit between the smart battery assembly 486 and the ultrasonic transducer/generator assembly 484 so that electrical power is applied to the ultrasonic transducer, as previously described. In another aspect, depression of the activation switch 485 closes electrical contacts to the smart battery assembly 486. Of course, the description of closing electrical contacts in a circuit is, here, merely an example general description of switch operation. There are many alternative aspects that can include opening contacts or processor-controlled power delivery that receives information from the switch and directs a corresponding circuit reaction based on the information.

[0225] FIG. 27 is a fragmentary, enlarged perspective view of an end effector 492, according to one aspect of the present disclosure, from a distal end with a jaw member 495 in an open position. Referring to FIG. 27, a perspective partial view of the distal end 498 of the waveguide shaft assembly 490 is shown. The waveguide shaft assembly 490 includes an outer tube 494 surrounding a portion of the waveguide. The ultrasonic blade 496 portion of the waveguide 499 protrudes from the distal end 498 of the outer tube 494. It is the ultrasonic blade 496 portion that contacts the tissue during a medical procedure and transfers its ultrasonic energy to the tissue. The waveguide shaft assembly 490 also includes a jaw member 495 that is coupled to the outer tube 494 and an inner tube (not visible in this view). The jaw member 495, together with the inner and outer tubes and the ultrasonic blade 496 portion of the waveguide 499, can be referred to as an end effector 492. As will be explained below, the outer tube 494 and the non-illustrated inner tube slide longitudinally with respect to each other. As the relative movement between the outer tube 494 and the non-illustrated inner tube occurs, the jaw member 495 pivots upon a pivot point, thereby causing the jaw member 495 to open and close. When closed, the jaw member 495 imparts a pinching force on tissue located between the jaw member 495 and the ultrasonic blade 496, insuring positive and efficient blade-to-tissue contact.

[0226] FIG. 28 illustrates a modular shaft assembly 110 and end effector 112 portions of the surgical instrument 100, according to one aspect of the present disclosure. The shaft assembly 110 comprises an outer tube 144, an inner tube 147, and an ultrasonic transmission waveguide 145. The shaft assembly 110 is removably mounted to the handle assembly 102. The inner tube 147 is slidably received within the outer tube 144. The ultrasonic transmission waveguide 145 is positioned within the inner tube 147. The jaw member 114 of the end effector 112 is pivotally coupled to the outer tube 144 at a pivot point 151. The jaw member 114 also is coupled to inner

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tube 147 by a pin 153 such that as the inner tube 147 slides within the slot 155, the jaw member opens and closes. In the illustrated configuration, the inner tube 147 is in its distal position and the jaw member 114 is open. To close the jaw member 114, the inner tube 147 is retracted in the proximal direction 157 and to open the jaw member is advanced in the distal direction 159. The proximal end of the shaft assembly 110 comprises a jaw member tube (e.g., inner tube)/spring assembly 141 . A spring 139 is provided to apply a constant force control mechanism for use with different shaft assemblies, motor closures to control constant force closures, two bar mechanism to drive closure systems, cam lobes to push and pull closure system, drive screw designs to drive closure or wave spring designs to control constant force.

[0227] FIG. 29 is a detail view of the inner tube/spring assembly 141 . A closure mechanism 149 is operably coupled to the trigger 108 (FIGS. 1-3). Accordingly, as the trigger108 is squeezed, the inner tube 143 is retracted in the proximal direction 157 to close the jaw member 114. Accordingly, as the trigger 108 is released, the inner tube 143 is advanced in the distal direction 159 to open the jaw member 114.

[0228] For a more detailed description of a combination ultrasonic/electrosurgical instrument, reference is made to U.S. Pat. No. 9,107,690, which is herein incorporated by reference.

[0229] FIG. 30 illustrates a modular battery powered handheld combination ultrasonic/electrosurgical instrument 500, according to one aspect of the present disclosure. FIG. 31 is an exploded view of the surgical instrument 500 shown in FIG. 30, according to one aspect of the present disclosure. With reference now to FIGS. 30 and 31, the surgical instrument 500 comprises a handle assembly 502, an ultrasonic transducer/RF generator assembly 504, a battery assembly 506, a shaft assembly 510, and an end effector 512. The ultrasonic transducer/RF generator assembly 504, battery assembly 506, and shaft assembly 510 are modular components that are removably connectable to the handle assembly 502. The handle assembly 502 also comprises a motor assembly 560. The surgical instrument 500 is configured to use both ultrasonic vibration and electrosurgical high-frequency current to carry out surgical coagulation/cutting treatments on living tissue, and uses high-frequency current to carry out a surgical coagulation treatment on living tissue. The ultrasonic vibrations and the high-frequency (e.g., RF) current can be applied independently or in combination according to algorithms or user input control.

[0230] The ultrasonic transducer/RF generator assembly 504 comprises a housing 548, a display 576, such as an LCD display, for example, an ultrasonic transducer 530, an electrical circuit 177 (FIGS. 4, 10 and/or electrical circuit 300 in FIG. 14), and a electrical circuit 702 (FIG.

34) configured to drive an RF electrode and forms a portion of an RF generator circuit. The shaft assembly 510 comprises an outer tube 544 an ultrasonic transmission waveguide 545, and an inner tube (not shown). The end effector 512 comprises a jaw member 514 and an ultrasonic blade 516. The jaw member 514 comprises an electrode 515 that is coupled to an RF generator circuit. The ultrasonic blade 516 is the distal end of the ultrasonic transmission waveguide 545. The jaw member 514 is pivotally rotatable to grasp tissue between the jaw member 514 and the ultrasonic blade 516. The jaw member 514 is operably coupled to a trigger 508. The trigger 508 functions to close the jaw member 514 when the trigger 508 is squeezed and to open the jaw member 514 when the trigger 508 is released to release the tissue. In a one-stage trigger configuration, the trigger 508 is squeezed to close the jaw member 514 and, once the jaw member 514 is closed, a first switch 521a of a switch section is activated to energize the RF generator to seal the tissue. After the tissue is sealed, a second switch 521b of the switch section 520 is activated to energize the ultrasonic generator to cut the tissue. In various aspects, the trigger 508 may be a two-stage, or a multi-stage, trigger. In a two-stage trigger configuration, during the first stage, the trigger 508 is squeezed part of the way to close the jaw member 514 and, during the second stage, the trigger 508 is squeezed the rest of the way to energize the RF generator circuit to seal the tissue. After the tissue is sealed, one of the switches 521a, 521b can be activated to energize the ultrasonic generator to cut the tissue. After the tissue is cut, the jaw member 514 is opened by releasing the trigger 508 to release the tissue. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the trigger 508 to measure the force applied to the trigger 508 by the user. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the switch 520 button such that displacement intensity corresponds to the force applied by the user to the switch 520 button.

[0231] The battery assembly 506 is electrically connected to the handle assembly 502 by an electrical connector 532. The handle assembly 502 is provided with a switch section 520. A first switch 520a and a second switch 520b are provided in the switch section 520. The RF generator is activated by actuating the first switch 520a and the ultrasonic blade 516 is activated by actuating the second switch 520b. Accordingly, the first switch 520a energizes the RF circuit to drive high-frequency current through the tissue to form a seal and the second switch 520b energizes the ultrasonic transducer 530 to vibrate the ultrasonic blade 516 and cut the tissue.

[0232] A rotation knob 518 is operably coupled to the shaft assembly 510. Rotation of the rotation knob 518 ±360° in the direction indicated by the arrows 526 causes an outer tube 544

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to rotate ±360° in the respective direction of the arrows 528. In one aspect, another rotation knob 522 may be configured to rotate the jaw member 514 while the ultrasonic blade 516 remains stationary and the rotation knob 518 rotates the outer tube 144 ±360°. The outer tube 144 may have a diameter D_1 ranging from 5mm to 10mm, for example.

[0233] FIG. 32 is a partial perspective view of a modular battery powered handheld combination ultrasonic/RF surgical instrument 600, according to one aspect of the present disclosure. The surgical instrument 600 is configured to use both ultrasonic vibration and high-frequency current to carry out surgical coagulation/cutting treatments on living tissue, and uses high-frequency current to carry out a surgical coagulation treatment on living tissue. The ultrasonic vibrations and the high-frequency (e.g., RF) current can be applied independently or in combination according to algorithms or user input control. The surgical instrument 600 comprises a handle assembly 602, an ultrasonic transducer/RF generator assembly 604, a battery assembly 606, a shaft assembly (not shown), and an end effector (not shown). The ultrasonic transducer/RF generator assembly 604, battery assembly 606, and shaft assembly are modular components that are removably connectable to the handle assembly 602. A trigger 608 is operatively coupled to the handle assembly 602. As previously described, the trigger operates the end effector.

[0234] The ultrasonic transducer/RF generator assembly 604 comprises a housing 648, a display 676, such as an LCD display, for example. The display 676 provides a visual display of surgical procedure parameters such as tissue thickness, status of seal, status of cut, tissue thickness, tissue impedance, algorithm being executed, battery capacity, energy being applied (either ultrasonic vibration or RF current), among other parameters. The ultrasonic transducer/RF generator assembly 604 also comprises two visual feedback indicators 678, 679 to indicate the energy modality currently being applied in the surgical procedure. For example, one indicator 678 shows when RF energy is being used and another indicator 679 shows when ultrasonic energy is being used. It will be appreciated that when both energy modalities RF and ultrasonic are being applied, both indicators will show this condition. The surgical instrument 600 also comprises an ultrasonic transducer, an ultrasonic generator circuit and/or electrical circuit, a shaft assembly, and an end effector comprising a jaw member and an ultrasonic blade, the modular components being similar to those described in connection with FIGS. 30 and 31 and the description will not be repeated here for conciseness and clarity of disclosure.

[0235] The battery assembly 606 is electrically connected to the handle assembly 602 by an electrical connector. The handle assembly 602 is provided with a switch section 620. A first

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switch 620a and a second switch 620b are provided in the switch section 620. The ultrasonic blade is activated by actuating the first switch 620a and the RF generator is activated by actuating the second switch 620b. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the trigger 608 to measure the force applied to the trigger 608 by the user. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the switch 620 button such that displacement intensity corresponds to the force applied by the user to the switch 620 button.

[0236] A rotation knob 618 is operably coupled to the shaft assembly. Rotation of the rotation knob 618 ±360° causes an outer tube to rotate ±360° in the respective direction, as described herein in connection with FIGS. 30 and 31. In one aspect, another rotation knob may be configured to rotate the jaw member while the ultrasonic blade remains stationary and the rotation knob 618 rotates the outer tube ±360°. A button 673 is used to connect and retain the shaft assembly to the handle assembly 602. Another slide switch 675 is used to lock in and release the ultrasonic transducer/RF generator assembly 604.

[0237] In one aspect, the surgical instrument 500, 600 includes a battery powered advanced energy (ultrasonic vibration plus high-frequency current) with driver amplification broken into multiple stages. The different stages of amplification may reside in different modular components of the surgical instrument 500, 600 such as the handle assembly 502, 602 ultrasonic transducer/RF generator assembly 504, 604, battery assembly 506, 606, shaft assembly 510, and/or the end effector 112. In one aspect, the ultrasonic transducer/RF generator assembly 504, 604 may include an amplification stage in the ultrasonic transducer and/or RF electronic circuits within the housing 548, 648 and different ratios of amplification based on the energy modality associated with the particular energy mode. The final stage may be controlled via signals from the electronic system of the surgical instrument 100 located in the handle assembly 502, 602 and/or the battery assembly 506, 606 through a bus structure, such as I^2C, as previously described. Final stage switches system may be employed to apply power to the transformer and blocking capacitors to form the RF waveform. Measurements of the RF output, such as voltage and current, are fed back to the electronic system over the bus. The handle assembly 502, 602 and/or battery assembly 506, 606 may contain the majority of the primary amplification circuits including any electrical isolation components, motor control, and waveform generator. The two differing ultrasonic transducers (e.g., ultrasonic transducer 130, 130' shown in FIGS. 8 and 9) and the RF transducer contain the electronics to utilize the preconditions generator signals and perform the final conditioning to power different frequency

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transducers of RF signals in the desired frequency ranges and amplitudes. This minimizes the weight size and cost of the electronics residing only in the transducers themselves. It also allows the primary processor boards to occupy the areas of the handle that have the most useful space which is rarely where the transducer is, due to its size. It also allows the electronics to be divided in such a way as the high wear high duty cycle elements could be only connectively attached to the primary electronics enabling it to be more serviceable and repairable since the system is designed for high repeated use before disposal.

[0238] The surgical instruments 500, 600 described in connection with FIGS. 30-32 are configured to use high-frequency current to carry out surgical coagulation/cutting treatments on living tissue, and uses high-frequency current to carry out a surgical coagulation treatment on living tissue. Accordingly, additional structural and functional components to carry out this additional functionality will be described hereinbelow in connection with FIGS. 33-44.

[0239] The structural and functional aspects of the battery assembly 506, 606 are similar to those of the battery assembly 106 for the surgical instrument 100 described in connection with FIGS. 1, 2, and 16-24, including the battery circuits described in connection with FIGS. 20-24. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the battery assembly 106 are incorporated herein by reference and will not be repeated here. Similarly, unless otherwise noted, the structural and functional aspects of the shaft assembly 510 are similar to those of the shaft assembly 110 for the surgical instrument 100 described in connection with FIGS. 1-3. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the shaft assembly 110 are incorporated herein by reference and will not be repeated here. Furthermore, the structural and functional aspects of the ultrasonic transducer 530 generator circuits are similar to those of the ultrasonic transducer 130 generator circuits for the surgical instrument 100 described in connection with FIGS. 1, 2, and 4-15. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the ultrasonic transducer 130 and generator circuits are incorporated herein by reference and will not be repeated here. Furthermore, the surgical instruments 500, 600 include the circuits described in connection with FIGS. 12-15, including, for example, the control circuit 210 described in connection with FIG. 14 and the electrical circuit 300 described in connection withe FIG. 15. Accordingly, for conciseness and clarity of disclosure, the description of the circuits described in connection with FIGS. 12-15 is incorporated herein by reference and will not be repeated here.

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[0240] Turning now to FIG. 33, there is shown a nozzle 700 portion of the surgical instruments 500, 600 described in connection with FIGS. 30-32, according to one aspect of the present disclosure. The nozzle 700 contains an electrical circuit 702 configured to drive the high-frequency RF current to an electrode located in the end effector as described hereinbelow in connection with FIGS. 38-44. The electrical circuit 702 is coupled to the primary winding of a transformer 704. The positive side of the secondary winding of the transformer 704 is coupled to series connected first and second blocking capacitors 706, 708. The load side of the second blocking capacitor 708 is coupled to the positive RF(+) terminal which is coupled to the positive side of the end effector electrode. The negative side of the secondary winding of the transformer 704 is coupled to the negative RF(-) terminal, otherwise referred to as ground. It will be appreciated that the RF(-) or ground terminal of the RF energy circuit is coupled to an outer tube 744, which is formed of an electrically conductive metal. Accordingly, in use, high-frequency current is conducted from the end effector electrode RF(+), through the tissue, and returns through the negative electrode RF(-).

[0241] With reference now also to FIGS. 30, 31, in one aspect, the outer tube 744 is operably coupled to the jaw member 514 portion of the end effector 512 such that the jaw member 514 opens when the outer tube 744 is advanced in the distal direction 722 and the jaw member 514 closes when the outer tube 744 is retracted in the proximal direction 724. Although not shown in FIG. 33, the outer tube 744 is operably coupled to the trigger 508, which is used to open and close the jaw member 514 portion of the end effector 512. Examples of actuation mechanisms for use with ultrasonic surgical instruments as described herein are disclosed in U.S. Pub. No. 2006/0079879 and U.S. Pub. No. 2015/0164532, each of which is herein incorporated by reference.

[0242] Still with reference to FIGS. 30, 31, and 33, in one aspect, an inner tube 714 is slidably disposed within the outer tube 744. The inner tube 714 is operably coupled to the jaw member 514 to rotate the jaw member 514 while maintaining the ultrasonic blade 516 stationary. In the aspect shown in FIGS. 30 and 31 the inner tube 714 is rotated by the rotation knob 522. In the aspect shown in FIG. 33, a motor 719 may be provided within the handle assembly 502 to engage a gear 721 on the proximal end of the outer tube 744, optionally through an idler gear 725.

[0243] Still with reference to FIGS. 30, 31, and 33, in one aspect, an inner electrically insulative (e.g., rubber, plastic) tube 716 is slidably disposed within the inner tube 714. A flex circuit 728 may be disposed within the inner electrically insulative tube 716 to electrically couple

energy and sensor circuits to the end effector 512. For example, the jaw member 514 may comprise an electrode coupled to conductors in the flex circuit 728. In other aspects, the end effector 512, jaw member 514, or the ultrasonic blade 516 may comprise various sensors or other electrical elements that can be interconnected to electrical circuits and components in the shaft assembly 510, the handle assembly 502, the ultrasonic transducer/RF generator assembly 504, and/or the battery assembly 506, for example.

[0244] Still with reference to FIGS. 30, 31, and 33, in one aspect, the ultrasonic transmission waveguide 545 (shown in FIG. 32 only; not shown in FIG. 33 for clarity) is disposed within the inner electrically insulative tube 716. In one aspect, the positive electrode RF(+) of the electrical circuit 702 is electrically coupled to the ultrasonic transmission waveguide 545 and the negative electrode RF(-) of the electrical circuit 702 is electrically coupled to an electrode disposed in the jaw member 514, which is electrically coupled to the outer tube 744. In operation, after tissue is grasped between the ultrasonic blade 516 and the jaw member 514, control circuits of the surgical instrument 500 can execute various algorithms to seal and the cut the tissue. The ultrasonic vibrations and high-frequency energy may be applied to the tissue in accordance with monitored tissue conditions such as tissue impedance, friction, and the like. In some situations, high-frequency current is applied to the tissue through the ultrasonic blade 516 and back to the outer tube 744 return path. The tissue impedance is monitored and when a tissue seal is formed, as may be determined by the tissue impedance, the ultrasonic blade 516 is mechanically energized to induce vibrational energy into the tissue to cut the tissue. In other aspects ultrasonic vibrations and high-frequency may be applied by pulsing these energy modalities, applying the energy modalities alternatively or simultaneously. In somewhat unique situations, an algorithm can detect when the tissue impedance is extremely low to deliver energy to the tissue. In response, the algorithm energizes the ultrasonic blade 516 mechanically to apply vibratory energy to the tissue until such time that the impedance rises above a threshold suitable for the application of the high-frequency current. Upon reaching this threshold, the algorithm switches energy delivery mode to high-frequency current to seal the tissue.

[0245] FIG. 34 is a schematic diagram of one aspect of an electrical circuit 702 configured to drive a high-frequency current (RF), according to one aspect of the present disclosure. The electrical circuit 702 comprises an analog multiplexer 580. The analog multiplexer 580 multiplexes various signals from the upstream channels SCL-A/SDA-A such as RF, battery, and power control circuit. A current sensor 582 is coupled in series with the return or ground leg of

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the power supply circuit to measure the current supplied by the power supply. A field effect transistor (FET) temperature sensor 584 provides the ambient temperature. A pulse width modulation (PWM) watchdog timer 588 automatically generates a system reset if the main program neglects to periodically service it. It is provided to automatically reset the electrical circuit 702 when it hangs or freezes because of a software or hardware fault. It will be appreciated that the electrical circuit 702 may be configured for driving RF electrodes or for driving the ultrasonic transducer 130 as described in connection with FIG. 11, for example. Accordingly, with reference now back to FIG. 34, the electrical circuit 702 can be used to drive both ultrasonic and RF electrodes interchangeably.

[0246] A drive circuit 586 provides left and right RF energy outputs. A digital signal that represents the signal waveform is provided to the SCL-A/SDA-A inputs of the analog multiplexer 580 from a control circuit, such as the control circuit 210 (FIG. 14). A digital-to-analog converter 590 (DAC) converts the digital input to an analog output to drive a PWM circuit 592 coupled to an oscillator 594. The PWM circuit 592 provides a first signal to a first gate drive circuit 596a coupled to a first transistor output stage 598a to drive a first RF+ (Left) energy output. The PWM circuit 592 also provides a second signal to a second gate drive circuit 596b coupled to a second transistor output stage 598b to drive a second RF- (Right) energy output. A voltage sensor 599 is coupled between the RF Left/RF output terminals to measure the output voltage. The drive circuit 586, the first and second drive circuits 596a, 596b, and the first and second transistor output stages 598a, 598b define a first stage amplifier circuit. In operation, the control circuit 210 (FIG. 14) generates a digital waveform 1800 (FIG. 67) employing circuits such as direct digital synthesis (DDS) circuits 1500, 1600 (FIGS. 65 and 66). The DAC 590 receives the digital waveform 1800 and converts it into an analog waveform, which is received and amplified by the first stage amplifier circuit.

[0247] FIG. 35 is a schematic diagram of the transformer 704 coupled to the electrical circuit 702 shown in FIG. 34, according to one aspect of the present disclosure. The RF Left/RF input terminals (primary winding) of the transformer 704 are electrically coupled to the RF Left/RF output terminals of the electrical circuit 702. One side of the secondary winding is coupled in series with first and second blocking capacitors 706, 708. The second blocking capacitor is coupled to the RF+ 574a terminal. The other side of the secondary winding is coupled to the RF- 574b terminal. As previously discussed, the RF+ 574a output is coupled to the ultrasonic blade 516 (FIG. 30) and the RF- 574b ground terminal is coupled to the outer tube 544 (FIG. 30). In one aspect, the transformer 166 has a turns-ratio of n1:n2 of 1:50.

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[0248] FIG. 36 is a schematic diagram of a circuit 710 comprising separate power sources for high power energy/drive circuits and low power circuits, according to one aspect of the present disclosure. A power supply 712 includes a primary battery pack comprising first and second primary batteries 715, 717 (e.g., Li-ion batteries) that are connected into the circuit 710 by a switch 718 and a secondary battery pack comprising a secondary battery 720 that is connected into the circuit by a switch 723 when the power supply 712 is inserted into the battery assembly. The secondary battery 720 is a sag preventing battery that has componentry resistant to gamma or other radiation sterilization. For instance, a switch mode power supply 727 and optional charge circuit within the battery assembly can be incorporated to allow the secondary battery 720 to reduce the voltage sag of the primary batteries 715, 717. This guarantees full charged cells at the beginning of a surgery that are easy to introduce into the sterile field. The primary batteries 715, 717 can be used to power the motor control circuits 726 and the energy circuits 732 directly. The power supply/battery pack 712 may comprise a dual type battery assembly including primary Li-ion batteries 715, 717 and secondary NiMH batteries 720 with dedicated energy cells 720 to control the handle electronics circuits 730 from dedicated energy cells 715, 717 to run the motor control circuits 726 and the energy circuits 732. In this case the circuit 710 pulls from the secondary batteries 720 involved in driving the handle electronics circuits 730 when the primary batteries 715, 717 involved in driving the energy circuits 732 and/or motor control circuits 726 are dropping low. In one various aspect, the circuit 710 may include a one way diode that would not allow for current to flow in the opposite direction (e.g., from the batteries involved in driving the energy and/or motor control circuits to the batteries involved in driving the electronics circuits).

[0249] Additionally, a gamma friendly charge circuit may be provided that includes a switch mode power supply 727 using diodes and vacuum tube components to minimize voltage sag at a predetermined level. With the inclusion of a minimum sag voltage that is a division of the NiMH voltages (3 NiMH cells) the switch mode power supply 727 could be eliminated. Additionally a modular system may be provided wherein the radiation hardened components are located in a module, making the module sterilizable by radiation sterilization. Other non-radiation hardened components may be included in other modular components and connections made between the modular components such that the componentry operates together as if the components were located together on the same circuit board. If only two NiMH cells are desired the switch mode power supply 727 based on diodes and vacuum tubes allows for sterilizable electronics within the disposable primary battery pack.

[0250] Turning now to FIG. 37, there is shown a control circuit 800 for operating a battery 801 powered RF generator circuit 802 for use with the surgical instrument 500 shown in FIGS. 30 and 31, according to one aspect of the present disclosure. The surgical instrument 500 is configured to use both ultrasonic vibration and high-frequency current to carry out surgical coagulation/cutting treatments on living tissue, and uses high-frequency current to carry out a surgical coagulation treatment on living tissue.

[0251] FIG. 37 illustrates a control circuit 800 that allows a dual generator system to switch between the RF generator circuit 802 and the ultrasonic generator circuit 820 (similar to the electrical circuit 177 shown in FIGS. 11 and 12) energy modalities for the surgical instrument 500 shown in FIGS. 30 and 31. In one aspect, a current threshold in an RF signal is detected. When the impedance of the tissue is low the high-frequency current through tissue is high when RF energy is used as the treatment source for the tissue. According to one aspect, a visual indicator 812 or light located on the surgical instrument 500 may be configured to be in an on-state during this high current period. When the current falls below a threshold, the visual indicator 812 is in an off-state. Accordingly, a photo-transistor 814 may be configured to detect the transition from an on-state to an off-state and disengages the RF energy as shown in the control circuit 800 shown in FIG. 37. Therefore, when the energy button is released and the energy switch 826 is opened, the control circuit 800 is reset and both the RF and ultrasonic generator circuits 802, 820 are held off.

[0252] With reference to FIGS. 30-33 and 37, in one aspect, a method of managing an RF generator circuit 802 and ultrasound generator circuit 820 is provided. As previously described the RF generator circuit 802 and/or the ultrasound generator circuit 820 may be located in the handle assembly 502, the ultrasonic transducer/RF generator assembly 504, the battery assembly 506, the shaft assembly 510, and/or the nozzle 700. The control circuit 800 is held in a reset state if the energy switch 826 is off (e.g., open). Thus, when the energy switch 826 is opened, the control circuit 800 is reset and both the RF and ultrasonic generator circuits 802, 820 are turned off. When the energy switch 826 is squeezed and the energy switch 826 is engaged (e.g., closed), RF energy is delivered to the tissue and a visual indicator 812 operated by a current sensing step-up transformer 804 will be lit while the tissue impedance is low. The light from the visual indicator 812 provides a logic signal to keep the ultrasonic generator circuit 820 in the off state. Once the tissue impedance increases above a threshold and the high-frequency current through the tissue decreases below a threshold, the visual indicator 812 turns off and the light transitions to an off-state. A logic signal generated by this transition turns off the

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relay 808, whereby the RF generator circuit 802 is turned off and the ultrasonic generator circuit 820 is turned on, to complete the coagulation and cut cycle.

[0253] Still with reference to FIGS. 30-33 and 37, in one aspect, the dual generator circuit 802, 820 configuration employs an on-board RF generator circuit 802, which is battery 801 powered, for one modality and a second, on-board ultrasound generator circuit 820, which may be on-board in the handle assembly 502, battery assembly 506, shaft assembly 510, nozzle 700, and/or the ultrasonic transducer/RF generator assembly 504. The ultrasonic generator circuit 820 also is battery 801 operated. In various aspects, the RF generator circuit 802 and the ultrasonic generator circuit 820 may be an integrated or separable component of the handle assembly 502. According to various aspects, having the dual RF/ultrasonic generator circuits 802, 820 as part of the handle assembly 502 may eliminate the need for complicated wiring in an environment where the surgical instrument 500. The RF/ultrasonic generator circuits 802, 820 may be configured to provide the full capabilities of an existing generator while utilizing the capabilities of a cordless generator system simultaneously.

[0254] Either type of system can have separate controls for the modalities that are not communicating with each other. The surgeon activates the RF and Ultrasonic separately and at their discretion. Another approach would be to provide fully integrated communication schemes that share buttons, tissue status, instrument operating parameters (such as jaw closure, forces, etc.) and algorithms to manage tissue treatment. Various combinations of this integration can be implemented to provide the appropriate level of function and performance.

[0255] In one aspect, the control circuit 800 includes a battery 801 powered RF generator circuit 802 comprising a battery as an energy source. As shown, RF generator circuit 802 is coupled to two electrically conductive surfaces referred to herein as electrodes 806a, 806b and is configured to drive the electrodes 806a, 806b with RF energy (e.g., high-frequency current). A first winding 810a of a step-up transformer 804 is connected in series with one pole of the bipolar RF generator circuit 802 and the return electrode 806b. In one aspect, the first winding 810a and the return electrode 806b are connected to the negative pole of the bipolar RF generator circuit 802. The other pole of the bipolar RF generator circuit 802 is connected to the active electrode 806a through a switch contact 809 of a relay 808, or any suitable electromagnetic switching device comprising an armature which is moved by an electromagnet 836 to operate the switch contact 809. The switch contact 809 is closed when the electromagnet 836 is energized and the switch contact 809 is open when the electromagnet 836 is de-energized. When the switch contact is closed, RF current flows through conductive tissue (not

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shown) located between the electrodes 806a, 806b. It will be appreciated, that in one aspect, the active electrode 806a is connected to the positive pole of the bipolar RF generator circuit 802.

[0256] A visual indicator circuit 805 comprises a step-up transformer 804, a series resistor R2, and a visual indicator 812. The visual indicator 812 can be adapted for use with the surgical instrument 500 and other electrosurgical systems and tools, such as those described herein. The first winding 810a of the step-up transformer 804 is connected in series with the return electrode 806b and a second winding 810b of the step-up transformer 804 is connected in series with a resistor R2 and a visual indicator 812 comprising a type NE-2 neon bulb, for example.

[0257] In operation, when the switch contact 809 of the relay 808 is open, the active electrode 806a is disconnected from the positive pole of the bipolar RF generator circuit 802 and no current flows through the tissue, the return electrode 806b, and the first winding 810a of the step-up transformer 804. Accordingly, the visual indicator 812 is not energized and does not emit light. When the switch contact 809 of the relay 808 is closed, the active electrode 806a is connected to the positive pole of the bipolar RF generator circuit 802 enabling current to flow through tissue, the return electrode 806b, and the first winding 810a of the step-up transformer 804 to operate on tissue, for example cut and cauterize the tissue.

[0258] A first current flows through the first winding 810a as a function of the impedance of the tissue located between the active and return electrodes 806a, 806b providing a first voltage across the first winding 810a of the step-up transformer 804. A stepped up second voltage is induced across the second winding 810b of the step-up transformer 804. The secondary voltage appears across the resistor R2 and energizes the visual indicator 812 causing the neon bulb to light when the current through the tissue is greater than a predetermined threshold. It will be appreciated that the circuit and component values are illustrative and not limited thereto. When the switch contact 809 of the relay 808 is closed, current flows through the tissue and the visual indicator 812 is turned on.

[0259] Turning now to the energy switch 826 portion of the control circuit 800, when the energy switch 826 is open position, a logic high is applied to the input of a first inverter 828 and a logic low is applied of one of the two inputs of the AND gate 832. Thus, the output of the AND gate 832 is low and the transistor 834 is off to prevent current from flowing through the winding of the electromagnet 836. With the electromagnet 836 in the de-energized state, the switch contact 809 of the relay 808 remains open and prevents current from flowing through the

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electrodes 806a, 806b. The logic low output of the first inverter 828 also is applied to a second inverter 830 causing the output to go high and resetting a flip-flop 818 (e.g., a D-Type flip-flop). At which time, the Q output goes low to turn off the ultrasound generator circuit 820 circuit and the $\overline{Q}$ output goes high and is applied to the other input of the AND gate 832.

[0260] When the user presses the energy switch 826 on the instrument handle to apply energy to the tissue between the electrodes 806a, 806b, the energy switch 826 closes and applies a logic low at the input of the first inverter 828, which applies a logic high to other input of the AND gate 832 causing the output of the AND gate 832 to go high and turns on the transistor 834. In the on state, the transistor 834 conducts and sinks current through the winding of the electromagnet 836 to energize the electromagnet 836 and close the switch contact 809 of the relay 808. As discussed above, when the switch contact 809 is closed, current can flow through the electrodes 806a, 806b and the first winding 810a of the step-up transformer 804 when tissue is located between the electrodes 806a, 806b.

[0261] As discussed above, the magnitude of the current flowing through the electrodes 806a, 806b depends on the impedance of the tissue located between the electrodes 806a, 806b. Initially, the tissue impedance is low and the magnitude of the current high through the tissue and the first winding 810a. Consequently, the voltage impressed on the second winding 810b is high enough to turn on the visual indicator 812. The light emitted by the visual indicator 812 turns on the phototransistor 814, which pulls the input of the inverter 816 low and causes the output of the inverter 816 to go high. A high input applied to the ***CLK*** of the flip-flop 818 has no effect on the Q or the $\overline{Q}$ outputs of the flip-flop 818 and Q output remains low and the $\overline{Q}$ output remains high. Accordingly, while the visual indicator 812 remains energized, the ultrasound generator circuit 820 is turned OFF and the ultrasonic transducer 822 and ultrasonic blade 824 are not activated.

[0262] As the tissue between the electrodes 806a, 806b dries up, due to the heat generated by the current flowing through the tissue, the impedance of the tissue increases and the current therethrough decreases. When the current through the first winding 810a decreases, the voltage across the second winding 810b also decreases and when the voltage drops below a minimum threshold required to operate the visual indicator 812, the visual indicator 812 and the phototransistor 814 turn off. When the phototransistor 814 turns off, a logic high is applied to the input of the inverter 816 and a logic low is applied to the ***CLK*** input of the flip-flop 818 to clock a logic high to the Q output and a logic low to the $\overline{Q}$ output. The logic high at the Q output turns on the ultrasound generator circuit 820 to activate the ultrasonic transducer 822 and the ultrasonic

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blade 824 to initiate cutting the tissue located between the electrodes 806a, 806a. Simultaneously or near simultaneously with the ultrasound generator circuit 820 turning on, the $\overline{Q}$ output of the flip-flop 818 goes low and causes the output of the AND gate 832 to go low and turn off the transistor 834, thereby de-energizing the electromagnet 836 and opening the switch contact 809 of the relay 808 to cut off the flow of current through the electrodes 806a, 806b.

[0263] While the switch contact 809 of the relay 808 is open, no current flows through the electrodes 806a, 806b, tissue, and the first winding 810a of the step-up transformer 804. Therefore, no voltage is developed across the second winding 810b and no current flows through the visual indicator 812.

[0264] The state of the Q and the $\overline{Q}$ outputs of the flip-flop 818 remain the same while the user squeezes the energy switch 826 on the instrument handle to maintain the energy switch 826 closed. Thus, the ultrasonic blade 824 remains activated and continues cutting the tissue between the jaws of the end effector while no current flows through the electrodes 806a, 806b from the bipolar RF generator circuit 802. When the user releases the energy switch 826 on the instrument handle, the energy switch 826 opens and the output of the first inverter 828 goes low and the output of the second inverter 830 goes high to reset the flip-flop 818 causing the Q output to go low and turn off the ultrasound generator circuit 820. At the same time, the $\overline{Q}$ output goes high and the circuit is now in an off state and ready for the user to actuate the energy switch 826 on the instrument handle to close the energy switch 826, apply current to the tissue located between the electrodes 806a, 806b, and repeat the cycle of applying RF energy to the tissue and ultrasonic energy to the tissue as described above.

[0265] FIG. 38 is a sectional view of an end effector 900, according to one aspect of the present disclosure. The end effector 900 comprises an ultrasonic blade 902 and a jaw member 904. The jaw member 904 has a channel-shaped groove 906 in which part of the end effector 900 is engaged, along an axial direction. The channel-shaped groove 906 has a wide channel shape with a wide opening in a section orthogonal to an axis of the jaw member 904. The jaw member 904 is made of a conductive material, and an insulating member 910 is provided in a range where the ultrasonic blade 902 is in contact along the axial direction on a bottom surface portion 912 of the channel shape.

[0266] The ultrasonic blade 902 has a rhombic shape partially cut out in the section orthogonal to the axial direction. The sectional shape of the ultrasonic blade 902 is a shape which is cut out in the direction orthogonal to a longer diagonal line of the rhombic shape as shown in FIG. 38. The ultrasonic blade 902 with part of the rhombic shape cut out in the

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sectional shape has a trapezoidal portion 914 which is engaged in the channel-shaped groove 906 of the jaw member 904. A portion in which part of the rhombic shape is not cut out in the sectional shape is an isosceles triangle portion 916 of the ultrasonic blade 902.

[0267] When the trigger of the handle assembly is closed, the ultrasonic blade 902 and the jaw member 904 are fitted to each other. When they are fitted, the bottom surface portion 912 of the channel-shaped groove 906 abuts on a top surface portion 918 of the trapezoidal portion 914 of the ultrasonic blade 902, and two inner wall portions 920 of the channel-shaped groove 906 abut on inclined surface portions 922 of the trapezoidal portion 914.

[0268] Further, an apex portion 924 of the isosceles triangle portion 916 of the ultrasonic blade 902 is formed to be rounded, but the apex portion 924 has a slightly sharp angle.

[0269] When the surgical instrument is used as a spatulate ultrasound treatment instrument, the ultrasonic blade 902 acts as an ultrasound vibration treatment portion, and the apex portion 924 and its peripheral portion (shown by the dotted line) particularly act as a scalpel knife to the tissue of the treatment object.

[0270] Further, when the surgical instrument is used as a spatulate high-frequency treatment instrument, the apex portion 924 and its peripheral portion (shown by the dotted line) act as an electric scalpel knife to the tissue of the treatment object.

[0271] In one aspect, the bottom surface portion 912 and the inner wall portions 920, and the top surface portion 918 and the inclined surface portions 922 act as the working surfaces of an ultrasound vibration.

[0272] Further, in one aspect, the inner wall portions 920 and the inclined surface portions 922 act as the working surfaces of a bipolar high-frequency current.

[0273] In one aspect, the surgical instrument may be used as a spatulate treatment instrument of simultaneous output of ultrasound and high-frequency current, the ultrasonic blade 902 acts as the ultrasound vibration treatment portion, and the apex portion 924 and its peripheral portion (shown by the dotted line) particularly act as an electrical scalpel knife to the tissue of the treatment object.

[0274] Further, when the surgical instrument provides simultaneous output of ultrasound and high-frequency current, the bottom surface portion 912 and the top surface portion 918 act as the working surfaces of an ultrasound vibration, and the inner wall portions 920 and the inclined surface portions 922 act as the working surfaces of a bipolar high-frequency current.

[0275] Consequently, according to the configuration of the treatment portion shown in FIG. 37, excellent operability is provided not only in the case of use of the surgical instrument as an

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ultrasound treatment instrument or a high-frequency treatment instrument, but also in the case of use of the surgical instrument as an ultrasound treatment instrument or high-frequency current treatment instrument, and further in the case of use of the surgical instrument for the time of simultaneous output of ultrasound and high frequency.

[0276] When the surgical instrument performs high-frequency current output or simultaneous output of high-frequency current and ultrasound, monopolar output may be enabled instead of a bipolar output as the high-frequency output.

[0277] FIG. 39 is a sectional view of an end effector 930, according to one aspect of the present disclosure. The jaw member 932 is made of a conductive material, and an insulating member 934 is provided along the axial direction on a bottom surface portion 936 of the channel shape.

[0278] The ultrasonic blade 938 has a rhombic shape partially cut out in the section orthogonal to the axial direction. The sectional shape of the ultrasonic blade 938 is a shape in which part of the rhombic shape is cut out in the direction orthogonal to one diagonal line as shown in FIG. 39. The ultrasonic blade 938 with part of the rhombic shape cut out in the sectional shape has a trapezoidal portion 940 which is engaged in a channel-shaped groove 942 of the jaw member 932. A portion in which part of the rhombic shape is not cut out in the sectional shape is an isosceles triangle portion 944 of the end effector 900.

[0279] When the trigger of the handle assembly is closed, the ultrasonic blade 938 and the jaw member 906 are fitted to each other. When they are fitted, the bottom surface portion 936 of the channel-shaped groove 942 abuts on a top surface portion 946 of the trapezoidal portion 940 of the ultrasonic blade 938, and two inner wall portions 954 of the channel-shaped groove 932 abut on inclined surface portions 948 of the trapezoidal portion 940.

[0280] Further, an apex portion 950 of the isosceles triangle portion 944 of the ultrasonic blade 938 is formed to be rounded, but an apex portion 952 of the inner side of the hook shape has a slightly sharp angle. An angle $\Theta$of the apex portion 952 is preferably 45° to 100°. 45° is a strength limit of the ultrasonic blade 938. As above, the apex portion 952 of the ultrasonic blade 938 configures a protruding portion having a predetermined angle at the inner side of the hook-shaped portion, that is, an edge portion.

[0281] The treatment portion in the hook shape is often used for dissection. The apex portion 952 of the end effector 930 becomes a working portion at the time of dissection. Since the apex portion 952 has the slightly sharp angle Θ, the apex portion 952 is effective for dissection treatment.

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[0282] The ultrasonic blade 938 and the jaw member 932 shown in FIG. 39 perform the same operation as the ultrasonic blade 938 and the jaw member 932 shown in FIG. 38 at the time of ultrasound output, at the time of high-frequency output, and at the time of simultaneous output of ultrasound and high frequency respectively, except for the aforementioned operation at the time of dissection.

[0283] Referring now to FIGS. 40-43, there is shown and end effector 1000 operably coupled to an insertion sheath 1001, which is formed by an outer sheath 1002 and an inner sheath 1004. The end effector 1000 comprises an ultrasonic blade 1006 and a jaw member 1014. In the outer sheath 1002, the outside of a conductive metal pipe is covered with an insulating resin tube. The inner sheath 1004 is a conductive metal pipe. The inner sheath 1004 can be axially moved back and forth relative to the outer sheath 1002.

[0284] The ultrasonic blade 1006 is made of a conductive material having high acoustic effects and biocompatibility, for example, a titanium alloy such as a Ti-6Al-4V alloy. In the ultrasonic blade 1006, an insulating and elastic rubber lining 1008 is externally equipped in the position of nodes of the ultrasonic vibration. The rubber lining 1008 is disposed between the inner sheath 1004 and the ultrasonic blade 1006 in a compressed state. The ultrasonic blade 1006 is held to the inner sheath 1004 by the rubber lining 1008. A clearance is maintained between the inner sheath 1004 and the ultrasonic blade 1006.

[0285] An abutting portion 1010 is formed by the part of the ultrasonic blade 1012 facing the jaw member 1014 at the distal end portion of the ultrasonic blade 1006. Here, the ultrasonic blade 1012 is octagonal in its cross section perpendicular to the axial directions of the ultrasonic blade 1006. An abutting surface 1016 is formed by one surface of the abutting portion 1010 facing the jaw member! 014. A pair of electrode surfaces 1018 is formed by surfaces provided to the sides of the abutting surface 1016.

[0286] The jaw member 1014 is formed by a body member 1020, an electrode member 1022, a pad member 1024, and a regulating member 1026 as a regulating section.

[0287] The body member 1020 is made of a hard and conductive material. A proximal end portion of the body member 1020 constitutes a pivot connection portion 1028. The pivot connection portion 1028 is pivotally connected to a distal end portion of the outer sheath 1002 via a pivot connection shaft 1030. The pivot connection shaft 1030 extends in width directions perpendicular to the axial directions and the opening/closing directions. The body member 1020 can turn about the pivot connection shaft 1030 in the opening/closing directions relative to the outer sheath 1002. A distal end portion of the inner sheath 1004 is pivotally connected to the

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pivot connection portion 1028 of the body member 1020 at a position provided to the distal side and the opening-direction side of the pivot connection shaft 1030. If the movable handle is turned relative to the fixed handle in the handle unit, the inner sheath 1004 is moved back and forth relative to the outer sheath 1002, and the body member 1020 is driven by the inner sheath 1004 to turn about the pivot connection shaft 1030 in the opening/closing directions relative to the outer sheath 1002. In one aspect, a distal part of the body member 1020 constitutes a pair of pivot bearings 1032. The pair of pivot bearings 1032 are in the form of plates which extend in the axial directions and which are perpendicular to the width directions, and are disposed apart from each other in the width directions.

[0288] The electrode member 1022 is made of a hard and conductive material. The part of the electrode member 1022 provided on the opening-direction side constitutes a pivot support 1034. An insertion hole 1036 is formed through the pivot support 1034 in the width directions. A pivot support shaft 1038 is inserted through the insertion hole 1036 and extends in the width directions. The pivot support 1034 is disposed between the pair of pivot bearings 1032 of the body member 1020, and is pivotally supported on the pair of pivot bearings 1032 via the pivot support shaft 1038. The electrode member 1022 can oscillate about the pivot support shaft 1038 relative to the body member 1020. Further, the part of the electrode member 1022 provided on the closing-direction side constitutes an electrode section 1040. The electrode section 1040 extends in the axial directions and projects to the sides in the width directions. A recessed groove 1042 which is open toward the closing direction extends in the axial directions in the part of the electrode section 1040 provided on the closing-direction side. Teeth are axially provided in the parts of the groove 1042 provided in the closing direction side, thus forming a tooth portion 1044. The side surfaces that define the groove 1042 constitute a pair of electrode receiving surfaces 1046 that are inclined from the closing direction toward the sides in the width directions. A recessed mating receptacle 1048 which is open toward the closing direction axially extends in a bottom portion that defines the groove 1042. An embedding hole 1050 is formed through the pivot support 1034 of the electrode member 1022 in the opening/closing directions perpendicularly to the insertion hole 1036. The embedding hole 1050 is open to the mating receptacle 1048.

[0289] The pad member 1024 is softer than the ultrasonic blade 1006, and is made of an insulating material having biocompatibility such as polytetrafluorethylene. The pad member 1024 is mated with the mating receptacle 1048 of the electrode member 1022. The part of the pad member 1024 provided on the closing-direction side protrudes from the electrode member

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1022 to the closing direction, thus forming an abutting receptacle 1052. In the cross section perpendicular to the axial directions, the abutting receptacle 1052 is in a recessed shape corresponding to the projecting shape of the abutting portion 1010 of the ultrasonic blade 1012. When the jaw member! 014 is closed relative to the ultrasonic blade 1012, the abutting portion 1010 of the ultrasonic blade 1012 abuts onto and engages with the abutting receptacle 1052 of the pad member 1024. The pair of electrode surfaces 1018 of the ultrasonic blade 1012 are arranged parallel to the pair of electrode receiving surfaces 1046 of the electrode section 1040, and a clearance is maintained between the electrode section 1040 and the ultrasonic blade 1012.

[0290] The regulating member 1026 is harder than the ultrasonic blade 1006, and is made of an insulating high-strength material such as ceramics. The regulating pad member 1024 is pin-shaped. The regulating pad member 1024 is inserted into the embedding hole 1050 of the pivot support 1034 of the electrode member 1022, protrudes toward the mating receptacle 1048 of the electrode section 1040, and is embedded in the abutting receptacle 1052 of the pad member 1024 in the mating receptacle 1048. A closing-direction end of the regulating member 1026 constitutes a regulating end 1054. The regulating end 1054 does not protrude from the abutting receptacle 1052 to the closing direction, and is accommodated in the abutting receptacle 1052. The insertion hole 1036 is also formed through the regulating member 1026, and the pivot support shaft 1038 is inserted through the insertion hole 1036 of the regulating member 1026.

[0291] Here, the inner sheath 1004, the body member 1020, and the electrode member 1022 are electrically connected to one another, and constitute the first electrical path 1056 used in a high-frequency surgical treatment. The electrode section 1040 of the electrode member 1022 functions as one of bipolar electrodes used in a high-frequency surgical treatment. In one aspect, the ultrasonic blade 1006 constitutes the second electrical path 1058 used in the high-frequency treatment. The ultrasonic blade 1012 provided to the distal end portion of the ultrasonic blade 1006 functions as the other of the bipolar electrodes used in a high-frequency treatment. As described above, the ultrasonic blade 1006 is held to the inner sheath 1004 by the insulating rubber lining 1008, and the clearance is maintained between the inner sheath 1004 and the ultrasonic blade 1006. This prevents a short circuit between the inner sheath 1004 and the ultrasonic blade 1006. When the jaw member! 014 is closed relative to the ultrasonic blade 1012, the abutting portion 1010 of the ultrasonic blade 1012 abuts onto and engages with the abutting receptacle 1052 of the pad member 1024. Thus, the pair of electrode surfaces 1018 of

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the ultrasonic blade 1012 are arranged parallel to the pair of electrode receiving surfaces 1046 of the electrode section 1040, and the clearance is maintained between the electrode section 1040 and the ultrasonic blade 1012. This prevents a short circuit between the electrode section 1040 and the ultrasonic blade 1012.

[0292] Referring to FIG. 44, the pad member 1024 is softer than the ultrasonic blade 1006. Therefore, the abutting receptacle 1052 is worn by the ultrasonic blade 1012 in the case where the ultrasonic blade 1012 is ultrasonically vibrated when the jaw member! 014 is closed relative to the ultrasonic blade 1012 and the abutting portion 1010 of the ultrasonic blade 1012 abuts onto and engages with the abutting receptacle 1052 of the pad member 1024. As the abutting receptacle 1052 is worn, the clearance between the electrode section 1040 and the ultrasonic blade 1012 is gradually reduced when the abutting portion 1010 is in a frictional engagement with the abutting receptacle 1052. When the abutting receptacle 1052 is worn more than a predetermined amount, the regulating end 1054 of the regulating member 1026 is exposed from the abutting receptacle 1052 in the closing direction. When the regulating end 1054 is exposed from the abutting receptacle 1052 in the closing direction, the regulating end 1054 contacts the ultrasonic blade 1012 before the electrode section 1040 contacts the ultrasonic blade 1012 if the jaw memberl 014 is closed relative to the ultrasonic blade 1012. As a result, the contact between the ultrasonic blade 1012 and the electrode section 1040 is regulated. Here, the electrode section 1040 and the ultrasonic blade 1012 are hard. Therefore, when the ultrasonically vibrated ultrasonic blade 1012 contacts the electrode section 1040, the ultrasonic blade 1012 rapidly and repetitively comes in and out of contact with the electrode section 58. When a high-frequency voltage is applied between the electrode section 1040 and the ultrasonic blade 1012, sparking occurs between the ultrasonic blade 1012 and the electrode section 1040. In one aspect, the contact between the ultrasonic blade 1012 and the electrode section 1040 is regulated by the regulating end 1054 of the regulating member 1026, so that sparking is prevented. The regulating member 1026 is made of an insulating material, and is electrically insulated relative to the electrode member 1022. Thus, if the ultrasonically vibrated ultrasonic blade 1012 contacts the regulating end 1054 of the regulating member 1026, no sparking occurs between the regulating end 1054 and the ultrasonic blade 1012 even when the ultrasonic blade 1012 rapidly and repetitively comes in and out of contact with the regulating end 1054. This prevents sparking between the ultrasonic blade 1012 and the jaw memberl 014.

[0293] The regulating member 1026 is made of a high-strength material harder than the ultrasonic blade 1006. Therefore, when the regulating end 1054 contacts the ultrasonically

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vibrated ultrasonic blade 1012, the regulating member 1026 is not worn, and the ultrasonic blade 1006 cracks. In the surgical treatment system according to one aspect, when the abutting receptacle 1052 is worn more than a predetermined amount, the regulating end 1054 contacts the ultrasonic blade 1012 to intentionally crack the ultrasonic blade 1006. By detecting this crack, the end of the life of the surgical treatment instrument is detected. Therefore, the position of the contact between the ultrasonic blade 1012 and the regulating end 1054 is set at the stress concentration region in the ultrasonic blade 1012 to ensure that the ultrasonic blade 1006 cracks when the regulating end 1054 contacts the ultrasonic blade 1012. In a linear ultrasonic blade 1006, stress concentrates in the positions of the nodes of the ultrasonic vibration, and a stress concentration region is located at the proximal end portion of the ultrasonic blade 1012.

[0294] For a more detailed description of a combination ultrasonic/electrosurgical instrument, reference is made to U.S. Pat. No. 8,696,666 and U.S. Pat. No.8,663,223, each of which is herein incorporated by reference.

[0295] FIG. 45 illustrates a modular battery powered handheld electrosurgical instrument 1100 with distal articulation, according to one aspect of the present disclosure. The surgical instrument 1100 comprises having a handle assembly 1102, a knife drive assembly 1104, a battery assembly 1106, a shaft assembly 1110, and an end effector 1112. The end effector 1112 comprises a pair of jaw members 1114a, 1114b in opposing relationship affixed to a distal end thereof. The end effector 1112 is configured to articulate and rotate. FIG. 46 is an exploded view of the surgical instrument 1100 shown in FIG. 45, according to one aspect of the present disclosure. The end effector 1112 for use with the surgical instrument 1100 for sealing and cutting tissue includes a pair of jaw members 1114a, 1114b that in opposing relationship and movable relative to each other to grasp tissue therebetween. A jaw member 1114a, 1114b includes a jaw housing and an electrically conductive surface 1116a, 1116b, e.g., electrodes, adapted to connect to a source of electrosurgical energy (RF source) such that the electrically conductive surfaces are capable of conducting electrosurgical energy through tissue held therebetween to effect a tissue seal. One of the electrically conductive surfaces 1116b includes a channel defined therein and extending along a length thereof that communicates with a drive rod 1145 connected to a motor disposed in the knife drive assembly 1104. The knife is configured to translate and reciprocate along the channel to cut tissue grasped between the jaw members 1114a, 1114b.

[0296] FIG. 47 is a perspective view of the surgical instrument 1100 shown in FIGS. 45 and 46 with a display located on the handle assembly 1102, according to one aspect of the present

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disclosure. The handle assembly 1102 of the surgical instrument shown in FIGS. 45-47 comprises a motor assembly 1160 and a display assembly. The display assembly comprises a display 1176, such as an LCD display, for example, which is removably connectable to a housing 1148 portion of the handle assembly 1102. The display 1176 provides a visual display of surgical procedure parameters such as tissue thickness, status of seal, status of cut, tissue thickness, tissue impedance, algorithm being executed, battery capacity, among other parameters.

[0297] FIG. 48 is a perspective view of the instrument shown in FIGS. 45 and 46 without a display located on the handle assembly 1102, according to one aspect of the present disclosure. The handle assembly 1102 of the surgical instrument 1150 shown in FIG. 48 includes a different display assembly 1154 on a separate housing 1156. With reference now to FIGS. 45-48, the surgical instrument 1100, 1150 is configured to use high-frequency (RF) current and a knife to carry out surgical coagulation/cutting treatments on living tissue, and uses high-frequency current to carry out a surgical coagulation treatment on living tissue. The high-frequency (RF) current can be applied independently or in combination with algorithms or user input control. The display assembly, battery assembly 1106, and shaft assembly 1110 are modular components that are removably connectable to the handle assembly 1102. A motor 1140 is located within the handle assembly 1102. RF generator circuits and motor drive circuits are described herein in connection with FIGS. 34-37 and 50, for example, is located within the housing 1148.

[0298] The shaft assembly 1110 comprises an outer tube 1144, a knife drive rod1 145, and an inner tube (not shown). The shaft assembly 1110 comprises an articulation section 1130 and a distal rotation section 1134. The end effector 1112 comprises jaw members 1114a, 1114b in opposing relationship and a motor driven knife. The jaw member 1114a, 1114b comprises an electrically conductive surface 1116a, 1116b coupled to the RF generator circuit for delivering high-frequency current to tissue grasped between the opposed jaw members 1114a, 1114b. The jaw members 1114a, 1114b are pivotally rotatable about a pivot pin 1136 to grasp tissue between the jaw members 1114a, 1114b. The jaw members 1114a, 1114b are operably coupled to a trigger 1108 such that when the trigger 1108 is squeezed the jaw members 1114a, 1114b close to grasp tissue and when the trigger 1108 is released the jaw members 1114a, 1114b open to release tissue.

[0299] The jaw members 1114a, 1114b are operably coupled to a trigger 1108 such that when the trigger 1108 is squeezed the jaw members 1114a, 1114b close to grasp tissue and when

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the trigger 1108 is released the jaw members 1114a, 1114b open to release tissue. In a one-stage trigger configuration, the trigger 1108 is squeezed to close the jaw members 1114a, 1114b and, once the jaw members 1114a, 1114b are closed, a first switch 1121a of a switch section 1121 is activated to energize the RF generator to seal the tissue. After the tissue is sealed, a second switch 1121b of the switch section 1120 is activated to advance a knife to cut the tissue. In various aspects, the trigger 1108 may be a two-stage, or a multi-stage, trigger. In a two-stage trigger configuration, during the first stage, the trigger 1108 is squeezed part of the way to close the jaw members 1114a, 1114b and, during the second stage, the trigger 1108 is squeezed the rest of the way to energize the RF generator circuit to seal the tissue. After the tissue is sealed, one of the first and second switches 1121a, 1121b can be activated to advance the knife to cut the tissue. After the tissue is cut, the jaw members 1114a, 1114b are opened by releasing the trigger 1108 to release the tissue. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the trigger 1108 to measure the force applied to the trigger 1108 by the user. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the switch section 1120 first and second switch 1121a, 1121b buttons such that displacement intensity corresponds to the force applied by the user to the switch section 1120 first and second switch 1121a, 1121b buttons.

[0300] The battery assembly 1106 is electrically connected to the handle assembly 1102 by an electrical connector 1132. The handle assembly 1102 is provided with a switch section 1120. A first switch 1121a and a second switch 1121 b are provided in the switch section 1120. The RF generator is energized by actuating the first switch 1121a and the knife is activated by energizing the motor 1140 by actuating the second switch 1121b. Accordingly, the first switch 1121a energizes the RF circuit to drive the high-frequency current through the tissue to form a seal and the second switch 1121b energizes the motor to drive the knife to cut the tissue. The structural and functional aspects of the battery assembly 1106 are similar to those of the battery assembly 106 for the surgical instrument 100 described in connection with FIGS. 1, 2, and 16-24. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the battery assembly 106 are incorporated herein by reference and will not be repeated here.

[0301] A rotation knob 1118 is operably coupled to the shaft assembly 1110. Rotation of the rotation knob 1118 ±360° in the direction indicated by the arrows 1126 causes the outer tube 1144 to rotate ±360° in the respective direction of the arrows 1119. In one aspect, another rotation knob 1122 may be configured to rotate the end effector 1112 ±360° in the direction

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indicated by the arrows 1128 independently of the rotation of the outer tube 1144. The end effector 1112 may be articulated by way of first and second control switches 1124a, 1124b such that actuation of the first control switch 1124a articulates the end effector 1112 about a pivot 1138 in the direction indicated by the arrow 1132a and actuation of the second control switch 1124b articulates the end effector 1112 about the pivot 1138 in the direction indicated by the arrow 1132b. Further, the outer tube 1144 may have a diameter D_3 ranging from 5mm to 10mm, for example.

[0302] FIG. 49 is a motor assembly 1160 that can be used with the surgical instrument 1100, 1150 to drive the knife, according to one aspect of the present disclosure. The motor assembly 1160 comprises a motor 1162, a planetary gear 1164, a shaft 1166, and a drive gear 1168. The gear may be operably coupled to drive the knife bar 1145 (FIG. 46). In one aspect, the drive gear 1168 or the shaft 1166 is operably coupled to a rotary drive mechanism 1170 described in connection with FIG. 50 to drive distal head rotation, articulation, and jaw closure.

[0303] FIG. 50 is diagram of a motor drive circuit 1165, according to one aspect of the present disclosure. The motor drive circuit 1165 is suitable for driving the motor M, which may be employed in the surgical instruments 1100, 1150 described herein. The motor M is driven by an H-bridge comprising four switches **S1-S4**. The switches SrS $_4$ are generally solid state switches such as MOSFET switches. To turn the motor M in one direction, two switches S_1, S_4 are turned on and the other two switches S_3, S_1 are turned off. To reverse the direction of the motor M, the state of the switches S_1-S_4 is reversed such that the switches S_1, S_4 are turned off and the other two switches S_3, S_1 are turned on. Current sensing circuits can be placed in the motor drive circuit 1165 to sense motor currents i_{1a}, i_{2a}, ii_b, i_{2b}.

[0304] FIG. 51 illustrates a rotary drive mechanism 1170 to drive distal head rotation, articulation, and jaw closure, according to one aspect of the present disclosure. The rotary drive mechanism 1170 has a primary rotary drive shaft 1172 that is operably coupled to the motor assembly 1160. The primary rotary drive shaft 1172 is capable of being selectively coupled to at least two independent actuation mechanisms (first, second, both, neither) with a clutch mechanism located within the outer tube 1144 of the shaft assembly 1110. The primary rotary drive shaft 1172 is coupled to independent clutches that allow the shaft functions to be independently coupled to the rotary drive shaft 1172. For example, the articulation clutch 1174 is engaged to articulate the shaft assembly 1110 about the articulation axis 1175 of the articulation section 1130. The distal head rotation clutch 1178 is engaged to rotate the distal rotation section 1134 and the jaw closure clutch 1179 is engaged to close the jaw members

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1114a, 1114b of the end effector 1112. The knife is advanced and retracted by the knife drive rodl 145. All, none, or any combination of rotary mechanisms can be couple at any one time.

[0305] In one aspect, a micro-electrical clutching configuration enables rotation of the distal rotation section 1134 and articulation of the articulation section 1130 about pivot 1138 and articulation axis 1175. In one aspect, a ferro-fluid clutch couples the clutch to the primary rotary drive shaft 1172 via a fluid pump. The clutch ferro-fluid is activated by electrical coils 1181 , 1183, 1185 which are wrapped around the knife drive rod1145. The other ends of the coils 1181 , 1183, 1185 are connected to three separate control circuits to independently actuate the clutches 1174, 1178, 1179. In operation, when the coils 1181, 1183, 1185 are not energized, the clutches 1174, 1178, 1179 are disengaged and there is no articulation, rotation, or jaw movements.

[0306] When the articulation clutch 1174 is engaged by energizing the coil 1181 and the distal head rotation clutch 1178 and the jaw closure clutch 1179 are disengaged by de-energizing the coils 1183, 1185, a gear 1180 is mechanically coupled to the primary rotary drive shaft 1172 to articulate the articulation section 1130. In the illustrated orientation, when the primary rotary drive shaft 1172 rotates clockwise, the gear 1180 rotates clockwise and the shaft articulates in the right direction about the articulation axis 1175 and when the primary rotary drive shaft 1172 rotates counter clockwise, the gear 1180 rotates counter clockwise and the shaft articulates in the left direction about the articulation axis 1175. It will be appreciated that left/right articulation depends on the orientation of the surgical instrument 1100, 1150.

[0307] When the articulation clutch 1174 and the jaw closure clutch 1179 are disengaged by de-energizing the coils 1181 , 1185, and the distal head rotation clutch 1178 is engaged by energizing the coil 1183, the primary rotary drive shaft 1172 rotates the distal rotation section 1134 in the same direction of rotation. When the coil 1183 is energized, the distal head rotation clutch 1178 engages the primary rotary drive shaft 1172 with the distal rotation section 1134. Accordingly, the distal rotation section 1134 rotates with the primary rotary drive shaft 1172.

[0308] When the articulation clutch 1174 and the distal head rotation clutch 1178 are disengaged by de-energizing the coils 1181 , 1183, and the jaw closure clutch 1179 is engaged by energizing the coil 1185, the jaw members 1114a, 114b can be opened or closed depending on the rotation of the primary rotary drive shaft 1172. When the coil 1185 is energized, the jaw closure clutch 1179 engages a captive inner threaded drive member 1186, which rotates in place in the direction of the primary rotary drive shaft 1172. The captive inner threaded drive member 1186 includes outer threads that are in threaded engagement with an outer threaded

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drive member 1188, which includes an inner threaded surface. As the primary rotary drive shaft 1172 rotates clockwise, the outer threaded drive member 1188 that is in threaded engagement with the captive inner threaded drive member 1186 will be driven in a proximal direction 1187 to close the jaw members 1114a, 1114b. As the primary rotary drive shaft 1172 rotates counterclockwise, the outer threaded drive member 1188 that is in threaded engagement with the captive inner threaded drive member 1186 will be driven in a distal direction 1189 to open the jaw members 1114a, 1114b.

[0309] FIG. 52 is an enlarged, left perspective view of an end effector assembly with the jaw members shown in an open configuration, according to one aspect of the present disclosure. FIG. 53 is an enlarged, right side view of the end effector assembly of FIG. 52, according to one aspect of the present disclosure. Referring now to FIGS. 52 and 53, enlarged views of an end effector 1112 shown in an open position for approximating tissue. Jaw members 1114, 1114b are generally symmetrical and include similar component features which cooperate to permit facile rotation about pivot pin 1136 to effect the sealing and dividing of tissue. As a result and unless otherwise noted, only the jaw member 1114a and the operative features associated therewith are describe in detail herein but as can be appreciated, many of these features apply to the other jaw member 1114b as well.

[0310] The jaw member 1114a also includes a jaw housing 1115a, an insulative substrate or insulator 1117a and an electrically conductive surface 1116a. The insulator 1117a is configured to securely engage the electrically conductive sealing surface 1116a. This may be accomplished by stamping, by overmolding, by overmolding a stamped electrically conductive sealing plate and/or by overmolding a metal injection molded seal plate. These manufacturing techniques produce an electrode having an electrically conductive surface 1116a that is surrounded by an insulator 1117a.

[0311] As mentioned above, the jaw member 1114a includes similar elements which include: a jaw housing 1115b; insulator 1117b; and an electrically conductive surface 1116b that is dimensioned to securely engage the insulator 1117b. Electrically conductive surface 1116b and the insulator 1117b, when assembled, form a longitudinally-oriented knife channel 1113 defined therethrough for reciprocation of the knife blade 1123. The knife channel 1113 facilitates longitudinal reciprocation of the knife blade 1123 along a predetermined cutting plane to effectively and accurately separate the tissue along the formed tissue seal. Although not shown, the jaw member 1114a may also include a knife channel that cooperates with the knife channel 1113 to facilitate translation of the knife through tissue.

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[0312] The jaw members 1114a, 1114b are electrically isolated from one another such that electrosurgical energy can be effectively transferred through the tissue to form a tissue seal. The electrically conductive surfaces 1116a, 1116b are also insolated from the remaining operative components of the end effector 1112 and the outer tube 1144. A plurality of stop members may be employed to regulate the gap distance between the electrically conductive surfaces 1116a, 1116b to insure accurate, consistent, and reliable tissue seals.

[031 3] The structural and functional aspects of the battery assembly 1106 are similar to those of the battery assembly 106 for the surgical instrument 100 described in connection with FIGS. 1, 2, and 16-24, including the battery circuits described in connection with FIGS. 20-24. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the battery assembly 106 are incorporated herein by reference and will not be repeated here. Furthermore, the structural and functional aspects of the RF generator circuits are similar to those of the RF generator circuits described in for the surgical instruments 500, 600 described in connection with FIGS. 34-37. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the RF generator circuits are incorporated herein by reference and will not be repeated here. Furthermore, the surgical instrument 1100 includes the battery and control circuits described in connection with FIGS. 12-15, including, for example, the control circuit 210 described in connection with FIG. 14 and the electrical circuit 300 described in connection withe FIG. 15. Accordingly, for conciseness and clarity of disclosure, the description of the circuits described in connection with FIGS. 12-15 is incorporated herein by reference and will not be repeated here.

[0314] For a more detailed description of an electrosurgical instrument comprising a cutting mechanism and an articulation section that is operable to deflect the end effector away from the longitudinal axis of the shaft, reference is made to U.S. Pat. No. 9,028,478 and U.S. Pat. No. 9,1 13,907, each of which is herein incorporated by reference.

[0315] FIG. 54 illustrates a modular battery powered handheld electrosurgical instrument 1200 with distal articulation, according to one aspect of the present disclosure. The surgical instrument 1200 comprises a handle assembly 1202, a knife drive assembly 1204, a battery assembly 1206, a shaft assembly 1210, and an end effector 1212. The end effector 1212 comprises a pair of jaw members 1214a, 1214b in opposing relationship affixed to a distal end thereof. The end effector 1212 is configured to articulate and rotate. FIG. 55 is an exploded view of the surgical instrument 1200 shown in FIG. 54, according to one aspect of the present disclosure. The end effector 1212 for use with the surgical instrument 1200 for sealing and

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cutting tissue includes a pair of jaw members 1214a, 1214b in opposing relationship movable relative to each other to grasp tissue therebetween. Either jaw member 1214a, 1214b may include a jaw housing and an electrically conductive surface 1216a, 1216b, e.g., electrodes, adapted to connect to a source of electrosurgical energy (RF source) such that the electrically conductive surfaces are capable of conducting electrosurgical energy through tissue held therebetween to effect a tissue seal. The jaw members 1214a, 1214b and the electrically conductive surfaces 1216a, 1216b include a channel defined therein and extending along a length thereof that communicates with a knife drive rod 1245 connected to a knife drive assembly 1204. The knife 1274 (FIGS. 60-61) is configured to translate and reciprocate along the channels to cut tissue grasped between the jaw members 1214a, 1214b. The knife has an I-beam configuration such that the jaw members 1214a, 1214b are brought closer together as the knife 1274 advances through the channels. In one aspect, the electrically conductive surfaces 1216a, 1216b are offset relative to each other. The knife 1274 includes a sharp distal end.

[0316] The handle assembly 1202 of the surgical instrument shown in FIGS. 54-55 comprises a motor assembly 1260 and a knife drive assembly 1204. In one aspect, a display assembly may be provided on the housing 1248. The display assembly may comprise a display, such as an LCD display, for example, which is removably connectable to a housing 1248 portion of the handle assembly 1202. The LCD display provides a visual display of surgical procedure parameters such as tissue thickness, status of seal, status of cut, tissue thickness, tissue impedance, algorithm being executed, battery capacity, among other parameters. With reference now to FIGS. 54-55, the surgical instrument 1200 is configured to use high-frequency (RF) current and a knife 1274 (FIGS. 60-61) to carry out surgical coagulation/cutting treatments on living tissue, and uses high-frequency current to carry out a surgical coagulation treatment on living tissue. The high-frequency (RF) current can be applied independently or in combination with algorithms or user input control. The knife drive assembly 1204, battery assembly 1206, and shaft assembly 1210 are modular components that are removably connectable to the handle assembly 1202. A motor assembly 1240 may be located within the handle assembly 1202. The RF generator and motor drive circuits are described in connection with FIGS. 34-37 and 50, for example, are located within the housing 1248. The housing 1248 includes a removable cover plate 1276 to provide access to the circuits and mechanisms located within the housing 1248. The knife drive assembly 1204 includes gears and linkages operably coupled to the handle assembly 1202 and the switch section 1220 to activate and drive

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the knife 1274. As discussed in more detail hereinbelow, the knife 1274 has an I-beam configuration.

[0317] The shaft assembly 1210 comprises an outer tube 1244, a knife drive rod 1245, and an inner tube (not shown). The shaft assembly 1210 comprises an articulation section 1230. The end effector 1212 comprises a pair of jaw members 1214a, 1214b and a knife 1274 configured to reciprocate with channels formed in the jaw members 1214a, 1214b. In one aspect, the knife 1274 may be driven by a motor. The jaw member 1214a, 1214b comprises an electrically conductive surface 1216a, 1216b coupled to the RF generator circuit for delivering high-frequency current to tissue grasped between the jaw members 1214a, 1214b. The jaw members 1214a, 1214b are pivotally rotatable about a pivot pin 1235 to grasp tissue between the jaw members 1214a, 1214b. The jaw members 1214a, 1214b are operably coupled to a trigger 1208 such that when the trigger 1208 is squeezed one or both of the jaw members 1214a, 1214b close to grasp tissue and when the trigger 1208 is released the jaw members 1214a, 1214b open to release tissue. In the illustrated example, one jaw member 1214a is movable relative to the other jaw member 1214b. In other aspects, both jaw members 1214a, 1214b may be movable relative to each other. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the trigger 1208 to measure the force applied to the trigger 1208 by the user. In another aspect, force sensors such as strain gages or pressure sensors may be coupled to the switch section 1220 first and second switch 1221a, 1221b buttons such that displacement intensity corresponds to the force applied by the user to the switch section 1220 first and second switch 1221a, 1221b buttons.

[0318] The jaw member 1214a is operably coupled to a trigger 1208 such that when the trigger 1208 is squeezed the jaw member 1214a closes to grasp tissue and when the trigger 1208 is released the jaw member 1214a opens to release tissue. In a one-stage trigger configuration, the trigger 1208 is squeezed to close the jaw member 1214a and, once the jaw member 1214a is closed, a first switch 1221a of a switch section 1220 is activated to energize the RF generator to seal the tissue. After the tissue is sealed, a second switch 1221b of the switch section 1220 is activated to advance a knife to cut the tissue. In various aspects, the trigger 1208 may be a two-stage, or a multi-stage, trigger. In a two-stage trigger configuration, during the first stage, the trigger 1208 is squeezed part of the way to close the jaw member 1214a and during the second stage, the trigger 1208 is squeezed the rest of the way to energize the RF generator circuit to seal the tissue. After the tissue is sealed, one of the switches 1221a,

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1221 b can be activated to advance the knife to cut the tissue. After the tissue is cut, the jaw member 1214a is opened by releasing the trigger 1208 to release the tissue.

[0319] The shaft assembly 1210 includes an articulation section 1230 that is operable to deflect the end effector 1212 away from the longitudinal axis "A" of the shaft assembly 1210. The dials 1232a, 1232b are operable to pivot the articulation section 1230 at the distal end of the elongated shaft assembly 1210 to various articulated orientations with respect to the longitudinal axis A-A. More particularly, the articulation dials 1232a, 1232b operably couple to a plurality of cables or tendons that are in operative communication with the articulation section 1230 of the shaft assembly 1210, as described in greater detail below. One articulation dial 1232a may be rotated in the direction of arrows "CO" to induce pivotal movement in a first plane, e.g., a vertical plane, as indicated by arrows "C1". Similarly, another articulation dial 1232b may be rotated in the direction of arrows "DO" to induce pivotal movement in a second plane, e.g., a horizontal plane, as indicated by arrows "D1". Rotation of the articulation dials 1232a, 1232b in either direction of arrows "CO" or "DO" results in the tendons pivoting or articulating the shaft assembly 1210 about the articulation section 1230.

[0320] The battery assembly 1206 is electrically connected to the handle assembly 1202 by an electrical connector 1231. The handle assembly 1202 is provided with a switch section 1220. A first switch 1221a and a second switch 1221b are provided in the switch section 1220. The RF generator is energized by actuating the first switch 1221a and the knife 1274 may be activated by energizing the motor assembly 1240 by actuating the second switch 1221b. Accordingly, the first switch 1221a energizes the RF circuit to drive the high-frequency current through the tissue to form a seal and the second switch 1221b energizes the motor to drive the knife 1274 to cut the tissue. In other aspects, the knife 1274 may be fired manually using a two-stage trigger 1208 configuration. The structural and functional aspects of the battery assembly 1206 are similar to those of the battery assembly 106 for the surgical instrument 100 described in connection with FIGS. 1, 2, and 16-24. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the battery assembly 106 are incorporated herein by reference and will not be repeated here.

[0321] A rotation knob 1218 is operably coupled to the shaft assembly 1210. Rotation of the rotation knob 1218 ±360° in the direction indicated by the arrows 1226 causes the outer tube 1244 to rotate ±360° in the respective direction of the arrows 1228. The end effector 1212 may be articulated by way of control buttons such that actuation of control buttons articulates the end

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effector 1212 in one direction indicated by arrows C1 and D1. Further, the outer tube 1244 may have a diameter D_3 ranging from 5mm to 10mm, for example.

[0322] FIG. 56 is an enlarged area detail view of an articulation section illustrated in FIG. 54 including electrical connections, according to one aspect of the present disclosure. FIG. 57 is an enlarged area detail view articulation section illustrated in FIG. 56 including electrical connections, according to one aspect of the present disclosure. With reference now to FIGS. 56-57, there is shown the articulation section 1230 is operably disposed on or coupled to the shaft assembly 1210 between the proximal end and the distal end 1222, respectively. In the aspect illustrated in FIGS. 56-57, the articulation section 1230 is defined by a plurality of articulating links 1233 (links 1233). The links 1233 are configured to articulate the shaft assembly 1210 transversely across the longitudinal axis "A-A" in either a horizontal or vertical plane, see FIG. 54. For illustrative purposes, the shaft assembly 1210 is shown articulated across the horizontal plane.

[0323] The links 1233 collectively define a central annulus 1238 therethrough that is configured to receive a drive mechanism, e.g., a drive rod, therethrough. As can be appreciated, the configuration of the central annulus 1238 provides adequate clearance for the drive rod therethrough. The central annulus 1238 defines an axis "B-B" therethrough that is parallel to the longitudinal axis "A-A" when the shaft assembly 1210 is in a non-articulated configuration, see FIG. 54.

[0324] Continuing with reference to FIGS. 56-57, the links 1233 are operably coupled to the articulation dials 1232a, 1232b via tendons 1234. For illustrative purposes, four (4) tendons 1234 are shown. The tendons 1234 may be constructed of stainless steel wire or other material suitable for transmitting tensile forces to a distal-most link of links 1233. Regardless of the construction materials, the tendons 1234 exhibit a spring rate that is amplified over the length of the tendons 1234 and thus, the tendons 1234 may tend to stretch when external loads are applied to the elongated shaft assembly 1210. This tendency to stretch may be associated with an unintended change in orientation of the distal end 1222 of the elongated shaft assembly 1210, e.g., without a corresponding movement of the articulation dials 1232a, 1232b initiated by the surgeon.

[0325] The tendons 1234 operably couple to the articulating dials 1232a, 1232b that are configured to actuate the tendons 1234, e.g., "pull" the tendons 1234, when the articulating dials 1232a, 1232b are rotated. The plurality of tendons 1234 operably couple to the links 1233 via one or more suitable coupling methods. More particularly, the link 1233 includes a

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corresponding plurality of first apertures or bores 1236a defined therein (four (4) bores 1236a are shown in the representative figures) that are radially disposed along the links 1233 and centrally aligned along a common axis, see FIG. 56. A bore of the plurality of bores 1236a is configured to receive a tendon 1234. A distal end of a tendon 1234 is operably coupled to a distal most link of the links 1233 by suitable methods, e.g., one or more of the coupling methods described above.

[0326] Continuing with reference to FIGS. 56-57 a link 1233 includes a second plurality of bores 1236b (four (4) bores 1236b are shown in the representative drawings, as best seen in FIG. 56). A bore 1236b is configured to receive a corresponding conductive lead of a plurality of conductive leads 1237 (four (4) conductive leads 1237 are shown in the representative drawings). The conductive leads 1237 are configured to transition between first and second states within the second plurality of bores 1236b. To facilitate transitioning of the conductive leads 1237, a bore 1236b includes a diameter that is greater than a diameter of the conductive leads 1237 when the conductive leads 1237 are in the first state.

[0327] The surgical instrument 1220 includes electrical circuitry that is configured to selectively induce a voltage and current flow to the plurality of conductive leads 1237 such that a conductive lead 1237 transitions from the first state to the second state. To this end, the generator G provides a voltage potential Eo of suitable proportion. A voltage is induced in a conductive lead 1237 and current flow therethrough. The current flowing through a conductive lead 1237 causes the conductive lead 1237 to transition from the first state (FIG. 56) to the second state (FIG. 57). In the second state, the conductive lead 1237 provides an interference fit between the conductive lead 1237 and the corresponding bores 1236b, as best seen in FIG. 57.

[0328] FIG. 58 illustrates a perspective view of components of the shaft assembly 1210, end effector 1212, and cutting member 1254 of the surgical instrument 1200 of FIG. 54, according to one aspect of the present disclosure. FIG. 59 illustrates the articulation section in a second stage of articulation, according to one aspect of the present disclosure. With reference now to FIGS. 58-59, one articulation band 1256a is slidably disposed in one side recess of a separator 1261 while a second articulation band 1256b (FIG. 59) is slidably disposed in the other side recess of the separator 1261 . A cutting member driver tube is movable longitudinally to drive a driver block 1258 longitudinally, to thereby move cutting member 1254 longitudinally. The side recesses include longitudinally extending grooves that are configured to reduce the contact surface area with articulation bands 1256a, 1256b, thereby reducing friction between separator

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1261 and articulation bands 1256a, 1256b. The separator 1261 also may be formed of a low friction material and/or include a surface treatment to reduce friction. Articulation bands 1256a, 1256b extend longitudinally along the length of the shaft assembly 1210, including through the articulation section 1230. The distal end 1252 of one articulation band 1256a is secured to one side of the proximal portion 1250 of end effector 1212 at an anchor point. The distal end 1262 of the second articulation band 1256b is secured to the other side of proximal portion 1250 of end effector 1212 at an anchor point. A rotary articulation knob is operable to selectively advance the articulation band 1256a distally while simultaneously retracting the second articulation band 1256b proximally, and vice-versa. It should be understood that this opposing translation will cause articulation section 1230 to bend, thereby articulating end effector 1212. In particular, the end effector 1212 will deflect toward whichever articulation band 1256a, 1256b is being retracted proximally; and away from whichever articulation band 1256a, 1256b is being advanced distally.

[0329] With continued referenced to FIGS. 58-59, several of the above described components are shown interacting to bend the articulation section 1230 to articulate end effector 1212. In FIG. 58, articulation 1230 is in a straight configuration. Then, one of the articulation dials 1232a, 1232b (FIGS. 54-55) is rotated, which causes a lead screw to translate proximally and another lead screw to advance distally. This proximal translation of one lead screw pulls the articulation band 1256b proximally, which causes articulation section 1230 to start bending as shown in FIG. 59. This bending of articulation section 1230 pulls the other articulation band 1256a distally. The distal advancement of lead screw in response to rotation of the articulation dials 1232a, 1232b enables the articulation band 1256a and the drive member to advance distally. In some other versions, the distal advancement of the lead screw actively drives drive member and articulation band 1256a distally. As the user continues rotating one of the articulation dials 1232a, 1232b, the above described interactions continue in the same fashion, resulting in further bending of articulation section 1230 as shown in FIG. 59. It should be understand that rotating the articulation dials 1232a, 1232b in the opposite direction will cause articulation section 1230 to straighten, and further rotation in the opposite direction will cause articulation section 1230 to bend in the opposite direction.

[0330] FIG. 60 illustrates a perspective view of the end effector 1212 of the device of FIGS. 54-59 in an open configuration, according to one aspect of the present disclosure. The end effector 1212 of the present example comprises a pair of jaw members 1214a, 1214b. In the present example, one jaw member 1214b is fixed relative to shaft assembly; while the other jaw

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member 1214a pivots relative to shaft assembly, toward and away from the other jaw member 1214b. In some versions, actuators such as rods or cables, etc., may extend through a sheath and be joined with one jaw member 1214a at a pivotal coupling, such that longitudinal movement of the actuator rods/cables/etc. through the shaft assembly provides pivoting of the jaw member 1214a relative to shaft assembly and relative to the second jaw member 1214b. Of course, the jaw members 1214a, 1214b instead may have any other suitable kind of movement and may be actuated in any other suitable fashion. By way of example only, the jaw members 1214a, 1214b may be actuated and thus closed by longitudinal translation of a firing beam 1266, such that actuator rods/cables/etc. may simply be eliminated in some versions. The upper side of one jaw member 1214a including a plurality of teeth serrations 1272. It should be understood that the lower side of the other jaw member 1214b may include complementary serrations 1277 that nest with the serrations 1272, to enhance gripping of tissue captured between the jaw members 1214a, 1214b of the end effector 1212 without necessarily tearing the tissue.

[0331] FIG. 6 1 illustrates a cross-sectional end view of the end effector 1212 of FIG. 60 in a closed configuration and with the blade 1274 in a distal position, according to one aspect to the present disclosure. With reference now to FIGS. 60-61 , one jaw member 1214a defines a longitudinally extending elongate slot 1268; while the other jaw member 1214b also defines a longitudinally extending elongate slot 1270. In addition, the underside of one jaw member 1214a presents an electrically conductive surface 1216a; while the top side of the other jaw member 1214b presents another electrically conductive surface 1216b. The electrically conductive surfaces 1216a, 1216b are in communication with an electrical source 1278 and a controller 1280 via one or more conductors (not shown) that extend along the length of shaft assembly. The electrical source 1278 is operable to deliver RF energy to first electrically conductive surface 1216b at a first polarity and to second electrically conductive surface 1216a at a second (opposite) polarity, such that RF current flows between electrically conductive surfaces 1216a, 1216b and thereby through tissue captured between the jaw members 1214a, 1214b. In some versions, firing beam 1266 serves as an electrical conductor that cooperates with the electrically conductive surfaces 1216a, 1216b (e.g., as a ground return) for delivery of bipolar RF energy captured between the jaw members 1214a, 1214b. The electrical source 1278 may be external to surgical instrument 1200 or may be integral with surgical instrument 1200 (e.g., in the handle assembly 1202, etc.), as described in one or more references cited herein or otherwise. A controller 1280 regulates delivery of power from electrical source 1278 to the electrically

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conductive surfaces 1216a, 1216b. The controller 1280 may also be external to surgical instrument 1200 or may be integral with surgical instrument 1200 (e.g., in handle assembly 1202, etc.), as described in one or more references cited herein or otherwise. It should also be understood that the electrically conductive surfaces 1216a, 1216b may be provided in a variety of alternative locations, configurations, and relationships.

[0332] Still with reference to FIGS. 60-61 , the surgical instrument 1200 of the present example includes a firing beam 1266 that is longitudinally movable along part of the length of end effector 1212. The firing beam 1266 is coaxially positioned within the shaft assembly 1210, extends along the length of the shaft assembly 1210, and translates longitudinally within the shaft assembly 1210 (including the articulation section 1230 in the present example), though it should be understood that firing beam 12660 and the shaft assembly 1210 may have any other suitable relationship. The firing beam 1266 includes a knife 1274 with a sharp distal end, an upper flange 1281, and a lower flange 1282. As best seen in FIG. 61, the knife 1274 extends through slots 1268, 1270 of the jaw members 1214a, 1214b, with the upper flange 1281 being located above the jaw member 1214a in a recess 1284 and the lower flange 1282 being located below the jaw member 1214b in a recess 1286. The configuration of the knife 1274 and the flanges 1281, 1282 provides an "I-beam" type of cross section at the distal end of firing beam 1266. While the flanges 1281, 1282 extend longitudinally only along a small portion of the length of firing beam 1266 in the present example, it should be understood that the flanges 1281, 1282 may extend longitudinally along any suitable length of firing beam 1266. In addition, while the flanges 1281, 1282 are positioned along the exterior of the jaw members 1214a, 1214b, the flanges 1281 , 1282 may alternatively be disposed in corresponding slots formed within jaw members 1214a, 1214b. For instance, the jaw members 1214a, 1214b may define a T"-shaped slot, with parts of the knife 1274 being disposed in one vertical portion of a "T'-shaped slot and with the flanges 1281, 1282 being disposed in the horizontal portions of the T'-shaped slots. Various other suitable configurations and relationships will be apparent to those of ordinary skill in the art in view of the teachings herein. By way of example only, the end effector 1212 may include one or more positive temperature coefficient (PTC) thermistor bodies 1288, 1290 (e.g., PTC polymer, etc.), located adjacent to the electrically conductive surfaces 1216a, 1216b and/or elsewhere.

[0333] The structural and functional aspects of the battery assembly 1206 are similar to those of the battery assembly 106 for the surgical instrument 100 described in connection with FIGS. 1, 2, and 16-24, including the battery circuits described in connection with FIGS. 20-24.

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Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the battery assembly 106 are incorporated herein by reference and will not be repeated here. Furthermore, the structural and functional aspects of the RF generator circuits are similar to those of the RF generator circuits described in for the surgical instruments 500, 600 described in connection with FIGS. 34-37. Accordingly, for conciseness and clarity of disclosure, such the structural and functional aspects of the RF generator circuits are incorporated herein by reference and will not be repeated here. Furthermore, the surgical instrument 1200 includes the battery and control circuits described in connection with FIGS. 12-15, including, for example, the control circuit 210 described in connection with FIG. 14 and the electrical circuit 300 described in connection withe FIG. 15. Accordingly, for conciseness and clarity of disclosure, the description of the circuits described in connection with FIGS. 12-15 is incorporated herein by reference and will not be repeated here.

[0334] For a more detailed description of an electrosurgical instrument comprising a cutting mechanism and an articulation section that is operable to deflect the end effector away from the longitudinal axis of the shaft, reference is made to U.S. Pub. No. 2013/0023868, which is herein incorporated by reference.

[0335] It should also be understood that any of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein may be modified to include a motor or other electrically powered device to drive an otherwise manually moved component. Various examples of such modifications are described in U.S. Pub. No. 2012/01 16379 and U.S. Pub. No. 2016/0256184, each of which is incorporated herein by reference. Various other suitable ways in which a motor or other electrically powered device may be incorporated into any of the devices herein will be apparent to those of ordinary skill in the art in view of the teachings herein.

[0336] It should also be understood that the circuits described in connection with FIGS. 11-15, 20-24, 34-37, and 50 may be configured to operate either alone or in combination with any of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein.

[0337] FIGS. 62-70 describe various circuits that are configured to operate with any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connections with FIGS. 1-61. Turning now to FIG. 62, there is shown the components of a control circuit 1300 of the surgical instrument, according to one aspect of the present disclosure. The control circuit 1300 comprises a processor 1302 coupled to a volatile memory 1304, one or more sensors 1306, a nonvolatile memory 1308 and a battery 1310. In one aspect, the surgical instrument may comprise a handle housing to house the control circuit 1300 and to contain general purpose

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controls to implement the power conservation mode. In some aspects, the processor 1302 may be a primary processor of the surgical instrument that includes one or more secondary processors. In some aspects, the processor 1302 may be stored within the battery 1310. The processor 1302 is configured to control various operations and functions of the surgical instrument by executing machine executable instructions, such as control programs or other software modules. For example, execution of an energy modality control program by the processor 1302 enables selection of a particular type of energy to be applied to patient tissue by a surgeon using the surgical instrument. The surgical instrument may comprise an energy modality actuator located on the handle of the surgical instrument. The actuator may be a slider, a toggle switch, a segmented momentary contact switch, or some other type of actuator. Actuation of the energy modality actuator causes the processor 1302 to activate an energy modality corresponding to a selected type of energy. The type of energy can be ultrasonic, RF, or a combination of ultrasonic and RF energy. In various aspects general, the processor 1302 is electrically coupled to the plurality of circuit segments of the surgical instrument as illustrated in FIG. 63 to activate or deactivate the circuit segments in accordance with energization and deenergization sequences.

[0338] The volatile memory 1304, such as a random-access memory (RAM), temporarily stores selected control programs or other software modules while the processor 1302 is in operation, such as when the processor 1302 executes a control program or software module. The one or more sensors 1306 may include force sensors, temperature sensors, current sensors or motion sensors. In some aspects, the one or more sensors 1306 may be located at the shaft, end effector, battery, or handle, or any combination or sub-combination thereof. The one or more sensors 1306 transmit data associated with the operation of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connection with FIGS. 1-61, such as the presence of tissue grasped by the jaws of the end effector or the force applied by the motor. In one aspect, the one or more sensors 1306 may include an accelerometer to verify the function or operation of the circuit segments, based on a safety check and a Power On Self Test (POST). Machine executable instructions such as control programs or other software modules are stored in the nonvolatile memory 1308. For example, the nonvolatile memory 1308 stores the Basic Input/Output System (BIOS) program. The nonvolatile memory 1308 may be a read-only memory, erasable programmable ROM (EPROM), an EEPROM, flash memory or some other type of nonvolatile memory device. Various examples of control programs are described in U.S. Pub. No. 2015/0272578, which is incorporated herein by reference in its

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entirety. The battery 1310 powers the surgical instrument by providing a source voltage that causes a current. The battery 1310 may comprise the motor control circuit segment 1428 illustrated in FIG. 63.

[0339] In one aspect, the processor 1302 may be any single core or multicore processor such as those known under the trade name ARM Cortex by Texas Instruments. In one aspect, the processor 1302 may be implemented as a safety processor comprising two microcontroller-based families such as TMS570 and RM4x known under the trade name Hercules ARM Cortex R4, also by Texas Instruments. Nevertheless, other suitable substitutes for microcontrollers and safety processor may be employed, without limitation. In one aspect, the safety processor may be configured specifically for IEC 61508 and ISO 26262 safety critical applications, among others, to provide advanced integrated safety features while delivering scalable performance, connectivity, and memory options.

[0340] In certain aspects, the processor 1302 may be an LM 4F230H5QR, available from Texas Instruments, for example. In at least one example, the Texas Instruments LM4F230H5QR is an ARM Cortex-M4F Processor Core comprising on-chip memory of 256 KB single-cycle flash memory, or other non-volatile memory, up to 40 MHz, a prefetch buffer to improve performance above 40 MHz, a 32 KB single-cycle serial random access memory (SRAM), internal read-only memory (ROM) loaded with StellarisWare® software, 2 KB electrically erasable programmable read-only memory (EEPROM), one or more pulse width modulation (PWM) modules, one or more quadrature encoder inputs (QED analog, one or more 12-bit Analog-to-Digital Converters (ADC) with 12 analog input channels, among other features that are readily available for the product datasheet. Other processors may be readily substituted and, accordingly, the present disclosure should not be limited in this context.

[0341] FIG. 63 is a system diagram 1400 of a segmented circuit 1401 comprising a plurality of independently operated circuit segments 1402, 1414, 1416, 1420, 1424, 1428, 1434, 1440, according to one aspect of the present disclosure. A circuit segment of the plurality of circuit segments of the segmented circuit 1401 comprises one or more circuits and one or more sets of machine executable instructions stored in one or more memory devices. The one or more circuits of a circuit segment are coupled to for electrical communication through one or more wired or wireless connection media. The plurality of circuit segments are configured to transition between three modes comprising a sleep mode, a standby mode and an operational mode.

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[0342] In one aspect shown, the plurality of circuit segments 1402, 1414, 1416, 1420, 1424, 1428, 1434, 1440 start first in the standby mode, transition second to the sleep mode, and transition third to the operational mode. However, in other aspects, the plurality of circuit segments may transition from any one of the three modes to any other one of the three modes. For example, the plurality of circuit segments may transition directly from the standby mode to the operational mode. Individual circuit segments may be placed in a particular state by the voltage control circuit 1408 based on the execution by the processor 1302 of machine executable instructions. The states comprise a deenergized state, a low energy state, and an energized state. The deenergized state corresponds to the sleep mode, the low energy state corresponds to the standby mode, and the energized state corresponds to the operational mode. Transition to the low energy state may be achieved by, for example, the use of a potentiometer.

[0343] In one aspect, the plurality of circuit segments 1402, 1414, 1416, 1420, 1424, 1428, 1434, 1440 may transition from the sleep mode or the standby mode to the operational mode in accordance with an energization sequence. The plurality of circuit segments also may transition from the operational mode to the standby mode or the sleep mode in accordance with a deenergization sequence. The energization sequence and the deenergization sequence may be different. In some aspects, the energization sequence comprises energizing only a subset of circuit segments of the plurality of circuit segments. In some aspects, the deenergization sequence comprises deenergizing only a subset of circuit segments of the plurality of circuit segments.

[0344] Referring back to the system diagram 1400 in FIG. 63, the segmented circuit 1401 comprise a plurality of circuit segments comprising a transition circuit segment 1402, a processor circuit segment 1414, a handle circuit segment 1416, a communication circuit segment 1420, a display circuit segment 1424, a motor control circuit segment 1428, an energy treatment circuit segment 1434, and a shaft circuit segment 1440. The transition circuit segment comprises a wake up circuit 1404, a boost current circuit 1406, a voltage control circuit 1408, a safety controller 1410 and a POST controller 1412. The transition circuit segment 1402 is configured to implement a deenergization and an energization sequence, a safety detection protocol, and a POST.

[0345] In some aspects, the wake up circuit 1404 comprises an accelerometer button sensor 1405. In aspects, the transition circuit segment 1402 is configured to be in an energized state while other circuit segments of the plurality of circuit segments of the segmented circuit 1401

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are configured to be in a low energy state, a deenergized state or an energized state. The accelerometer button sensor 1405 may monitor movement or acceleration of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61. For example, the movement may be a change in orientation or rotation of the surgical instrument. The surgical instrument may be moved in any direction relative to a three dimensional Euclidean space by for example, a user of the surgical instrument. When the accelerometer button sensor 1405 senses movement or acceleration, the accelerometer button sensor 1405 sends a signal to the voltage control circuit 1408 to cause the voltage control circuit 1408 to apply voltage to the processor circuit segment 1414 to transition the processor 1302 and the volatile memory 1304 to an energized state. In aspects, the processor 1302 and the volatile memory 1304 are in an energized state before the voltage control circuit 1409 applies voltage to the processor 1302 and the volatile memory 1304. In the operational mode, the processor 1302 may initiate an energization sequence or a deenergization sequence. In various aspects, the accelerometer button sensor 1405 may also send a signal to the processor 1302 to cause the processor 1302 to initiate an energization sequence or a deenergization sequence. In some aspects, the processor 1302 initiates an energization sequence when the majority of individual circuit segments are in a low energy state or a deenergized state. In other aspects, the processor 1302 initiates a deenergization sequence when the majority of individual circuit segments are in an energized state.

[0346] Additionally or alternatively, the accelerometer button sensor 1405 may sense external movement within a predetermined vicinity of the surgical instrument. For example, the accelerometer button sensor 1405 may sense a user of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 moving a hand of the user within the predetermined vicinity. When the accelerometer button sensor 1405 senses this external movement, the accelerometer button sensor 1405 may send a signal to the voltage control circuit 1408 and a signal to the processor 1302, as previously described. After receiving the sent signal, the processor 1302 may initiate an energization sequence or a deenergization sequence to transition one or more circuit segments between the three modes. In aspects, the signal sent to the voltage control circuit 1408 is sent to verify that the processor 1302 is in operational mode. In some aspects, the accelerometer button sensor 1405 may sense when the surgical instrument has been dropped and send a signal to the processor 1302 based on the sensed drop. For example, the signal can indicate an error in the operation of an individual circuit segment. The one or more sensors 1306 may sense damage or

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malfunctioning of the affected individual circuit segments. Based on the sensed damage or malfunctioning, the POST controller 1412 may perform a POST of the corresponding individual circuit segments.

[0347] An energization sequence or a deenergization sequence may be defined based on the accelerometer button sensor 1405. For example, the accelerometer button sensor 1405 may sense a particular motion or a sequence of motions that indicates the selection of a particular circuit segment of the plurality of circuit segments. Based on the sensed motion or series of sensed motions, the accelerometer button sensor 1405 may transmit a signal comprising an indication of one or more circuit segments of the plurality of circuit segments to the processor 1302 when the processor 1302 is in an energized state. Based on the signal, the processor 1302 determines an energization sequence comprising the selected one or more circuit segments. Additionally or alternatively, a user of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 may select a number and order of circuit segments to define an energization sequence or a deenergization sequence based on interaction with a graphical user interface (GUI) of the surgical instrument.

[0348] In various aspects, the accelerometer button sensor 1405 may send a signal to the voltage control circuit 1408 and a signal to the processor 1302 only when the accelerometer button sensor 1405 detects movement of any one the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 or external movement within a predetermined vicinity above a predetermined threshold. For example, a signal may only be sent if movement is sensed for 5 or more seconds or if the surgical instrument is moved 5 or more inches. In other aspects, the accelerometer button sensor 1405 may send a signal to the voltage control circuit 1408 and a signal to the processor 1302 only when the accelerometer button sensor 1405 detects oscillating movement of the surgical instrument. A predetermined threshold reduces inadvertent transition of circuit segments of the surgical instrument. As previously described, the transition may comprise a transition to operational mode according to an energization sequence, a transition to low energy mode according to a deenergization sequence, or a transition to sleep mode according to a deenergization sequence. In some aspects, the surgical instrument comprises an actuator that may be actuated by a user of the surgical instrument. The actuation is sensed by the accelerometer button sensor 1405. The actuator may be a slider, a toggle switch, or a momentary contact switch. Based on the sensed actuation, the accelerometer button sensor 1405 may send a signal to the voltage control circuit 1408 and a signal to the processor 1302.

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[0349] The boost current circuit 1406 is coupled to the battery 1310. The boost current circuit 1406 is a current amplifier, such as a relay or transistor, and is configured to amplify the magnitude of a current of an individual circuit segment. The initial magnitude of the current corresponds to the source voltage provided by the battery 1310 to the segmented circuit 1401. Suitable relays include solenoids. Suitable transistors include field-effect transistors (FET), MOSFET, and bipolar junction transistors (BJT). The boost current circuit 1406 may amplify the magnitude of the current corresponding to an individual circuit segment or circuit which requires more current draw during operation of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connection with FIGS. 1-61. For example, an increase in current to the motor control circuit segment 1428 may be provided when a motor of the surgical instrument requires more input power. The increase in current provided to an individual circuit segment may cause a corresponding decrease in current of another circuit segment or circuit segments. Additionally or alternatively, the increase in current may correspond to voltage provided by an additional voltage source operating in conjunction with the battery 1310.

[0350] The voltage control circuit 1408 is coupled to the battery 1310. The voltage control circuit 1408 is configured to provide voltage to or remove voltage from the plurality of circuit segments. The voltage control circuit 1408 is also configured to increase or reduce voltage provided to the plurality of circuit segments of the segmented circuit 1401. In various aspects, the voltage control circuit 1408 comprises a combinational logic circuit such as a multiplexer (MUX) to select inputs, a plurality of electronic switches, and a plurality of voltage converters. An electronic switch of the plurality of electronic switches may be configured to switch between an open and closed configuration to disconnect or connect an individual circuit segment to or from the battery 1310. The plurality of electronic switches may be solid state devices such as transistors or other types of switches such as wireless switches, ultrasonic switches, accelerometers, inertial sensors, among others. The combinational logic circuit is configured to select an individual electronic switch for switching to an open configuration to enable application of voltage to the corresponding circuit segment. The combination logic circuit also is configured to select an individual electronic switch for switching to a closed configuration to enable removal of voltage from the corresponding circuit segment. By selecting a plurality of individual electronic switches, the combination logic circuit may implement a deenergization sequence or an energization sequence. The plurality of voltage converters may provide a stepped-up voltage or a stepped-down voltage to the plurality of circuit segments. The voltage control circuit 1408 may also comprise a microprocessor and memory device, as illustrated in FIG. 62.

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[0351] The safety controller 1410 is configured to perform safety checks for the circuit segments. In some aspects, the safety controller 1410 performs the safety checks when one or more individual circuit segments are in the operational mode. The safety checks may be performed to determine whether there are any errors or defects in the functioning or operation of the circuit segments. The safety controller 1410 may monitor one or more parameters of the plurality of circuit segments. The safety controller 1410 may verify the identity and operation of the plurality of circuit segments by comparing the one or more parameters with predefined parameters. For example, if an RF energy modality is selected, the safety controller 1410 may verify that an articulation parameter of the shaft matches a predefined articulation parameter to verify the operation of the RF energy modality of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connection with FIGS. 1-61. In some aspects, the safety controller 1410 may monitor, by the sensors 1306, a predetermined relationship between one or more properties of the surgical instrument to detect a fault. A fault may arise when the one or more properties are inconsistent with the predetermined relationship. When the safety controller 1410 determines that a fault exists, an error exists, or that some operation of the plurality of circuit segments was not verified, the safety controller 1410 prevents or disables operation of the particular circuit segment where the fault, error or verification failure originated.

[0352] The POST controller 1412 performs a POST to verify proper operation of the plurality of circuit segments. In some aspects, the POST is performed for an individual circuit segment of the plurality of circuit segments prior to the voltage control circuit 1408 applying a voltage to the individual circuit segment to transition the individual circuit segment from standby mode or sleep mode to operational mode. If the individual circuit segment does not pass the POST, the particular circuit segment does not transition from standby mode or sleep mode to operational mode. POST of the handle circuit segment 1416 may comprise, for example, testing whether the handle control sensors 1418 sense an actuation of a handle control of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connection with FIGS. 1-61. In some aspects, the POST controller 1412 may transmit a signal to the accelerometer button sensor 1405 to verify the operation of the individual circuit segment as part of the POST. For example, after receiving the signal, the accelerometer button sensor 1405 may prompt a user of the surgical instrument to move the surgical instrument to a plurality of varying locations to confirm operation of the surgical instrument. The accelerometer button sensor 1405 may also monitor an output of a circuit segment or a circuit of a circuit segment as part of the POST. For example, the accelerometer button sensor 1405 can sense an incremental motor pulse

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generated by the motor 1432 to verify operation. A motor controller of the motor control circuit 1430 may be used to control the motor 1432 to generate the incremental motor pulse.

[0353] In various aspects, any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connection with FIGS. 1-61 may comprise additional accelerometer button sensors may be used. The POST controller 1412 may also execute a control program stored in the memory device of the voltage control circuit 1408. The control program may cause the POST controller 1412 to transmit a signal requesting a matching encrypted parameter from a plurality of circuit segments. Failure to receive a matching encrypted parameter from an individual circuit segment indicates to the POST controller 1412 that the corresponding circuit segment is damaged or malfunctioning. In some aspects, if the POST controller 1412 determines based on the POST that the processor 1302 is damaged or malfunctioning, the POST controller 1412 may send a signal to one or more secondary processors to cause one or more secondary processors to perform critical functions that the processor 1302 is unable to perform. In some aspects, if the POST controller 1412 determines based on the POST that one or more circuit segments do not operate properly, the POST controller 1412 may initiate a reduced performance mode of those circuit segments operating properly while locking out those circuit segments that fail POST or do not operate properly. A locked out circuit segment may function similarly to a circuit segment in standby mode or sleep mode.

[0354] The processor circuit segment 1414 comprises the processor 1302 and the volatile memory 1304 described with reference to FIG. 62. The processor 1302 is configured to initiate an energization or a deenergization sequence. To initiate the energization sequence, the processor 1302 transmits an energizing signal to the voltage control circuit 1408 to cause the voltage control circuit 1408 to apply voltage to the plurality or a subset of the plurality of circuit segments in accordance with the energization sequence. To initiate the deenergization sequence, the processor 1302 transmits a deenergizing signal to the voltage control circuit 1408 to cause the voltage control circuit 1408 to remove voltage from the plurality or a subset of the plurality of circuit segments in accordance with the deenergization sequence.

[0355] The handle circuit segment 1416 comprises handle control sensors 1418. The handle control sensors 1418 may sense an actuation of one or more handle controls of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 . In various aspects, the one or more handle controls comprise a clamp control, a release button, an articulation switch, an energy activation button, and/or any other suitable handle control. The user may activate the energy activation button to select between an RF

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energy mode, an ultrasonic energy mode or a combination RF and ultrasonic energy mode. The handle control sensors 1418 may also facilitate attaching a modular handle to the surgical instrument. For example, the handle control sensors 1418 may sense proper attachment of the modular handle to the surgical instrument and indicate the sensed attachment to a user of the surgical instrument. The LCD display 1426 may provide a graphical indication of the sensed attachment. In some aspects, the handle control sensors 1418 senses actuation of the one or more handle controls. Based on the sensed actuation, the processor 1302 may initiate either an energization sequence or a deenergization sequence.

[0356] The communication circuit segment 1420 comprises a communication circuit 1422. The communication circuit 1422 comprises a communication interface to facilitate signal communication between the individual circuit segments of the plurality of circuit segments. In some aspects, the communication circuit 1422 provides a path for the modular components of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 to communicate electrically. For example, a modular shaft and a modular transducer, when attached together to the handle of the surgical instrument, can upload control programs to the handle through the communication circuit 1422.

[0357] The display circuit segment 1424 comprises a LCD display 1426. The LCD display 1426 may comprise a liquid crystal display screen, LED indicators, etc. In some aspects, the LCD display 1426 is an organic light-emitting diode (OLED) screen. The Display 226 may be placed on, embedded in, or located remotely from any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61. For example, the Display 226 can be placed on the handle of the surgical instrument. The Display 226 is configured to provide sensory feedback to a user. In various aspects, the LCD display 1426 further comprises a backlight. In some aspects, the surgical instrument may also comprise audio feedback devices such as a speaker or a buzzer and tactile feedback devices such as a haptic actuator.

[0358] The motor control circuit segment 1428 comprises a motor control circuit 1430 coupled to a motor 1432. The motor 1432 is coupled to the processor 1302 by a driver and a transistor, such as a FET. In various aspects, the motor control circuit 1430 comprises a motor current sensor in signal communication with the processor 1302 to provide a signal indicative of a measurement of the current draw of the motor to the processor 1302. The processor transmits the signal to the Display 226. The Display 226 receives the signal and displays the measurement of the current draw of the motor 1432. The processor 1302 may use the signal,

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for example, to monitor that the current draw of the motor 1432 exists within an acceptable range, to compare the current draw to one or more parameters of the plurality of circuit segments, and to determine one or more parameters of a patient treatment site. In various aspects, the motor control circuit 1430 comprises a motor controller to control the operation of the motor. For example, the motor control circuit 1430 controls various motor parameters, such as by adjusting the velocity, torque and acceleration of the motor 1432. The adjusting is done based on the current through the motor 1432 measured by the motor current sensor.

[0359] In various aspects, the motor control circuit 1430 comprises a force sensor to measure the force and torque generated by the motor 1432. The motor 1432 is configured to actuate a mechanism of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 . For example, the motor 1432 is configured to control actuation of the shaft of the surgical instrument to realize clamping, rotation and articulation functionality. For example, the motor 1432 may actuate the shaft to realize a clamping motion with jaws of the surgical instrument. The motor controller may determine whether the material clamped by the jaws is tissue or metal. The motor controller may also determine the extent to which the jaws clamp the material. For example, the motor controller may determine how open or closed the jaws are based on the derivative of sensed motor current or motor voltage. In some aspects, the motor 1432 is configured to actuate the transducer to cause the transducer to apply torque to the handle or to control articulation of the surgical instrument. The motor current sensor may interact with the motor controller to set a motor current limit. When the current meets the predefined threshold limit, the motor controller initiates a corresponding change in a motor control operation. For example, exceeding the motor current limit causes the motor controller to reduce the current draw of the motor.

[0360] The energy treatment circuit segment 1434 comprises a RF amplifier and safety circuit 1436 and an ultrasonic signal generator circuit 1438 to implement the energy modular functionality of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described in connection with FIGS. 1-61 . In various aspects, the RF amplifier and safety circuit 1436 is configured to control the RF modality of the surgical instrument by generating an RF signal. The ultrasonic signal generator circuit 1438 is configured to control the ultrasonic energy modality by generating an ultrasonic signal. The RF amplifier and safety circuit 1436 and an ultrasonic signal generator circuit 1438 may operate in conjunction to control the combination RF and ultrasonic energy modality.

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[0361] The shaft circuit segment 1440 comprises a shaft module controller 1442, a modular control actuator 1444, one or more end effector sensors 1446, and a non volatile memory 1448. The shaft module controller 1442 is configured to control a plurality of shaft modules comprising the control programs to be executed by the processor 1302. The plurality of shaft modules implements a shaft modality, such as ultrasonic, combination ultrasonic and RF, RF I-blade, and RF-opposable jaw. The shaft module controller 1442 can select shaft modality by selecting the corresponding shaft module for the processor 1302 to execute. The modular control actuator 1444 is configured to actuate the shaft according to the selected shaft modality. After actuation is initiated, the shaft articulates the end effector according to the one or more parameters, routines or programs specific to the selected shaft modality and the selected end effector modality. The one or more end effector sensors 1446 located at the end effector may include force sensors, temperature sensors, current sensors or motion sensors. The one or more end effector sensors 1446 transmit data about one or more operations of the end effector, based on the energy modality implemented by the end effector. In various aspects, the energy modalities include an ultrasonic energy modality, a RF energy modality, or a combination of the ultrasonic energy modality and the RF energy modality. The non volatile memory 1448 stores the shaft control programs. A control program comprises one or more parameters, routines or programs specific to the shaft. In various aspects, the non volatile memory 1448 may be an ROM, EPROM, EEPROM or flash memory. The non volatile memory 1448 stores the shaft modules corresponding to the selected shaft of nay one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61. The shaft modules may be changed or upgraded in the non volatile memory 1448 by the shaft module controller 1442, depending on the surgical instrument shaft to be used in operation.

[0362] FIG. 64 illustrates a diagram of one aspect of a surgical instrument 1500 comprising a feedback system for use with any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61, which may include or implement many of the features described herein. For example, in one aspect, the surgical instrument 1500 may be similar to or representative of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200. The surgical instrument 1500 may include a generator 1502. The surgical instrument 1500 also may include an end effector 1506, which may be activated when a clinician operates a trigger 1510. In various aspects, the end effector 1506 may include an ultrasonic blade to deliver ultrasonic vibration to carry out surgical coagulation/cutting treatments on living tissue. In other aspects the end effector 1506 may include electrically

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conductive elements coupled to an electrosurgical high-frequency current energy source to carry out surgical coagulation or cauterization treatments on living tissue and either a mechanical knife with a sharp edge or an ultrasonic blade to carry out cutting treatments on living tissue. When the trigger 1510 is actuated, a force sensor 1512 may generate a signal indicating the amount of force being applied to the trigger 1510. In addition to, or instead of a force sensor 1512, the surgical instrument 1500 may include a position sensor 1513, which may generate a signal indicating the position of the trigger 1510 (e.g., how far the trigger has been depressed or otherwise actuated). In one aspect, the position sensor 1513 may be a sensor positioned with the outer tubular sheath described above or reciprocating tubular actuating member located within the outer tubular sheath described above. In one aspect, the sensor may be a Hall-effect sensor or any suitable transducer that varies its output voltage in response to a magnetic field. The Hall-effect sensor may be used for proximity switching, positioning, speed detection, and current sensing applications. In one aspect, the Hall-effect sensor operates as an analog transducer, directly returning a voltage. With a known magnetic field, its distance from the Hall plate can be determined.

[0363] A control circuit 1508 may receive the signals from the sensors 1512 and/or 1513. The control circuit 1508 may include any suitable analog or digital circuit components. The control circuit 1508 also may communicate with the generator 1502 and/or the transducer 1504 to modulate the power delivered to the end effector 1506 and/or the generator level or ultrasonic blade amplitude of the end effector 1506 based on the force applied to the trigger 1510 and/or the position of the trigger 1510 and/or the position of the outer tubular sheath described above relative to the reciprocating tubular actuating member 58 located within the outer tubular sheath 56 described above (e.g., as measured by a Hall-effect sensor and magnet combination). For example, as more force is applied to the trigger 1510, more power and/or a higher ultrasonic blade amplitude may be delivered to the end effector 1506. According to various aspects, the force sensor 1512 may be replaced by a multi-position switch.

[0364] According to various aspects, the end effector 1506 may include a clamp or clamping mechanism, for example, such as that described above with respect to FIGS. 1-5. When the trigger 1510 is initially actuated, the clamping mechanism may close, clamping tissue between a clamp arm and the end effector 1506. As the force applied to the trigger increases (e.g., as sensed by force sensor 1512) the control circuit 1508 may increase the power delivered to the end effector 1506 by the transducer 1504 and/or the generator level or ultrasonic blade amplitude brought about in the end effector 1506. In one aspect, trigger position, as sensed by

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position sensor 1513 or clamp or clamp arm position, as sensed by position sensor 1513 (e.g., with a Hall-effect sensor), may be used by the control circuit 1508 to set the power and/or amplitude of the end effector 1506. For example, as the trigger is moved further towards a fully actuated position, or the clamp or clamp arm moves further towards the ultrasonic blade (or end effector 1506), the power and/or amplitude of the end effector 1506 may be increased.

[0365] According to various aspects, the surgical instrument 1500 also may include one or more feedback devices for indicating the amount of power delivered to the end effector 1506. For example, a speaker 1514 may emit a signal indicative of the end effector power. According to various aspects, the speaker 1514 may emit a series of pulse sounds, where the frequency of the sounds indicates power. In addition to, or instead of the speaker 1514, the surgical instrument 1500 may include a visual display 1516. The visual display 1516 may indicate end effector power according to any suitable method. For example, the visual display 1516 may include a series of LEDs, where end effector power is indicated by the number of illuminated LEDs. The speaker 1514 and/or visual display 1516 may be driven by the control circuit 1508. According to various aspects, the surgical instrument 1500 may include a ratcheting device (not shown) connected to the trigger 1510. The ratcheting device may generate an audible sound as more force is applied to the trigger 1510, providing an indirect indication of end effector power. The surgical instrument 1500 may include other features that may enhance safety. For example, the control circuit 1508 may be configured to prevent power from being delivered to the end effector 1506 in excess of a predetermined threshold. Also, the control circuit 1508 may implement a delay between the time when a change in end effector power is indicated (e.g., by speaker 1514 or visual display 1516), and the time when the change in end effector power is delivered. In this way, a clinician may have ample warning that the level of ultrasonic power that is to be delivered to the end effector 1506 is about to change.

[0366] In one aspect, the ultrasonic or high-frequency current generators of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 may be configured to generate the electrical signal waveform digitally such that the desired using a predetermined number of phase points stored in a lookup table to digitize the wave shape. The phase points may be stored in a table defined in a memory, a field programmable gate array (FPGA), or any suitable non-volatile memory. FIG. 65 illustrates one aspect of a fundamental architecture for a digital synthesis circuit such as a direct digital synthesis (DDS) circuit 1600 configured to generate a plurality of wave shapes for the electrical signal waveform. The generator software and digital controls may command the FPGA to scan

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the addresses in the lookup table 1604 which in turn provides varying digital input values to a DAC circuit 1608 that feeds a power amplifier. The addresses may be scanned according to a frequency of interest. Using such a lookup table 1604 enables generating various types of wave shapes that can be fed into tissue or into a transducer, an RF electrode, multiple transducers simultaneously, multiple RF electrodes simultaneously, or a combination of RF and ultrasonic instruments. Furthermore, multiple lookup tables 1604 that represent multiple wave shapes can be created, stored, and applied to tissue from a generator.

[0367] The waveform signal may be configured to control at least one of an output current, an output voltage, or an output power of an ultrasonic transducer and/or an RF electrode, or multiples thereof (e.g. two or more ultrasonic transducers and/or two or more RF electrodes). Further, where the surgical instrument comprises an ultrasonic components, the waveform signal may be configured to drive at least two vibration modes of an ultrasonic transducer of the at least one surgical instrument. Accordingly, a generator may be configured to provide a waveform signal to at least one surgical instrument wherein the waveform signal corresponds to at least one wave shape of a plurality of wave shapes in a table. Further, the waveform signal provided to the two surgical instruments may comprise two or more wave shapes. The table may comprise information associated with a plurality of wave shapes and the table may be stored within the generator. In one aspect or example, the table may be a direct digital synthesis table, which may be stored in an FPGA of the generator. The table may be addressed by anyway that is convenient for categorizing wave shapes. According to one aspect, the table, which may be a direct digital synthesis table, is addressed according to a frequency of the waveform signal. Additionally, the information associated with the plurality of wave shapes may be stored as digital information in the table.

[0368] The analog electrical signal waveform may be configured to control at least one of an output current, an output voltage, or an output power of an ultrasonic transducer and/or an RF electrode, or multiples thereof (e.g., two or more ultrasonic transducers and/or two or more RF electrodes). Further, where the surgical instrument comprises ultrasonic components, the analog electrical signal waveform may be configured to drive at least two vibration modes of an ultrasonic transducer of the at least one surgical instrument. Accordingly, the generator circuit may be configured to provide an analog electrical signal waveform to at least one surgical instrument wherein the analog electrical signal waveform corresponds to at least one wave shape of a plurality of wave shapes stored in a lookup table 1604. Further, the analog electrical signal waveform provided to the two surgical instruments may comprise two or more wave

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shapes. The lookup table 1604 may comprise information associated with a plurality of wave shapes and the lookup table 1604 may be stored either within the generator circuit or the surgical instrument. In one aspect or example, the lookup table 1604 may be a direct digital synthesis table, which may be stored in an FPGA of the generator circuit or the surgical instrument. The lookup table 1604 may be addressed by anyway that is convenient for categorizing wave shapes. According to one aspect, the lookup table 1604, which may be a direct digital synthesis table, is addressed according to a frequency of the desired analog electrical signal waveform. Additionally, the information associated with the plurality of wave shapes may be stored as digital information in the lookup table 1604.

[0369] With the widespread use of digital techniques in instrumentation and communications systems, a digitally-controlled method of generating multiple frequencies from a reference frequency source has evolved and is referred to as direct digital synthesis. The basic architecture is shown in FIG. 65. In this simplified block diagram, a DDS circuit is coupled to a processor, controller, or a logic device of the generator circuit and to a memory circuit located either in the generator circuit of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61. The DDS circuit 1600 comprises an address counter 1602, lookup table 1604, a register 1606, a DAC circuit 1608, and a filter 1612. A stable clock f_c is received by the address counter 1602 and the register 1606 drives a programmable-read-only-memory (PROM) which stores one or more integral number of cycles of a sinewave (or other arbitrary waveform) in a lookup table 1604. As the address counter 1602 steps through memory locations, values stored in the lookup table 1604 are written to a register 1606, which is coupled to a DAC circuit 1608. The corresponding digital amplitude of the signal at the memory location of the lookup table 1604 drives the DAC circuit 1608, which in turn generates an analog output signal 1610. The spectral purity of the analog output signal 1610 is determined primarily by the DAC circuit 1608. The phase noise is basically that of the reference clock f_c. The first analog output signal 1610 output from the DAC circuit 1608 is filtered by the filter 1612 and a second analog output signal 1614 output by the filter 1612 is provided to an amplifier having an output coupled to the output of the generator circuit. The second analog output signal has a frequency f_{out}.

[0370] Because the DDS circuit 1600 is a sampled data system, issues involved in sampling must be considered: quantization noise, aliasing, filtering, etc. For instance, the higher order harmonics of the DAC circuit 1608 output frequencies fold back into the Nyquist bandwidth, making them unfilterable, whereas, the higher order harmonics of the output of phase-locked-

loop (PLL) based synthesizers can be filtered. The lookup table 1604 contains signal data for an integral number of cycles. The final output frequency f_{out} can be changed changing the reference clock frequency f_c or by reprogramming the PROM.

[0371] The DDS circuit 1600 may comprise multiple lookup tables 1604 where the lookup table 1604 stores a waveform represented by a predetermined number of samples, wherein the samples define a predetermined shape of the waveform. Thus multiple waveforms having a unique shape can be stored in multiple lookup tables 1604 to provide different tissue treatments based on instrument settings or tissue feedback. Examples of waveforms include high crest factor RF electrical signal waveforms for surface tissue coagulation, low crest factor RF electrical signal waveform for deeper tissue penetration, and electrical signal waveforms that promote efficient touch-up coagulation. In one aspect, the DDS circuit 1600 can create multiple wave shape lookup tables 1604 and during a tissue treatment procedure (e.g., "on-the-fly" or in virtual real time based on user or sensor inputs) switch between different wave shapes stored in separate lookup tables 1604 based on the tissue effect desired and/or tissue feedback. Accordingly, switching between wave shapes can be based on tissue impedance and other factors, for example. In other aspects, the lookup tables 1604 can store electrical signal waveforms shaped to maximize the power delivered into the tissue per cycle (i.e., trapezoidal or square wave). In other aspects, the lookup tables 1604 can store wave shapes synchronized in such way that they make maximizing power delivery by the multifunction surgical instrument any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 while delivering RF and ultrasonic drive signals. In yet other aspects, the lookup tables 1604 can store electrical signal waveforms to drive ultrasonic and RF therapeutic, and/or sub-therapeutic, energy simultaneously while maintaining ultrasonic frequency lock. Custom wave shapes specific to different instruments and their tissue effects can be stored in the non-volatile memory of the generator circuit or in the non-volatile memory (e.g., EEPROM) of any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 and be fetched upon connecting the multifunction surgical instrument to the generator circuit. An example of an exponentially damped sinusoid, as used in many high crest factor "coagulation" waveforms is shown in FIG. 67.

[0372] A more flexible and efficient implementation of the DDS circuit 1600 employs a digital circuit called a Numerically Controlled Oscillator (NCO). A block diagram of a more flexible and efficient digital synthesis circuit such as a DDS circuit 1700 is shown in FIG. 66. In this simplified

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block diagram, a DDS circuit 1700 is coupled to a processor, controller, or a logic device of the generator and to a memory circuit located either in the generator or in any of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61. The DDS circuit 1700 comprises a load register 1702, a parallel delta phase register 1704, an adder circuit 1716, a phase register 1708, a lookup table 1710 (phase-to-amplitude converter), a DAC circuit 1712, and a filter 1714. The adder circuit 1716 and the phase register 1708 a form part of a phase accumulator 1706. A clock signal f_c is applied to the phase register 1708 and the DAC circuit 1712. The load register 1702 receives a tuning word that specifies output frequency as a fraction of the reference clock frequency f_c. The output of the load register 1702 is provided to a parallel delta phase register 1704 with a tuning word M.

[0373] The DDS circuit 1700 includes a sample clock that generates a clock frequency f_c, a phase accumulator 1706, and a lookup table 1710 (e.g., phase to amplitude converter). The content of the phase accumulator 1706 is updated once per clock cycle f_c. When time the phase accumulator 1706 is updated, the digital number, M, stored in the parallel delta phase register 1704 is added to the number in the phase register 1708 by an adder circuit 1716. Assuming that the number in the parallel delta phase register 1704 is 00...01 and that the initial contents of the phase accumulator 1706 is 00...00. The phase accumulator 1706 is updated by 00...01 per clock cycle. If the phase accumulator 1706 is 32-bits wide, 232 clock cycles (over 4 billion) are required before the phase accumulator 1706 returns to 00...00, and the cycle repeats.

[0374] The truncated output 1718 of the phase accumulator 1706 is provided to a phase-to amplitude converter lookup table 1710 and the output of the lookup table 1710 is coupled to a DAC circuit 1712. The truncated output 1718 of the phase accumulator 1706 serves as the address to a sine (or cosine) lookup table. An address in the lookup table corresponds to a phase point on the sinewave from 0° to 360°. The lookup table 1710 contains the corresponding digital amplitude information for one complete cycle of a sinewave. The lookup table 1710 therefore maps the phase information from the phase accumulator 1706 into a digital amplitude word, which in turn drives the DAC circuit 1712. The output of the DAC circuit is a first analog signal 1720 and is filtered by a filter 1714. The output of the filter 1714 is a second analog signal 1722, which is provided to a power amplifier coupled to the output of the generator circuit.

[0375] In one aspect, the electrical signal waveform may be digitized into 1024 (210) phase points, although the wave shape may be digitized is any suitable number of 2n phase points ranging from 256 (28) to 281,474,976,710,656 (248), where n is a positive integer, as shown in TABLE 1. The electrical signal waveform may be expressed as $A\eta(\theta\eta)$, where a normalized

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amplitude An at a point n is represented by a phase angle 0η is referred to as a phase point at point n. The number of discrete phase points n determines the tuning resolution of the DDS circuit 1700 (as well as the DDS circuit 1600 shown in FIG. 65).

N	Number of Phase Points 2^n
8	256
10	1,024
12	4,096
14	16,384
16	65,536
18	262,144
20	1,048,576
22	4,194,304
24	16,777,216
26	67,108,864
28	268,435,456
...	...
32	4,294,967,296
...	...
48	281,474,976,710,656
...	...

TABLE 1

[0376] The generator circuit algorithms and digital control circuits scan the addresses in the lookup table 1710, which in turn provides varying digital input values to the DAC circuit 1712 that feeds the filter 1714 and the power amplifier. The addresses may be scanned according to a frequency of interest. Using the lookup table enables generating various types of shapes that can be converted into an analog output signal by the DAC circuit 1712, filtered by the filter 1714, amplified by the power amplifier coupled to the output of the generator circuit, and fed to the tissue in the form of RF energy or fed to an ultrasonic transducer and applied to the tissue in the form of ultrasonic vibrations which deliver energy to the tissue in the form of heat. The output of the amplifier can be applied to an RF electrode, multiple RF electrodes simultaneously, an ultrasonic transducer, multiple ultrasonic transducers simultaneously, or a combination of RF and ultrasonic transducers, for example. Furthermore, multiple wave shape tables can be created, stored, and applied to tissue from a generator circuit.

[0377] With reference back to FIG. 65, for n = 32, and M = 1, the phase accumulator 1706 steps through 232 possible outputs before it overflows and restarts. The corresponding output wave frequency is equal to the input clock frequency divided by 232. If M = 2, then the phase

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register 1708 "rolls over" twice as fast, and the output frequency is doubled. This can be generalized as follows.

[0378] For a phase accumulator 1706 configured to accumulate n-bits (n generally ranges from 24 to 32 in most DDS systems, but as previously discussed n may be selected from a wide range of options), there are 2" possible phase points. The digital word in the delta phase register, M, represents the amount the phase accumulator is incremented per clock cycle. If fc is the clock frequency, then the frequency of the output sinewave is equal to:

$$f_o = \frac{M \cdot f_c}{2^n} \quad \text{Eq. 1}$$

[0379] Equation 1 is known as the DDS "tuning equation." Note that the frequency resolution of the system is equal to $\frac{f_c}{2^n}$. For n = 32, the resolution is greater than one part in four billion. In one aspect of the DDS circuit 1700, not all of the bits out of the phase accumulator 1706 are passed on to the lookup table 1710, but are truncated, leaving only the first 13 to 15 most significant bits (MSBs), for example. This reduces the size of the lookup table 1710 and does not affect the frequency resolution. The phase truncation only adds a small but acceptable amount of phase noise to the final output.

[0380] The electrical signal waveform may be characterized by a current, voltage, or power at a predetermined frequency. Further, where any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 comprises ultrasonic components, the electrical signal waveform may be configured to drive at least two vibration modes of an ultrasonic transducer of the at least one surgical instrument. Accordingly, the generator circuit may be configured to provide an electrical signal waveform to at least one surgical instrument wherein the electrical signal waveform is characterized by a predetermined wave shape stored in the lookup table 1710 (or lookup table 1604 FIG. 65). Further, the electrical signal waveform may be a combination of two or more wave shapes. The lookup table 1710 may comprise information associated with a plurality of wave shapes. In one aspect or example, the lookup table 1710 may be generated by the DDS circuit 1700 and may be referred to as a direct digital synthesis table. DDS works by first storing a large repetitive waveform in onboard memory. A cycle of a waveform (sine, triangle, square, arbitrary) can be represented by a predetermined number of phase points as shown in TABLE 1 and stored into memory. Once the waveform is stored into memory, it can be generated at very precise frequencies. The direct digital synthesis table may be stored in a non-volatile memory of the generator circuit and/or may be implemented with a FPGA circuit in the generator circuit. The lookup table 1710 may be addressed by any suitable technique that is convenient for categorizing wave shapes.

According to one aspect, the lookup table 1710 is addressed according to a frequency of the electrical signal waveform. Additionally, the information associated with the plurality of wave shapes may be stored as digital information in a memory or as part of the lookup table 1710.

[0381] In one aspect, the generator circuit may be configured to provide electrical signal waveforms to at least two surgical instruments simultaneously. The generator circuit also may be configured to provide the electrical signal waveform, which may be characterized two or more wave shapes, via an output channel of the generator circuit to the two surgical instruments simultaneously. For example, in one aspect the electrical signal waveform comprises a first electrical signal to drive an ultrasonic transducer (e.g., ultrasonic drive signal), a second RF drive signal, and/or a combination thereof. In addition, an electrical signal waveform may comprise a plurality of ultrasonic drive signals, a plurality of RF drive signals, and/or a combination of a plurality of ultrasonic and RF drive signals.

[0382] In addition, a method of operating the generator circuit according to the present disclosure comprises generating an electrical signal waveform and providing the generated electrical signal waveform to any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61, where generating the electrical signal waveform comprises receiving information associated with the electrical signal waveform from a memory. The generated electrical signal waveform comprises at least one wave shape. Furthermore, providing the generated electrical signal waveform to the at least one surgical instrument comprises providing the electrical signal waveform to at least two surgical instruments simultaneously.

[0383] The generator circuit as described herein may allow for the generation of various types of direct digital synthesis tables. Examples of wave shapes for RF/Electrosurgery signals suitable for treating a variety of tissue generated by the generator circuit include RF signals with a high crest factor (which may be used for surface coagulation in RF mode), a low crest factor RF signals (which may be used for deeper tissue penetration), and waveforms that promote efficient touch-up coagulation. The generator circuit also may generate multiple wave shapes employing a direct digital synthesis lookup table 1710 and, on the fly, can switch between particular wave shapes based on the desired tissue effect. Switching may be based on tissue impedance and/or other factors.

[0384] In addition to traditional sine /cosine wave shapes, the generator circuit may be configured to generate wave shape(s) that maximize the power into tissue per cycle (i.e., trapezoidal or square wave). The generator circuit may provide wave shape(s) that are

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synchronized to maximize the power delivered to the load when driving RF and ultrasonic signals simultaneously and to maintain ultrasonic frequency lock, provided that the generator circuit includes a circuit topology that enables simultaneously driving RF and ultrasonic signals. Further, custom wave shapes specific to instruments and their tissue effects can be stored in a non-volatile memory (NVM) or an instrument EEPROM and can be fetched upon connecting any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 to the generator circuit.

[0385] The DDS circuit 1700 may comprise multiple lookup tables 1604 where the lookup table 1710 stores a waveform represented by a predetermined number of phase points (also may be referred to as samples), wherein the phase points define a predetermined shape of the waveform. Thus multiple waveforms having a unique shape can be stored in multiple lookup tables 1710 to provide different tissue treatments based on instrument settings or tissue feedback. Examples of waveforms include high crest factor RF electrical signal waveforms for surface tissue coagulation, low crest factor RF electrical signal waveform for deeper tissue penetration, and electrical signal waveforms that promote efficient touch-up coagulation. In one aspect, the DDS circuit 1700 can create multiple wave shape lookup tables 1710 and during a tissue treatment procedure (e.g., "on-the-fly" or in virtual real time based on user or sensor inputs) switch between different wave shapes stored in different lookup tables 1710 based on the tissue effect desired and/or tissue feedback. Accordingly, switching between wave shapes can be based on tissue impedance and other factors, for example. In other aspects, the lookup tables 1710 can store electrical signal waveforms shaped to maximize the power delivered into the tissue per cycle (i.e., trapezoidal or square wave). In other aspects, the lookup tables 1710 can store wave shapes synchronized in such way that they make maximizing power delivery by any one of the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-61 when delivering RF and ultrasonic drive signals. In yet other aspects, the lookup tables 1710 can store electrical signal waveforms to drive ultrasonic and RF therapeutic, and/or sub-therapeutic, energy simultaneously while maintaining ultrasonic frequency lock. Generally, the output wave shape may be in the form of a sine wave, cosine wave, pulse wave, square wave, and the like. Nevertheless, the more complex and custom wave shapes specific to different instruments and their tissue effects can be stored in the non-volatile memory of the generator circuit or in the non-volatile memory (e.g., EEPROM) of the surgical instrument and be fetched upon connecting the surgical instrument to the generator

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circuit. One example of a custom wave shape is an exponentially damped sinusoid as used in many high crest factor "coagulation" waveforms, as shown in FIG. 67.

[0386] FIG. 67 illustrates one cycle of a discrete time digital electrical signal waveform 1800, according to one aspect of the present disclosure of an analog waveform 1804 (shown superimposed over the discrete time digital electrical signal waveform 1800 for comparison purposes). The horizontal axis represents Time (t) and the vertical axis represents digital phase points. The digital electrical signal waveform 1800 is a digital discrete time version of the desired analog waveform 1804, for example. The digital electrical signal waveform 1800 is generated by storing an amplitude phase point 1802 that represents the amplitude per clock cycle T_{clk} over one cycle or period T_0. The digital electrical signal waveform 1800 is generated over one period T_0 by any suitable digital processing circuit. The amplitude phase points are digital words stored in a memory circuit. In the example illustrated in FIGS. 65, 66, the digital word is a six-bit word that is capable of storing the amplitude phase points with a resolution of 26 or 64 bits. It will be appreciated that the examples shown in FIGS. 65, 66 is for illustrative purposes and in actual implementations the resolution can be much higher. The digital amplitude phase points 1802 over one cycle T_0 are stored in the memory as a string of string words in a lookup table 1604, 1710 as described in connection with FIGS. 65, 66, for example. To generate the analog version of the analog waveform 1804, the amplitude phase points 1802 are read sequentially from the memory from 0 to T_0 per clock cycle T_{clk} and are converted by a DAC circuit 1608, 1712, also described in connection with FIGS. 65, 66. Additional cycles can be generated by repeatedly reading the amplitude phase points 1802 of the digital electrical signal waveform 1800 the from 0 to T_0 for as many cycles or periods as may be desired. The smooth analog version of the analog waveform 1804 is achieved by filtering the output of the DAC circuit 1608, 1712 by a filter 1612, 1714 (FIGS. 65 and 66). The filtered analog output signal 1614, 1722 (FIGS. 65 and 66) is applied to the input of a power amplifier.

[0387] In one aspect, as illustrated in FIG. 68A, a circuit 1900 may comprise a controller comprising one or more processors 1902 (e.g., microprocessor, microcontroller) coupled to at least one memory circuit 1904. The at least one memory circuit 1904 stores machine executable instructions that when executed by the processor 1902, cause the processor 1902 to execute machine instructions to implement any of the algorithms, processes, or techniques described herein.

[0388] The processor 1902 may be any one of a number of single or multi-core processors known in the art. The memory circuit 1904 may comprise volatile and non-volatile storage

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media. In one aspect, as illustrated in FIG. 68A, the processor 1902 may include an instruction processing unit 1906 and an arithmetic unit 1908. The instruction processing unit may be configured to receive instructions from the one memory circuit 1904.

[0389] In one aspect, a circuit 1910 may comprise a finite state machine comprising a combinational logic circuit 1912, as illustrated in FIG. 68B, configured to implement any of the algorithms, processes, or techniques described herein. In one aspect, a circuit 1920 may comprise a finite state machine comprising a sequential logic circuit, as illustrated in FIG. 68C. The sequential logic circuit 1920 may comprise the combinational logic circuit 1912 and at least one memory circuit 1914, for example. The at least one memory circuit 1914 can store a current state of the finite state machine, as illustrated in FIG. 68C. The sequential logic circuit 1920 or the combinational logic circuit 1912 can be configured to implement any of the algorithms, processes, or techniques described herein. In certain instances, the sequential logic circuit 1920 may be synchronous or asynchronous.

[0390] In other aspects, the circuit may comprise a combination of the processor 1902 and the finite state machine to implement any of the algorithms, processes, or techniques described herein. In other aspects, the finite state machine may comprise a combination of the combinational logic circuit 1910 and the sequential logic circuit 1920.

[0391] FIG. 69 is a schematic diagram of a circuit 1925 of various components of a surgical instrument with motor control functions, according to one aspect of the present disclosure. In various aspects, the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-68C may include a drive mechanism 1930 which is configured to drive shafts and/or gear components in order to perform the various operations associated with the surgical instruments 100, 480, 500, 600, 1100, 1150, 1200. In one aspect, the drive mechanism 1930 160 includes a rotation drivetrain 1932 configured to rotate end effector 112, 512, 1000, 1112, 1212 as described in connection with FIGS. 1, 20, 40, 41, 45, 54, for example, about a longitudinal axis relative to handle housing. The drive mechanism 1930 further includes a closure drivetrain 1934 configured to close a jaw member to grasp tissue with the end effector. In addition, the drive mechanism 1930 includes a firing drive train 1936 configured to fire an I-beam knife of the end effector to cut tissue grasped by the end effector.

[0392] The drive mechanism 1930 includes a selector gearbox assembly 1938 that can be located in the handle assembly of the surgical instrument. Proximal to the selector gearbox assembly 1938 is a function selection module which includes a first motor 1942 that functions to selectively move gear elements within the selector gearbox assembly 1938 to selectively

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position one of the drivetrains 1932, 1934, 1936 into engagement with an input drive component of an optional second motor 1944 and motor drive circuit 1946 (shown in dashed line to indicate that the second motor 1944 and motor drive circuit 1946 are optional components).

[0393] Still referring to FIG. 69, the motors 1942, 1944 are coupled to motor control circuits 1946, 1948, respectively, which are configured to control the operation of the motors 1942, 1944 including the flow of electrical energy from a power source 1950 to the motors 1942, 1944. The power source 1950 may be a DC battery (e.g., rechargeable lead-based, nickel-based, lithium-ion based, battery etc.) or any other power source suitable for providing electrical energy to the surgical instrument.

[0394] The surgical instrument further includes a microcontroller 1952 ("controller"). In certain instances, the controller 1952 may include a microprocessor 1954 ("processor") and one or more computer readable mediums or memory units 1956 ("memory"). In certain instances, the memory 1956 may store various program instructions, which when executed may cause the processor 1954 to perform a plurality of functions and/or calculations described herein. The power source 1950 can be configured to supply power to the controller 1952, for example.

[0395] The processor 1954 be in communication with the motor control circuit 1946. In addition, the memory 1956 may store program instructions, which when executed by the processor 1954 in response to a user input 1958 or feedback elements 1960, may cause the motor control circuit 1946 to motivate the motor 1942 to generate at least one rotational motion to selectively move gear elements within the selector gearbox assembly 1938 to selectively position one of the drivetrains 1932, 1934, 1936 into engagement with the input drive component of the second motor 1944. Furthermore, the processor 1954 can be in communication with the motor control circuit 1948. The memory 1956 also may store program instructions, which when executed by the processor 1954 in response to a user input 1958, may cause the motor control circuit 1948 to motivate the motor 1944 to generate at least one rotational motion to drive the drivetrain engaged with the input drive component of the second motor 1948, for example.

[0396] The controller 1952 and/or other controllers of the present disclosure may be implemented using integrated and/or discrete hardware elements, software elements, and/or a combination of both. Examples of integrated hardware elements may include processors, microprocessors, microcontrollers, integrated circuits, ASICs, PLDs, DSPs, FPGAs, logic gates, registers, semiconductor devices, chips, microchips, chip sets, microcontrollers, system on a chip (SoC), and/or single in -line package (SIP). Examples of discrete hardware elements may

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include circuits and/or circuit elements such as logic gates, field effect transistors, bipolar transistors, resistors, capacitors, inductors, and/or relays. In certain instances, the controller 1952 may include a hybrid circuit comprising discrete and integrated circuit elements or components on one or more substrates, for example.

[0397] In certain instances, the controller 1952 and/or other controllers of the present disclosure may be an LM 4F230H5QR, available from Texas Instruments, for example. In certain instances, the Texas Instruments LM4F230H5QR is an ARM Cortex-M4F Processor Core comprising on-chip memory of 256 KB single-cycle flash memory, or other non-volatile memory, up to 40 MHz, a prefetch buffer to improve performance above 40 MHz, a 32 KB single-cycle SRAM, internal ROM loaded with StellarisWare® software, 2KB EEPROM, one or more PWM modules, one or more QEI analog, one or more 12-bit ADC with 12 analog input channels, among other features that are readily available. Other microcontrollers may be readily substituted for use with the present disclosure. Accordingly, the present disclosure should not be limited in this context.

[0398] In various instances, one or more of the various steps described herein can be performed by a finite state machine comprising either a combinational logic circuit or a sequential logic circuit, where either the combinational logic circuit or the sequential logic circuit is coupled to at least one memory circuit. The at least one memory circuit stores a current state of the finite state machine. The combinational or sequential logic circuit is configured to cause the finite state machine to the steps. The sequential logic circuit may be synchronous or asynchronous. In other instances, one or more of the various steps described herein can be performed by a circuit that includes a combination of the processor 1958 and the finite state machine, for example.

[0399] In various instances, it can be advantageous to be able to assess the state of the functionality of a surgical instrument to ensure its proper function. It is possible, for example, for the drive mechanism, as explained above, which is configured to include various motors, drivetrains, and/or gear components in order to perform the various operations of the surgical instrument, to wear out over time. This can occur through normal use, and in some instances the drive mechanism can wear out faster due to abuse conditions. In certain instances, a surgical instrument can be configured to perform self-assessments to determine the state, e.g. health, of the drive mechanism and it various components.

[0400] For example, the self-assessment can be used to determine when the surgical instrument is capable of performing its function before a re-sterilization or when some of the

components should be replaced and/or repaired. Assessment of the drive mechanism and its components, including but not limited to the rotation drivetrain 1932, the closure drivetrain 1934, and/or the firing drivetrain 1936, can be accomplished in a variety of ways. The magnitude of deviation from a predicted performance can be used to determine the likelihood of a sensed failure and the severity of such failure. Several metrics can be used including: Periodic analysis of repeatably predictable events, Peaks or drops that exceed an expected threshold, and width of the failure.

[0401] In various instances, a signature waveform of a properly functioning drive mechanism or one or more of its components can be employed to assess the state of the drive mechanism or the one or more of its components. One or more vibration sensors can be arranged with respect to a properly functioning drive mechanism or one or more of its components to record various vibrations that occur during operation of the properly functioning drive mechanism or the one or more of its components. The recorded vibrations can be employed to create the signature waveform. Future waveforms can be compared against the signature waveform to assess the state of the drive mechanism and its components.

[0402] Still referring to FIG. 69, the surgical instrument 1930 includes a drivetrain failure detection module 1962 configured to record and analyze one or more acoustic outputs of one or more of the drivetrains 1932, 1934, 1936. The processor 1954 can be in communication with or otherwise control the module 1962. As described below in greater detail, the module 1962 can be embodied as various means, such as circuitry, hardware, a computer program product comprising a computer readable medium (for example, the memory 1956) storing computer readable program instructions that are executable by a processing device (for example, the processor 1954), or some combination thereof. In some aspects, the processor 36 can include, or otherwise control the module 1962.

[0403] FIG. 70 illustrates a handle assembly 1970 with a removable service panel 1972 removed to shown internal components of the handle assembly, according to one aspect of the present disclosure. The removable service panel 1972, or removable service cover, also includes reinforcing ribs 1990 for strength. The removable service panel 1972 comprises a plurality of fasteners 1988 that mate with a plurality of fasteners 1986 on the handle housing 1974 to removably attach the removable service panel 1972 to the handle housing 1974. In one aspect, the fasteners 1988 in the removable service panel 1972 comprise a first set of magnets and the handle housing 1974 comprises a second set of magnets that magnetically latch the

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service panel 1972 to the handle housing 1974. In one aspect, the first and second set of magnets 6112a, 6112b are rare-earth permanent magnets.

[0404] In FIG. 70, the removable service panel 1972 is shown removed from the handle housing 1974 to show the location of electrical and mechanical components of the surgical instrument such as the motor 1976 and electrical contacts 1984 to electrically couple the battery assembly or flexible circuits to the handle housing 1974. The motor 1976 and the electrical contacts 1984 are also removable from the handle housing 1974. The handle assembly 1970 also comprises a trigger 1982 and an actuation switch 1980, each of which is removable from the handle housing 1974. As previously described, the removable trigger 1982 may have multiple stages of operation to close the jaw member, fire the knife, activate the ultrasonic transducer, activate the high-frequency current, and/or open the jaw member. The actuation switch 1980 may be replaced with multiple switches to activate different functions such as, for example, close the jaw member, fire the knife, activate the ultrasonic transducer, activate the high-frequency current, and/or open the jaw member. As shown in FIG. 70, the handle assembly 1970 includes electrical contacts 1978 to electrically couple the handle assembly 1970 to the shaft assembly, where the electrical contacts 1978 are removable from the handle housing 1974. The handle housing 1974 also defines a space to receive a removable ultrasonic transducer assembly, ultrasonic transducer, ultrasonic transducer drive circuits, high-frequency current drive circuits, and/or display assembly, as previously discussed herein.

[0405] FIGS. 71-81 illustrate one aspect of the present disclosure that is directed to switching between energy modalities such as high-frequency (e.g., RF), ultrasonic, or a combination of high-frequency current and ultrasonic energy modalities automatically based on a sensed/calculated measure of a parameter of the surgical instrument 100, 480, 500, 600, 1100, 1150, 1200 described herein in connection with FIGS. 1-70 implying tissue thickness and/or type based on (impendence, current from the motor, jaw gap sensing, tissue compression, temperature, and the like. The first portion describes an example system wherein a change of energy modality is done based on the measure of tissue thickness by the combination of at least two measures of tissue parameters (impendence, current from the motor, jaw gap sensing, tissue compression, temperature). In one aspect, impedance, force, and velocity/displacement are measured to control energy modality of a combo ultrasonic/RF device. Measurement of force is used to determine the type of energy modality that can be used and indicate the timing at which the user can selectively switch if desired in an ultrasonic/RF combo device. One technique to accomplish this is by utilizing the slope of the motor current to dictate the

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ultrasonic, RF, or both energy modes. Another option is to use the rate of change of a measurable tissue characteristic to determine the energy modality which can be used (RF or Ultrasonic) or where in the cycle to start or stop using a specific energy modality. Again, the slope of the impedance may be utilized to dictate the ultrasonic, RF, or both energy modes.

[0406] Another technique to accomplish control of energy modality is by sensing of tissue gap by a rotary encoder, attached to the trigger or the clamp arm of the device or by measuring tissue thickness to set modality decision of the energy mode. In this scenario, wider gap indicates touch-up or debulking function is required while narrow gap indicates vessel sealing mode. Additionally, the maximum applicable power may be changed based on the slope and intensity of the impedance measured in order to only effect the raising portion of the impedance bath tub.

[0407] Yet another technique to accomplish control of energy modality is through motor current thresholds which indicate thickness of tissue and define energy modality options available and/or initiate switching of energy application levels or modes based on predefined levels. For instance, specific motor controls can be based on tissue parameters. As an example, wait and energy profile changes can be made due to sensing different tissue characteristics and types. Or a motor control circuit can be employed which increases the motor current for a motorized device closure and therefore increases forces at the end of the impedance curve for an ultrasonic and increases closure force in order to finish the cut cleanly. Although many of these embodiments may be done using tissue measurements, an alternative embodiment would be to measure the forces on the clamp arm directly through some form of force transducer. Some methods to measure tissue type, thickness and other parameters include tissue thickness sensing as part of closure. This may be done by pre-defining a time and measuring the displacement that the knife or closure system can reach within the pre¬ defined starting time interval to determine the thickness and compressibility of the tissue encountered, or by pre-defining a constant force level and determining the time that is required to reach that force at a pre-defined speed or acceleration.

[0408] Another method to accomplish control of energy modality is by using impedance measurements and force or velocity measures to correlate the density, conductivity and force resistance of the tissue to determine the type and thickness of the tissue as well as any irregularities that should impact rate of advance, wait, or energy density. Using combination of motor force closure measurements to determine if the jaw members of the end effector are closed on something that is likely to cause a short circuit (e.g., staple, clip, etc.) is also

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contemplated as is combining motor closure force with segmented flex force sensors that sense how much of the jaw member is filled in order to discriminate between large bites of softer tissue and smaller bites of harder tissue. For instance, the motor allows us new ways to determine if there is tissue or metal in the jaw members.

[0409] FIG. 71 is a graphical representation 3700 of determining wait time based on tissue thickness. A first graph 3702 represents tissue impedance Z versus time (t) where the horizontal axis represents time (t) and the vertical axis represents tissue impedance Z. A second graph 3704 represents change in gap distance Agap versus time (t) where the horizontal axis represents time (t) and the vertical axis represents change in gap distance Agap. A third graph 3706 represents force F versus time (t) where the horizontal axis represents time (t) and the vertical axis represents force F. A constant force F applied to tissue and impedance Z interrogation define a wait period, energy modality (e.g., RF and ultrasonic) and motor control parameters. Displacement at a time provides velocity. With reference to the three graphs 3702, 3704, 3706, impedance sensing energy is applied during a first period to determine the tissue type such as thin mesentery tissue (solid line), intermediate thickness vessel tissue (dashed line), or thick uterus/bowel tissue (dash-dot line).

[0410] Using the thin mesentery tissue (solid line) as an example, as shown in the third graph 3706, the clamp arm initially applies a force which ramps up from zero until it reaches a constant force 3724 at or about a first time t1. As shown in the first and second graphs 3702, 3704, from the time the clamp force is applied to the mesentery tissue until the first time t1, the gap distance Agap curve 3712 decreases and the tissue impedance 3718 also decreases until the first time t1 is reached. From the first time t1, a short wait period 3728 is applied before treatment energy, e.g., RF, is applied to the mesentery tissue at tE1. Treatment energy is applied for a second period 3710, after which the tissue may be ready for a cut operation.

[0411] As shown in the first and second graphs 3702, 3704, for intermediate thickness vessel tissue (dashed line), similar operations are performed. However, a medium wait period 3730 is applied before treatment energy is applied to the tissue at tE2.

[0412] As shown in the first and second graphs 3702, 3704, for thick uterus/bowel tissue (dash-dot line), similar operations are performed. However, a long wait period 3726 is applied before treatment energy is applied to the tissue at tE3.

[0413] Therefore, different wait periods may be applied based on the thickness of the tissue. The thickness of the tissue may be determined based on different gap distance behavior or impedance behavior before the time the constant force is reached. For example, as shown in

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the second graph 3704, depending on the minimum gap distance reached when the constant force is reached, i.e., small gap, medium gap, or large gap, the tissue is determined as a thin tissue, an intermediate thickness tissue, or a thick tissue, respectively. As shown in the first graph 3702, depending on the minimum impedance reached when the constant force is reached, e.g., small impedance, medium impedance, or large impedance, the tissue is determined as a thick tissue, an intermediate thickness tissue, or a thin tissue, respectively.

[0414] Alternatively, as shown in the second graph 3704, the thin tissue has a relatively steep gap distance slope, the intermediate thickness tissue has a medium gap distance slope, and the thick tissue has a relatively flat gap distance slope. As shown in the first graph 3702, the thin tissue has a relatively flat impedance slope, and the intermediate thickness and thick tissues have relatively steep impedance slopes. Tissue thickness may be determined accordingly.

[0415] The thickness of the tissue may also be determined as follows with reference to FIG. 72. FIG. 72 is a force versus time graph 3800 for thin, medium, and thick tissue types. The horizontal axis represents time (t) and the vertical axis represents force (F) applied by the clamp arm to the tissue. The graph 3800 depicts three curves, one for thin tissue 3802 shown in solid line, one for medium thickness tissue 3804 shown in dash-dot line, and one for thick tissue 3806 in dashed line. The graph 3800 depicts measuring time required to reach the preset force as an alternative to tissue gap to control delayed energy mode and other control parameters. Accordingly, the time to preset force 3808 for thick tissue 3806 is t1a, the time to preset force 3808 for medium thickness tissue 3804 is t1b, and the time to preset force 3808 for thin tissue 3802 is tic.

[0416] Once the force reaches the preset force 3808, energy is applied to the tissue. For thin tissue 3802 the time to preset force tic > 0.5 seconds, and then RF energy is applied for an energizing period of about 1-3 seconds. For thick tissue 3806 the time to preset force t1a < 0.5 seconds, and then RF energy is applied for an energizing period of about 5-9 seconds. For medium thickness tissue 3804 the time to preset force t1b is about 0.5 seconds and then RF energy is applied for an energizing period of about 3 to 5 seconds. These specific time periods may be adjusted without departing from the scope of the present disclosure.

[0417] Alternatively, instead of predefining a constant force 3808, a time period may be predefined. The force, gap distance, or impedance reached after the predefined time period may be measured, and may be used to determine the thickness of the tissue.

[0418] The gap distance referred to in the above examples may be a gap distance between two jaws of an end effector of a surgical device. As discussed above, the gap distance may be

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measured with a rotary encoder attached to one or both of the jaws, or attached to a trigger used to operate the jaws.

[041 9] The force referred to in the above examples may be a force applied by one or both of the jaws on the tissue. As discussed above, the force may be measured using a current of a motor driving the jaws. Alternatively, the force may be measured directly using a force transducer.

[0420] The impedance referred to in the above examples may be an impedance between the jaws across the tissue. The impedance may be measured using any conventional electrical techniques.

[0421] FIG. 73 is a graph 3900 of motor current I_{motor} versus time t for different tissue types. Here, motor current I_{motor} may be a measure of force applied by one or both of the jaws on the tissue. A first curve 3910 shown in solid line is a motor current versus time curve for a thick tissue. A second curve 3920 shown in dashed line is a motor current versus time curve for a thin tissue. As shown by a first portion 391 2 of the first curve 391 0, the motor current I_{motor} increases initially. Thereafter, as shown by a second portion 3914 (shadowed region) of the first curve 3910, ultrasonic energy is applied, and the motor current I_{motor} decreases sharply. When the motor current decreases below a threshold 3930, or when it reaches certain amount or certain percentage 3932 below the threshold 3930, energy is switched from ultrasonic to RF. The switching may also occur when the slope of the motor current becomes relatively flat. As shown by a third portion 3916 of the first curve 3910, RF energy is applied, and the motor current I_{motor} decreases slowly. In contrast, as shown in the second curve 3920 for a thin tissue, the motor current I_{motor} never increases beyond the threshold 3930, and thus ultrasonic energy is not applied.

[0422] FIG. 74 is a graphical depiction of impedance bath tub (e.g., the tissue impedance versus time initially decreases, stabilizes, and finally increases and the curve resembles a bath tub shape). A graph 4000 comprises three graphs 4002, 4004, 4006, where the first graph 4002 represents RF power (P), RF voltage(V_{RF}), and RF current (I_{RF}) versus tissue impedance (Z), the second graph 4004 and third graph 4006 represent tissue impedance (Z) versus time (t). The first graph 4002 illustrates the application of power (P) for thick tissue impedance range 4010 and thin tissue impedance range 4012. As the tissue impedance Z increases, the current I_{RF} decreases and the voltage V_{RF} increases. The power P increases until it reaches a maximum power output 4008. When the RF power P is not high enough, for example as shown in the impedance range 4010, RF energy may not be enough to treat tissues, therefore ultrasonic

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energy is applied instead.

[0423] The second graph 4004 represents the measured tissue impedance Z versus time (t). The tissue impedance threshold limit 4020 is the cross over limit for switching between the RF and ultrasonic energy modalities. For example, as shown in the third graph 4006, RF energy is applied while the tissue impedance is above the tissue impedance threshold limit 4020 and ultrasonic energy 4024 is applied while the tissue impedance is below the tissue impedance threshold limit 4020. Accordingly, with reference back to the second graph 4004, the tissue impedance of the thin tissue curve 4016 remains above the tissue impedance threshold limit 4020, thus only RF energy modality is applied to the tissue. On the other hand, for the thick tissue curve 418, RF energy modality is applied to the tissue while the impedance is above the tissue impedance threshold limit 4020 and ultrasonic energy is applied to the tissue when the impedance is below the tissue impedance threshold limit 4020.

[0424] Accordingly, the energy modality switches from RF to ultrasonic when the tissue impedance falls below the tissue impedance threshold limit 4020 and thus RF power P is low, and the energy modality switches from ultrasonic to RF when the tissue impedance rises above the tissue impedance threshold limit 4020 and thus RF power P is high enough. As shown in the third graph 4006, the switching from ultrasonic to RF may be set to occur when the impedance reaches a certain amount or certain percentage above the threshold limit 4020.

[0425] Measurement of current, velocity, or torque of the motor related to the compression applied to the tissue can be used to change the impedance threshold that triggers the control of the treatment energy applied to the tissue. FIG. 75 illustrates a graph 4100 depicting one aspect of adjustment of energy switching threshold due to the measurement of a secondary tissue parameter such as continuity, temperature, pressure, and the like. The horizontal axis of the graph 4100 is time (t) and the vertical axis is tissue impedance (Z). The curve 4112 represents the change of tissue impedance (Z) over time (t) as different energy modalities are applied to the tissue. For example, the threshold may be adjusted depending on whether tissue is present at all parts of the jaws or present at only a portion of the jaws. Accordingly, once the tissue is located in particular segments (zones) the control circuit in the generator adjusts the threshold accordingly. Reference is made to discussion below in connection with FIG. 80 for segmented measurement of tissue presence.

[0426] As shown in FIG. 75, similar to the example described with reference to FIG. 74, the curve 4112 includes three separate sections 4106, 4108, 4110. The first section 4106 of the curve 4112 represents the time when RF energy is applied to the tissue until the tissue

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impedance drops below the adjusted threshold 4104. At that point 4114, the energy modality applied to tissue is changed from RF energy to ultrasonic energy. The ultrasonic energy is then applied in the second section 4108.

[0427] Yet another embodiment of this concept may cause the wave shape to change in the RF signal based on the thickness measured by the force or force/position slope to determine whether to apply debulking or coagulation. For instance, sine wave or square waves are used to pre-heat the tissue and high voltage peak waves are used to coagulate the tissue.

[0428] According to aspects of the present disclosure, a tissue short circuit condition may be detected. Detecting metal in the end effector (such as a staple or clip) avoid short circuits in the end effector that can divert current through the short circuit and render the RF therapy or sensing signal ineffective. A small piece of metal, such as a staple, can become quite hot with therapeutic RF current flowing through it. This could result in undesired effects in the tissue. Metal in contact with a vibrating ultrasonic blade can cause complications with the blade staying in resonance or possibly damage the blade or metal piece. Metal in the jaws can damage the pad that opposes a vibrating blade in the case of a clamped device. Metal can damage the closure mechanism due to over-stress of components while trying to close. Metal can damage a knife blade that may be forced to come in contact with the metal or attempt to cut through it.

[0429] By using a motor, it is known (approximately) how open or closed the jaws are. If the jaws are open, the condition of how open or closed the jaws are can be identified in a variety of different methods - it could be the encoder count, the current going to the motor, a drop in motor voltage, etc. This can further be refined by looking at the derivative of either motor current or motor voltage. A short circuit is detected when the calculated impedance from the RF energy, is determined to be below a certain threshold. Due to cables and instrument design, this exact value varies. If the impedance is below or near this threshold, any of the following could aid in detecting a short circuit:

[0430] **Encoder count** - if the jaws are still open, this implies there is tissue. If the impedance is at or below threshold, this is indicative that all energy is going through metal.

[0431] **Motor Current** - if the motor has yet to detect its end of travel and it is experiencing high loads, the current increases (this is a method of force determination/calculation). As the current increases to a maximum, this coupled with the impedance measurement, could indicate a piece of metal is in the jaws. It takes more force to cut through a metal staple than it does of any tissue type. High current with low impedance (at or below threshold) implies possible short circuit.

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[0432] Motor Voltage - similar to the motor current example. If the motor current goes high and the encoder count slows down, the voltage decreases. Thus, it's possible that the motor voltage, coupled with impedance, could imply a short circuit.

[0433] Derivative of Motor Current - this indicates the trend of the current, and is faster at predicting if the current is going to increase or decrease, based on previous performance. If the derivative of the current indicates more current will be going to the motor and the impedance is low, it is likely a short circuit.

[0434] Derivative of Motor Voltage - this indicates the trend of the voltage, and is faster at predicting if the voltage is going to increase or decrease, based on previous performance. If the derivative of the voltage indicates less voltage will be going to the motor and the impedance is low, it is likely a short circuit.

[0435] Combinations of the above are contemplated. In summary, a short circuit equation could be enhanced by monitoring any of the following conditions:

[0436] Encoder Count + Impedance

[0437] Encoder Count + Motor Current + Impedance

[0438] Encoder Count + Motor Current + Motor Voltage + Impedance

[0439] Encoder Count + Derivative of Motor Current + Motor Current + Impedance

[0440] Encoder Count + Derivative of Motor Voltage + Motor Current + Impedance

[0441] Motor Current + Impedance

[0442] Motor Voltage + Impedance

[0443] Derivative of Motor Current + Impedance

[0444] Derivative of Motor Voltage + Impedance

[0445] Encoder Count + Motor Voltage + Impedance

[0446] Encoder Count + Derivative of Motor Current + Motor Voltage + Impedance

[0447] Encoder Count + Derivative of Motor Voltage + Motor Voltage + Impedance

[0448] Encoder Count + Derivative of Motor Current + Impedance

[0449] Encoder Count + Derivative of Motor Current + Motor Voltage + Motor Current + Impedance

[0450] Encoder Count + Derivative of Motor Voltage + Impedance

[0451] Encoder Count + Derivative of Motor Voltage + Motor Voltage + Motor Current + Impedance

[0452] Encoder Count + Derivative of Motor Voltage + Derivative of Motor Current + Motor Voltage + Motor Current + Impedance

[0453] It is worthwhile noting that there are 5 separate conditions. This implies $2^5 = 32$ different combinations of short circuit detection based on coupling impedance measurement to the 5 different conditions.

[0454] FIG. 76 is a diagram of a process 4200 illustrating selective application of radio frequency or ultrasonic treatment energy based on measured tissue characteristics according to aspects of the present disclosure. One or more parameters, e.g., impedance, gap distance, force, temperature or their derivatives, may be measured 4210. Based on the measured one or more parameters, one or more tissue characteristics, e.g., thickness, compressibility or short circuit condition may be determined 4220. A controller of energy application may start application of RF or ultrasonic energy at a first time based at least in part on the one or more tissue characteristics 4230. Optionally, the controller may switch between RF and ultrasonic energy at a second time based at least in part on the one or more tissue characteristics 4240. It should be noted that the measuring of the parameters 4210 and the determination of the tissue characteristics 4220 may occur during the application of energy 4230, 4240, and not necessarily prior to the application of energy 4230, 4240.

[0455] According to aspects of the present disclosure, specific energy control algorithms can be employed. For instance, measuring the force of the user input on the energy activation control button can be utilized. The user control button may comprise a continuous measure button sensing that allows the device to set the on/off threshold as well as sense button degradation and user intensity. A force capacitive or resistive contact may be used that gives a continuous signal (not a interrupt/contact signal) which has a predefined force threshold which technique activate, a separate threshold meaning deactivate, and another intensity threshold above activate which indicates the need for a higher desired energy level. In one embodiment of this, the higher energy level could indicate the desire to activate both energy modalities simultaneously.

[0456] Additionally or alternatively, a Hall sensor or other displacement based sensor on the energy activation button may also be utilized to get a continuous displacement of the button having a predefined activation position and a different energy deactivation threshold. In yet another embodiment, a control processor monitors the buttons use with a procedure and in-between procedures recording certain parameters of the button outputs, thereby allowing it to adjust the threshold to compensate for sensor wear and degradation, thus prolonging its useful life.

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[0457] In one aspect, the RF or ultrasonic energy may be terminated by the controller at a specific time. In some instances, the RF energy may desiccate the tissue to the point that application of ultrasonic energy comes too late to make a cut because the tissue is too dried out. For this type of event, the controller may be configured to terminate RF energy once a specific tissue impedance is met and going forward to apply only ultrasonic energy until the seal and cut is complete. For completeness, the present disclosure also contemplates terminating ultrasonic energy prior to terminating the RF energy to seal the tissue. Accordingly, in addition to switching between RF and ultrasonic energy, the present disclosure contemplates applying both RF and ultrasonic energy to the tissue simultaneously to achieve a seal and cut. In other aspects, the present disclosure contemplates applying both RF and ultrasonic energy to the tissue simultaneously and then terminating the RF energy at a predetermined time. This may be advantageous, for example, to prevent the desiccating the tissue to a point that would render the application of ultrasonic energy ineffective for cutting tissue. In yet another aspect, the intensity of the RF energy may be reduced from a therapeutic level to a non-therapeutic level suitable for sensing during the sealing process to measure the tissue impedance, for example, using RF sensing without having an RF therapeutic effect on the tissue when this is desired.

[0458] FIG. 77 is a graph 4300 depicting a relationship between trigger button displacement and sensor output. The vertical axis 4370 represents displacement of a trigger button. The trigger button, for example, may be located at a handle assembly or module and is used by a user to control application of RF and/or ultrasonic energy. The horizontal axis 4380 represents output of a displacement sensor, for example a Hall sensor. Shadowed zones 4350, 4360 represent out-of-bounds zones. As shown in the curve 4310 in FIG. 77, the sensor output is roughly proportional to the button displacement. A first zone 4320 may be an "OFF" zone, where button displacement is small and no energy is applied. A second zone 4330 may be an ON" zone, where button displacement is medium and energy is applied. A third zone 4340 may be a "HIGH" zone, where button displacement is large and energy with high intensity is applied. Alternatively, the third zone 4340 may be a "HYBRID" zone, where both RF energy and ultrasonic energy are applied. Although the range of the sensor output is shown as 12V, any appropriate voltage range may be used.

[0459] FIG. 78 is a graph 4400 depicting an abnormal relationship between trigger button displacement and sensor output. The vertical axis 4470 represents displacement of a trigger button. The horizontal axis 4480 represents output of a displacement sensor. A first curve 4410 represents a normal relationship between trigger button displacement and sensor output. A

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second curve 4420 represents an abnormal relationship between trigger button displacement and sensor output, where the sensor output does not reach its maximum value when the button is pressed all the way down. A third curve 4430 represents another abnormal relationship between trigger button displacement and sensor output, where the sensor output reaches its maximum value when the button is only pressed about halfway. These abnormal situations may be detected during servicing or sterilization, and may indicate button wear or damage. Upon detection of these abnormal situations, the sensor may be recalibrated to compensate for the wear or damage.

[0460] FIG. 79 is a graph A900 depicting an acceptable relationship between trigger button displacement and sensor output. The vertical axis 4570 represents displacement of a trigger button. The horizontal axis 4580 represents output of a displacement sensor. A first curve 4510 represents an as-manufactured relationship between trigger button displacement and sensor output. A second curve 4515 represents a changed relationship between trigger button displacement and sensor output due to aging. This relationship is acceptable because the user can still activate the three zones 4520, 4530, 4540.

[0461] Another embodiment allows for local influencing of the RF power by using other local sensors within the flex circuit to either dampen power output or redirect power to another electrode. For instance, local measurement of temperature within a specific segmented electrode pair is used to influence the balance of power available to each side of the electrode pair. Local measurement of force is used to direct more power to the heavier loaded pairs of electrodes.

[0462] FIG. 80 illustrates one aspect of a left-right segmented flexible circuit 4600. The left-right segmented flexible circuit 4600 comprises a plurality of segments L1-L5 on the left side of the left-right segmented flexible circuit 4600 and a plurality of segments R1-R5 on the right side of the left-right segmented flexible circuit 4600. Each of the segments L1-L5 and R1-R5 comprise temperature sensors and/or force sensors to sense tissue parameters locally within each segment L1-L5 and R1-R5. The left-right segmented flexible circuit 4600 is configured to influence the RF treatment energy based on tissue parameters sensed locally within each of the segments L1-L5 and R1-R5.

[0463] FIG. 81 is a cross-sectional view of one aspect of a flexible circuit A1100 comprising RF electrodes and data sensors embedded therein. The flexible circuit 4700 can be mounted to the right or left portion of an RF clamp arm A1102, which is made of electrically conductive material such as metal. Below the RF clamp arm 4702, down (vertical) force/pressure sensors

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4706a, 4706b are embedded below a laminate layer 4704. A transverse force/pressure sensor 4708 is located below the down (vertical) force/pressure sensor 4706a, 4706b layer and a temperature sensor 4710 is located below the transverse force/pressure sensor 4708. An electrode 4712 is electrically coupled to the generator and configured to apply RF energy to the tissue 4714 located below the temperature sensor 4710.

[0464] FIG. 82 is a cross sectional view of an end effector 6200 comprising a jaw member 6202, flexible circuits 6204a, 6204b, and segmented electrodes 6206a, 6206b provided on each flexible circuit 6204a, 6204b, according to one aspect of the present disclosure. FIG. 83 is a detailed view of the end effector 6200 shown in FIG. 82, according to one aspect of the present disclosure. As previously discussed, it may be advantageous to provide general purpose controls on the primary handle assembly housing of the surgical instrument with dedicated shaft assembly controls located only on the shafts. For instance, an RF instrument may include a distal head rotation electronic rotary shaft control along with articulation buttons while the primary handle includes energy activation controls and jaw member clamp/unclamp trigger controls. In addition, sensors and end effector measurement elements can be employed. Segmented electrodes can be employed that allow for the instrument to sense where in the jaw members tissue is present. Such systems also may employ asymmetric flexible circuit electrodes that sense multiple tissue parameters and have built in electrodes as well as pressure elements for the measurement of pressure against the ultrasonic blade. These systems may also employ flex electrodes that allow a combo device to have sensors built into each of the two electrodes layered within the flex electrode stack.

[0465] Turning now to FIGS. 82 and 83, the end effector 6200 comprises a jaw member 6202, flexible circuits 6204a, 6204b, and segmented electrodes 6206a, 6206b provided on each flexible circuit 6204a, 6204b. Each segmented electrode 6206a, 6206b comprises several segments. As shown, a first segmented electrode 6206a comprises first and second segment electrode segments 6208a, 6208b and a second segmented electrode 6206b comprises first and second segment electrode segments 6210a, 6210b. As shown particularly in FIG. 83 the jaw member 6202 is made of metal and conducts heat to maintain the jaw member 6202 cool. Each of the flexible circuits 6204a, 6204b comprises electrically conductive elements 6214a, 6214b made of metal or other electrical conductor materials and are electrically insulated from the metal jaw member 6202 by an electrically insulative laminate 6216. The conductive elements 6214a, 6214b are coupled to electrical circuits located either in the shaft assembly, handle assembly, transducer assembly, or battery assembly of any one of the combination

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ultrasonic/electrosurgical instruments 500, 600, 700 described herein in connection with FIGS. 30-44.

[0466] FIG. 84A is a cross sectional view of an end effector 6300 comprising a rotatable jaw member 6302, a flexible circuit 6304, and an ultrasonic blade 6306 positioned in a vertical orientation relative to the jaw member with no tissue located between the jaw member 6302 and the ultrasonic blade 6306, according to one aspect of the present disclosure. FIG. 84B is a cross sectional view of the end effector 6300 shown in FIG. 84A with tissue 6308 located between the jaw member 6302 and the ultrasonic blade 6306, according to one aspect of the present disclosure. The ultrasonic blade 6306 comprises side lobe sections 6310a, 6310b to enhance tissue dissection and uniform sections 6312a, 6312b to enhance tissue sealing. In the vertical orientation shown in FIGS. 84A and 84B, the ultrasonic blade 6308 is configured for tissue dissection.

[0467] FIG. 85A is a cross sectional view of the end effector 6300 shown in FIGS. 84A and 84B comprising a rotatable jaw member 6302, a flexible circuit 6304, and an ultrasonic blade 6306 positioned in a horizontal orientation relative to the jaw member 6302 with no tissue located between the jaw member 6302 and the ultrasonic blade 6306, according to one aspect of the present disclosure. FIG. 84B is a cross sectional view of the end effector 6300 shown in FIG. 84A with tissue 6308 located between the jaw member 6302 and the ultrasonic blade 6306, according to one aspect of the present disclosure. In the horizontal orientation shown in FIGS. 85A and 85B, the ultrasonic blade 6308 is configured for tissue sealing (e.g., cauterization).

[0468] With reference to FIGS. 84A-85B, the flexible circuit 6304 includes electrodes configured to deliver high-frequency (e.g., RF) current to the tissue 6308 grasped between the jaw member 6302 and the ultrasonic blade 6306. In one aspect, the electrodes may be segmented electrodes as described herein in connection with FIGS. 82-83 and 86-93. The flexible circuit 6304 is coupled to a high-frequency (e.g., RF) current drive circuit 702 shown in connection with FIGS. 33-37. In the illustrated example, the flexible circuit electrodes 6304 are coupled to the positive pole of the high-frequency (e.g., RF) current energy source and the ultrasonic blade 6306 is coupled to the negative (e.g., return) pole of the high-frequency (e.g., RF) current energy source. It will be appreciated that in some configurations, the positive and negative poles may be reversed such that the flexible circuit 6304 electrodes are coupled to the negative pole and the ultrasonic blade 6306 is coupled to the positive pole. The ultrasonic blade 6306 is acoustically coupled to an ultrasonic transducer 130, 130' as shown in connection with

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FIGS. 4-9. In operation, the high-frequency (e.g., RF) current is employed to seal the tissue 6308 and the ultrasonic blade 6306 is used to dissect tissue using ultrasonic vibrations.

[0469] In the example illustrated in FIGS. 784, 84B, 85A, and 85B the jaw member 6302 is rotatable about a stationary ultrasonic blade 6306. The jaw member 6302 may rotate 90° relative to the ultrasonic blade 6306. In another aspect, the jaw member 6302 may rotate greater than or equal to 360° relative to the ultrasonic blade 6306. In various other aspects, the ultrasonic blade 6306 is rotatable about a stationary jaw member 6302. The ultrasonic blade 6306 may rotate 90° relative to the jaw member 6302. In another aspect, the ultrasonic blade 6306 may rotate greater than or equal to 360° relative to the jaw member 6302.

[0470] Turning now to FIG. 86 The end effector 6400 comprises RF data sensors 6406, 6408a, 6408b located on the jaw member 6402. The end effector 6400 comprises a jaw member 6402 and an ultrasonic blade 6404. The jaw member 6402 is shown clamping tissue 641 0 located between the jaw member 6402 and the ultrasonic blade 6404. A first sensor 6406 is located in a center portion of the jaw member 6402. Second and third sensors 6408a, 6408b are located on lateral portions of the jaw member 6402. The sensors 6406, 6408a, 6408b are mounted or formed integrally with a flexible circuit 6412 (shown more particularly in FIG. 87) configured to be fixedly mounted to the jaw member 6402.

[0471] The end effector 6400 is an example end effector for the surgical instruments 500, 600, 700 described herein in connection in FIGS. 30-44. The sensors 6406, 6408a, 6408b are electrically connected to a control circuit such as the control circuit 210 (FIG. 14), 1300 (FIG. 62), 1400 (FIG. 63), 1500 (FIG. 64) via interface circuits such as circuits 6550, 6570 (FIGS. 96-97), for example. The sensors 6406, 6408a, 6408b are battery powered and the signals generated by the sensors 6406, 6408a, 6408b are provided to analog and/or digital processing circuits of the control circuit.

[0472] In one aspect, the first sensor 6406 is a force sensor to measure a normal force F_3 applied to the tissue 6410 by the jaw member 6402. The second and third sensors 6408a, 6408b include one or more elements to apply RF energy to the tissue 6410, measure tissue impedance, down force F_1, transverse forces F_2, and temperature, among other parameters. Electrodes 6409a, 6409b are electrically coupled to an energy source such as the electrical circuit 702 (FIG. 34) and apply RF energy to the tissue 6410. In one aspect, the first sensor 6406 and the second and third sensors 6408a, 6408b are strain gauges to measure force or force per unit area. It will be appreciated that the measurements of the down force F_1, the lateral forces F_2, and the normal force F_3 may be readily converted to pressure by determining the

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surface area upon which the force sensors 6406, 6408a, 6408b are acting upon. Additionally, as described with particularity herein, the flexible circuit 6412 may comprise temperature sensors embedded in one or more layers of the flexible circuit 6412. The one or more temperature sensors may be arranged symmetrically or asymmetrically and provide tissue 6410 temperature feedback to control circuits of the ultrasonic drive circuit 177 and the RF drive circuit 702.

[0473] FIG. 87 illustrates one aspect of the flexible circuit 6412 shown in FIG. 86 in which the sensors 6406, 6408a, 6408b may be mounted to or formed integrally therewith. The flexible circuit 6412 is configured to fixedly attach to the jaw member 6402. As shown particularly in FIG. 87, asymmetric temperature sensors 6414a, 6414b are mounted to the flexible circuit 6412 to enable measuring the temperature of the tissue 6410 (FIG. 86).

[0474] FIG. 88 is a cross-sectional view of the flexible circuit 6412 shown in FIG. 87. The flexible circuit 6412 comprises multiple layers and is fixedly attached to the jaw member 6402. A top layer of the flexible circuit 6412 is an electrode 6409a, which is electrically coupled to an energy source such as the electrical circuit 702 (FIG. 34) to apply RF energy to the tissue 6410 (FIG. 86). A layer of electrical insulation 6418 is provided below the electrode 6409a layer to electrically isolate the sensors 6414a, 6406, 6408a from the electrode 6409a. The temperature sensors 6414a are disposed below the layer of electrical insulation 6418. The first force (pressure) sensor 6406 is located below the layer containing the temperature sensors 6414a and above a compressive layer 6420. The second force (pressure) sensor 6408a is located below the compressive layer 6420 and above the jaw member 6402 frame.

[0475] FIG. 89 illustrates one aspect of a segmented flexible circuit 6430 configured to fixedly attach to a jaw member 6434 of an end effector. The segmented flexible circuit 6430 comprises a distal segment 6432a and lateral segments 6432b, 6432c that include individually addressable sensors to provide local tissue control. The segments 6432a, 6432b, 6432c are individually addressable to treat tissue and to measure tissue parameters based on individual sensors located within each of the segments 6432a, 6432b, 6432c. The segments 6432a, 6432b, 6432c of the segmented flexible circuit 6430 are mounted to the jaw member 6434 and are electrically coupled to an energy source such as the electrical circuit 702 (FIG. 34) via electrical conductive elements 6436. A Hall effect sensor 6438, or any suitable magnetic sensor, is located on a distal end of the jaw member 6434. The Hall effect sensor 6438 operates in conjunction with a magnet to provide a measurement of an aperture defined by the jaw member 6434, which otherwise may be referred to as a tissue gap, as shown with particularity in FIG. 91.

[0476] FIG. 90 illustrates one aspect of a segmented flexible circuit 6440 configured to mount

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to a jaw member 6444 of an end effector. The segmented flexible circuit 6580 comprises a distal segment 6442a and lateral segments 6442b, 6442c that include individually addressable sensors for tissue control. The segments 6442a, 6442b, 6442c are individually addressable to treat tissue and to read individual sensors located within each of the segments 6442a, 6442b, 6442c. The segments 6442a, 6442b, 6442c of the segmented flexible circuit 6440 are mounted to the jaw member 6444 and are electrically coupled to an energy source such as the electrical circuit 702 (FIG. 34), via electrical conductive elements 6446. A Hall effect sensor 6448, or other suitable magnetic sensor, is provided on a distal end of the jaw member 6444. The Hall effect sensor 6448 operates in conjunction with a magnet to provide a measurement of an aperture defined by the jaw member 6444 of the end effector or tissue gap as shown with particularity in FIG. 91. In addition, a plurality of lateral asymmetric temperature sensors 6450a, 6450b are mounted on or formally integrally with the segmented flexible circuit 6440 to provide tissue temperature feedback to control circuits in the ultrasonic drive circuit 177 and the RF drive circuit 702.

[0477] FIG. 91 illustrates one aspect of an end effector 6460 configured to measure a tissue gap G_T. The end effector 6460 comprises a jaw member 6462 and a jaw member 6444. The flexible circuit 6440 as described in FIG. 90, is mounted to the jaw member 6444. The flexible circuit 6440 comprises a Hall effect sensor 6448 that operates with a magnet 6464 mounted to the jaw member 6462 to measure the tissue gap G_T. This technique can be employed to measure the aperture defined between the jaw member 6444 and the jaw member 6462. The jaw member 6462 may be an ultrasonic blade.

[0478] FIG. 92 illustrates one aspect of an end effector 6470 comprising segmented flexible circuit 6468 as shown in FIG. 80. The end effector 6470 comprises a jaw member 6472 and an ultrasonic blade 6474. The segmented flexible circuit 6468 is mounted to the jaw member 6472. Each of the sensors disposed within the segments 1-5 are configured to detect the presence of tissue positioned between the jaw member 6472 and the ultrasonic blade 6474 and represent tissue zones 1-5. In the configuration shown in FIG. 92, the end effector 6470 is shown in an open position ready to receive or grasp tissue between the jaw member 6472 and the ultrasonic blade 6474.

[0479] FIG. 93 illustrates the end effector 6470 shown in FIG. 92 with the jaw member 6472 clamping tissue 6476 between the jaw member 6472 and the ultrasonic blade 6474. As shown in FIG. 93, the tissue 6476 is positioned between segments 1-3 and represents tissue zones 1-3. Accordingly, tissue 6476 is detected by the sensors in segments 1-3 and the absence of

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tissue (empty) is detected in section 6478 by segments 4-5. The information regarding the presence and absence of tissue 6476 positioned within certain segments 1-3 and 4-5, respectively, is communicated to a control circuit such as such as the control circuits 210 (FIG. 14), 1300 (FIG. 62), 1400 (FIG. 63), 1500 (FIG. 64) via interface circuits such as circuits 6550, 6570 (FIGS. 96-97), for example. The control circuit is configured to energize only the segments 1-3 where tissue 6476 is detected and does not energize the segments 4-5 where tissue is not detected. It will be appreciated that the segments 1-5 may contain any suitable temperature, force/pressure, and/or Hall effect magnetic sensors to measure tissue parameters of tissue located within certain segments 1-5 and electrodes to deliver RF energy to tissue located in certain segments 1-5.

[0480] FIG. 94 illustrates graphs 6480 of energy applied by the right and left side of an end effector based on locally sensed tissue parameters. As discussed herein, the jaw member of an end effector may comprise temperature sensors, force/pressure sensors, Hall effector sensors, among others, along the right and left sides of the jaw member. Thus, RF energy can be selectively applied to tissue positioned between the clam jaw and the ultrasonic blade. The top graph 6482 depicts power P_R applied to a right side segment of the jaw member versus time (t) based on locally sensed tissue parameters. Thus, the control circuit such as such as the control circuits 210 (FIG. 14), 1300 (FIG. 62), 1400 (FIG. 63), 1500 (FIG. 64) via interface circuits such as circuits 6550, 6570 (FIGS. 96-97), for example, is configured to measure the sensed tissue parameters and to apply power P_R to a right side segment of the jaw member. The RF drive circuit 702 (FIG. 34) delivers an initial power level Pi to the tissue via the right side segment and then decreases the power level to P_2 based on local sensing of tissue parameters (e.g., temperature, force/pressure, thickness) in one or more segments. The bottom graph 6484 depicts power P_L applied to a left side segment of the jaw member versus time (t) based on locally sensed tissue parameters. The RF drive circuit 702 delivers an initial power level of Pi to the tissue via the left side segment and then increases the power level to P_3 based local sensing of tissue parameters (e.g., temperature, force/pressure, thickness). As depicted in the bottom graph 6484, the RF drive circuit 702 is configured to re-adjust the energy delivered P_3 based on sensing of tissue parameters (e.g., temperature, force/pressure, thickness).

[0481] FIG. 95 is a cross-sectional view of one aspect of an end effector 6530 configured to sense force or pressure applied to tissue located between a jaw member and an ultrasonic blade. The end effector 6530 comprises a clamp jaw 6532 and a flexible circuit 6534 fixedly mounted to the jaw member 6532. The jaw member 6532 applies forces F_1 and F_2 to the tissue

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6536 of variable density and thickness, which can be measure by first and second force/pressure sensors 6538, 6540 located in different layers of the flexible circuit 6534. A compressive layer 6542 is sandwiched between the first and second force/pressure sensors 6538, 6540. An electrode 6544 is located on outer portion of the flexible circuit 6534 which contacts the tissue. As described herein, other layers of the flexible circuit 6534 may comprise additional sensors such temperature sensors, thickness sensors, and the like.

[0482] FIGS. 96-97 illustrate various schematic diagrams of flexible circuits of the signal layer, sensor wiring, and an RF energy drive circuit. FIG. 96 is a schematic diagram of one aspect of a signal layer of a flexible circuit 6550. The flexible circuit 6550 comprises multiple layers (~4 to ~6, for example). One layer will supply the integrated circuits with power and another layer with ground. Two additional layers will carry the RF power RF1 and RF2 separately. An analog multiplexer switch 6552 has eight bidirectional translating switches that can be controlled through the I^2C bus to interface to the control circuit 210 (FIG. 14) via the SCL-C/SDA-C interface channel. The SCL/SDA upstream pair fans out to eight downstream pairs, or channels. Any individual SCn/SDn channel or combination of channels can be selected, determined by the contents of a programmable control register. There are six down stream sensors, three on each side of the jaw member. A first side 6554a comprises a first thermocouple 6556a, a first pressure sensor 6558a, and a first Hall effect sensor 6560a. A second side 6554b comprises a second thermocouple 6556b, a second pressure sensor 6558b, and a second Hall effect sensor 6560b. FIG. 97 is a schematic diagram 6570 of sensor wiring for the flexible circuit 6550 shown in FIG. 96 to the switch 6552.

[0483] FIG. 98A illustrates an end effector 6670 comprising a jaw member 6672 and an ultrasonic blade 6674, where the jaw member 6672 includes electrodes 6676. The end effector 6670 can be employed in one of the surgical instruments combination ultrasonic/electrosurgical instruments 500, 600, 700 described herein in connection with FIGS. 30-44, where the combination ultrasonic/electrosurgical instruments 500, 600, 700 are configured to switch between RF, ultrasonic, and combination RF/ultrasonic energy automatically based on a sensed/calculated measure of device parameters such as, for example, impedance, current from the motor, jaw member gap, tissue compression, temperature, among others, implying tissue thickness and/or type. Referring to FIG. 984A, the end effector 6670 may be positioned by a physician to surround tissue 6678 prior to compression, cutting, or stapling. As shown in FIG. 98A, no compression may be applied to the tissue while preparing to use the end effector 6670. As shown in FIG. 98A, the tissue 6678 is not under compression between the jaw

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member 6672 and the ultrasonic blade 6674.

[0484] Referring now to FIG. 98B, by engaging the trigger on the handle of a surgical instrument, the physician may use the end effector 6670 to compress the tissue 6678. In one aspect, the tissue 6678 may be compressed to its maximum threshold, as shown in FIG. 98B. As shown in FIG. 98A, the tissue 6678 is under maximum compression between the jaw member 6672 and the ultrasonic blade 6674.

[0485] Referring to FIG. 99A, various forces may be applied to the tissue 6678 by the end effector 6670. For example, vertical forces F1 and F2 may be applied by the jaw member 6672 and the ultrasonic blade 6674 of the end effector 6670 as tissue 6678 is compressed between the two. Referring now to FIG. 99B, there is shown various diagonal and/or lateral forces also may be applied to the tissue 6678 when compressed by the end effector 6670. For example, a force F3 may be applied. For the purposes of operating the combination ultrasonic/electrosurgical instruments 500, 600, 700 (FIGS. 30-44), it may be desirable to sense or calculate the various forms of compression being applied to the tissue by the end effector. For example, knowledge of vertical or lateral compression may allow the end effector to more precisely or accurately apply a staple operation or may inform the operator of the surgical instrument such that the surgical instrument can be used more properly or safely.

[0486] In one form, a strain gauge can be used to measure the force applied to the tissue 6678 by the end effector shown in FIGS. 98A-B, 99A-B. A strain gauge can be coupled to the end effector 6670 to measure the force on the tissue 6678 being treated by the end effector 6670. With reference now also to FIG. 100, in the aspect illustrated in FIG. 100, a system 6680 for measuring forces applied to the tissue 6678 comprises a strain gauge sensor 6682, such as, for example, a micro-strain gauge, is configured to measure one or more parameters of the end effector 6670 such as, for example, the amplitude of the strain exerted on a jaw member of an end effector, such as the jaw member 6672 of FIGS. 99A-B, during a clamping operation, which can be indicative of the tissue compression. The measured strain is converted to a digital signal and provided to a processor 6690 of a microcontroller 6688. A load sensor 6684 can measure the force to operate the ultrasonic blade 6674 to cut the tissue 6678 captured between the jaw member 6672 and the ultrasonic blade 6674 of the end effector 6670. A magnetic field sensor 6686 can be employed to measure the thickness of the captured tissue 6678. The measurement of the magnetic field sensor 6686 also may be converted to a digital signal and provided to the processor 6690.

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[0487] Further to the above, a feedback indicator 6694 also can be configured to communicate with the microcontroller 6688. In one aspect, the feedback indicator 6694 can be disposed in the handle of the combination ultrasonic/electrosurgical instruments 500, 600, 700 (FIGS. 30-44). Alternatively, the feedback indicator 6694 can be disposed in a shaft assembly of a surgical instrument, for example. In any event, the microcontroller 6688 may employ the feedback indicator 6694 to provide feedback to an operator of the surgical instrument with regard to the adequacy of a manual input such as, for example, a selected position of a firing trigger that is used to cause the end effector to clamp down on tissue. To do so, the microcontroller 6688 may assess the selected position of the jaw member 6672 and/or firing trigger. The measurements of the tissue 6678 compression, the tissue 6678 thickness, and/or the force required to close the end effector 6670 on the tissue, as respectively measured by the sensors 6682, 6684, 6686, can be used by the microcontroller 6688 to characterize the selected position of the firing trigger and/or the corresponding value of the speed of end effector. In one instance, a memory 6692 may store a technique, an equation, and/or a look-up table which can be employed by the microcontroller 6688 in the assessment.

[0488] Aspects of the devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. Various aspects may, in either or both cases, be reconditioned for reuse after at least one use. Reconditioning may include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, aspects of the device may be disassembled, and any number of the particular pieces or parts of the device may be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, aspects of the device may be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those skilled in the art will appreciate that reconditioning of a device may utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

[0489] By way of example only, aspects described herein may be processed before surgery. First, a new or used instrument may be obtained and if necessary cleaned. The instrument may then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and instrument may then be placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or high-energy electrons. The radiation may kill bacteria on the instrument and in the container. The

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sterilized instrument may then be stored in the sterile container. The sealed container may keep the instrument sterile until it is opened in a medical facility. A device may also be sterilized using any other technique known in the art, including but not limited to beta or gamma radiation, ethylene oxide, or steam.

[0490] While various details have been set forth in the foregoing description, it will be appreciated that the various aspects of the techniques for operating a generator for digitally generating electrical signal waveforms and surgical instruments may be practiced without these specific details. One skilled in the art will recognize that the herein described components (e.g., operations), devices, objects, and the discussion accompanying them are used as examples for the sake of conceptual clarity and that various configuration modifications are contemplated. Consequently, as used herein, the specific exemplars set forth and the accompanying discussion are intended to be representative of their more general classes. In general, use of any specific exemplar is intended to be representative of its class, and the non-inclusion of specific components (e.g., operations), devices, and objects should not be taken limiting.

[0491] Further, while several forms have been illustrated and described, it is not the intention of the applicant to restrict or limit the scope of the appended claims to such detail. Numerous modifications, variations, changes, substitutions, combinations, and equivalents to those forms may be implemented and will occur to those skilled in the art without departing from the scope of the present disclosure. Moreover, the structure of each element associated with the described forms can be alternatively described as a technique for providing the function performed by the element. Also, where materials are disclosed for certain components, other materials may be used. It is therefore to be understood that the foregoing description and the appended claims are intended to cover all such modifications, combinations, and variations as falling within the scope of the disclosed forms. The appended claims are intended to cover all such modifications, variations, changes, substitutions, modifications, and equivalents.

[0492] For conciseness and clarity of disclosure, selected aspects of the foregoing disclosure have been shown in block diagram form rather than in detail. Some portions of the detailed descriptions provided herein may be presented in terms of instructions that operate on data that is stored in one or more computer memories or one or more data storage devices (e.g. floppy disk, hard disk drive, Compact Disc (CD), Digital Video Disk (DVD), or digital tape). Such descriptions and representations are used by those skilled in the art to describe and convey the substance of their work to others skilled in the art. In general, an algorithm refers to a self-consistent sequence of steps leading to a desired result, where a "step" refers to a manipulation

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of physical quantities and/or logic states which may, though need not necessarily, take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It is common usage to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like. These and similar terms may be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities and/or states.

[0493] Unless specifically stated otherwise as apparent from the foregoing disclosure, it is appreciated that, throughout the foregoing disclosure, discussions using terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

[0494] In a general sense, those skilled in the art will recognize that the various aspects described herein which can be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or any combination thereof can be viewed as being composed of various types of "electrical circuitry." Consequently, as used herein "electrical circuitry" includes, but is not limited to, electrical circuitry having at least one discrete electrical circuit, electrical circuitry having at least one integrated circuit, electrical circuitry having at least one application specific integrated circuit, electrical circuitry forming a general purpose computing device configured by a computer program (e.g., a general purpose computer configured by a computer program which at least partially carries out processes and/or devices described herein, or a microprocessor configured by a computer program which at least partially carries out processes and/or devices described herein), electrical circuitry forming a memory device (e.g., forms of random access memory), and/or electrical circuitry forming a communications device (e.g., a modem, communications switch, or optical-electrical equipment). Those having skill in the art will recognize that the subject matter described herein may be implemented in an analog or digital fashion or some combination thereof.

[0495] The foregoing detailed description has set forth various forms of the devices and/or processes via the use of block diagrams, flowcharts, and/or examples. Insofar as such block diagrams, flowcharts, and/or examples contain one or more functions and/or operations, it will be understood by those within the art that each function and/or operation within such block

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diagrams, flowcharts, and/or examples can be implemented, individually and/or collectively, by a wide range of hardware, software, firmware, or virtually any combination thereof. In one form, several portions of the subject matter described herein may be implemented via an application specific integrated circuits (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), or other integrated formats. However, those skilled in the art will recognize that some aspects of the forms disclosed herein, in whole or in part, can be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and or firmware would be well within the skill of one of skill in the art in light of this disclosure. In addition, those skilled in the art will appreciate that the mechanisms of the subject matter described herein are capable of being distributed as one or more program products in a variety of forms, and that an illustrative form of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. .Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a Compact Disc (CD), a Digital Video Disk (DVD), a digital tape, a computer memory, etc.; and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link (e.g., transmitter, receiver, transmission logic, reception logic, etc.), etc.).

[0496] In some instances, one or more elements may be described using the expression "coupled" and "connected" along with their derivatives. It should be understood that these terms are not intended as synonyms for each other. For example, some aspects may be described using the term "connected" to indicate that two or more elements are in direct physical or electrical contact with each other. In another example, some aspects may be described using the term "coupled" to indicate that two or more elements are in direct physical or electrical contact. The term "coupled," however, also may mean that two or more elements are not in direct contact with each other, but yet still co-operate or interact with each other. It is to be understood that depicted architectures of different components contained within, or connected with, different other components are merely examples, and that in fact many other architectures may be implemented which achieve the same functionality. In a conceptual sense, any

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arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated also can be viewed as being "operably connected," or "operably coupled," to each other to achieve the desired functionality, and any two components capable of being so associated also can be viewed as being "operably couplable," to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components, and/or wirelessly interactable, and/or wirelessly interacting components, and/or logically interacting, and/or logically interactable components, and/or electrically interacting components, and/or electrically interactable components, and/or optically interacting components, and/or optically interactable components.

[0497] In other instances, one or more components may be referred to herein as "configured to," "configurable to," "operable/operative to," "adapted/adaptable," "able to," "conformable/conformed to," etc. Those skilled in the art will recognize that "configured to" can generally encompass active-state components and/or inactive-state components and/or standby-state components, unless context requires otherwise.

[0498] While particular aspects of the present disclosure have been shown and described, it will be apparent to those skilled in the art that, based upon the teachings herein, changes and modifications may be made without departing from the subject matter described herein and its broader aspects and, therefore, the appended claims are to encompass within their scope all such changes and modifications as are within the true scope of the subject matter described herein. It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a

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claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to claims containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations.

[0499] In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically technique at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that typically a disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms unless context dictates otherwise. For example, the phrase "A or B" will be typically understood to include the possibilities of "A" or "B" or "A and B."

[0500] With respect to the appended claims, those skilled in the art will appreciate that recited operations therein may generally be performed in any order. Also, although various operational flows are presented in a sequence(s), it should be understood that the various operations may be performed in other orders than those which are illustrated, or may be performed concurrently. Examples of such alternate orderings may include overlapping, interleaved, interrupted, reordered, incremental, preparatory, supplemental, simultaneous, reverse, or other variant orderings, unless context dictates otherwise. Furthermore, terms like "responsive to," "related to," or other past-tense adjectives are generally not intended to exclude such variants, unless context dictates otherwise.

[0501] It is worthy to note that any reference to "one aspect," "an aspect," "one form," or "a form" technique that a particular feature, structure, or characteristic described in connection with the aspect is included in at least one aspect. Thus, appearances of the phrases "in one aspect," "in an aspect," "in one form," or "in an form" in various places throughout the specification are not necessarily all referring to the same aspect. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner in one or more aspects.

[0502] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations are not expressly set forth herein for sake of clarity.

[0503] In certain cases, use of a system or method may occur in a territory even if components are located outside the territory. For example, in a distributed computing context, use of a distributed computing system may occur in a territory even though parts of the system may be located outside of the territory (e.g., relay, server, processor, signal-bearing medium, transmitting computer, receiving computer, etc. located outside the territory).

[0504] A sale of a system or method may likewise occur in a territory even if components of the system or method are located and/or used outside the territory. Further, implementation of at least part of a system for performing a method in one territory does not preclude use of the system in another territory.

[0505] All of the above-mentioned U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications, non-patent publications referred to in this specification and/or listed in any Application Data Sheet, or any other disclosure material are incorporated herein by reference, to the extent not inconsistent herewith. As such, and to the extent necessary, the disclosure as explicitly set forth herein supersedes any conflicting material incorporated herein by reference. Any material, or portion thereof, that is said to be incorporated by reference herein, but which conflicts with existing definitions, statements, or other disclosure material set forth herein will only be incorporated to the extent that no conflict arises between that incorporated material and the existing disclosure material.

[0506] In summary, numerous benefits have been described which result from employing the concepts described herein. The foregoing description of the one or more forms has been presented for purposes of illustration and description. It is not intended to be exhaustive or limiting to the precise form disclosed. Modifications or variations are possible in light of the above teachings. The one or more forms were chosen and described in order to illustrate

principles and practical application to thereby enable one of ordinary skill in the art to utilize the various forms and with various modifications as are suited to the particular use contemplated. It is intended that the claims submitted herewith define the overall scope.

[0507] Various aspects of the subject matter described herein are set out in the following numbered clauses:

[0508] Various aspects of the subject matter described herein are set out in the following numbered clauses:

[0509] 1. A surgical instrument comprising: a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position; a handle assembly coupled to a proximal end of the shaft, the handle assembly comprising a button configured to be displaced when pressed by a user; a battery assembly coupled to the handle assembly; a sensor configured to measure a displacement or intensity of the button; a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue; an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and a controller configured to: control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy at a low level when the displacement or intensity measured by the sensor is above a first threshold but below a second threshold higher than the first threshold, and control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy at a high level when the displacement or intensity measured by the sensor is above the second threshold.

[0510] 2. The surgical instrument of clause 1, wherein the sensor is a Hall sensor.

[0511] 3. The surgical instrument of clause 1 or 2, wherein the sensor is configured to measure force applied to the button and the displacement or intensity of the button is the force applied to the button.

[0512] **4.** The surgical instrument of any one of clauses 1-3, wherein the sensor is configured to be calibrated after the surgical instrument is manufactured, such that an output of the sensor is substantially proportional to the displacement or intensity of the button.

[0513] 5. The surgical instrument of clause **4**, wherein the sensor is configured to be calibrated if the output of the sensor reaches maximum when the displacement or intensity of the button has not reached maximum.

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[0514] 6. The surgical instrument of clause **4**, wherein the sensor is configured to be calibrated if the displacement or intensity of the button reaches maximum when the output of the sensor has not reached maximum.

[0515] 7. A surgical instrument comprising: a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position; a handle assembly coupled to a proximal end of the shaft, the handle assembly comprising a button configured to be displaced when pressed by a user; a battery assembly coupled to the handle assembly; a sensor configured to measure a displacement or intensity of the button; a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue; an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and a controller configured to: control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy when the displacement or intensity measured by the sensor is above a first threshold but below a second threshold higher than the first threshold, and control the RF energy output to apply RF energy and control the ultrasonic energy output to apply ultrasonic energy when the displacement or intensity measured by the sensor is above the second threshold.

[0516] 8. The surgical instrument of clause 7, wherein the sensor is a Hall sensor.

[0517] 9. The surgical instrument of clause 7 or 8, wherein the sensor is configured to be calibrated after the surgical instrument is manufactured, such that an output of the sensor is substantially proportional to the displacement or intensity of the button.

[0518] 10. The surgical instrument of clause 9, wherein the sensor is configured to be calibrated after the surgical instrument is manufactured, such that an output of the sensor is substantially proportional to the displacement or intensity of the button.

[0519] 11. The surgical instrument of clause 9, wherein the sensor is configured to be calibrated if the displacement or intensity of the button reaches maximum when the output of the sensor has not reached maximum.

[0520] 12. A surgical instrument comprising: a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position, wherein the first or second jaw comprising: a first sensor configured to measure a tissue characteristic at a first location, and a second sensor configured to measure the tissue characteristic at a second location; a handle assembly coupled to a proximal end of the shaft; a battery assembly coupled

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to the handle assembly; a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue; an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and a controller configured to, based at least in part on the measured tissue characteristic at the first location and the second location, control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy.

[0521] 13. The surgical instrument of clause 12, wherein the first and second sensors are vertical pressure sensors.

[0522] 14. The surgical instrument of clause 13, wherein the controller is further configured to: apply high energy at a location with high sensor output; and apply low energy at a location with low sensor output.

[0523] 15. The surgical instrument of any one of clauses 12-14, wherein the first and second sensors are transverse pressure sensors.

[0524] 16. The surgical instrument of any one of clauses 12-15, wherein the first and second sensors are temperature sensors.

[0525] 17. The surgical instrument of any one of clauses 12-16, wherein the first and second sensors are configured to sense presence or absence of tissue at the first location and the second location.

[0526] 18. The surgical instrument of clause 16, wherein the controller is further configured to: set a first impedance threshold below which RF energy is switched to ultrasonic energy when tissue is present at both the first location and the second location; and set a second impedance threshold below which RF energy is switched to ultrasonic energy when tissue is present at only one of the first location and the second location, wherein the first and second impedance thresholds are different.

[0527] 19. The surgical instrument of clause 17 or 18, wherein the controller is further configured to: set a first force threshold used to control application of energy when tissue is present at both the first location and the second location; and set a second force threshold used to control application of energy when tissue is present at only one of the first location and the second location, wherein the first and second force thresholds are different.

[0528] 20. The surgical instrument of claim 17, wherein the controller is further configured to: apply energy at a location where tissue is present; and not apply energy at a location where tissue is absent.

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CLAIMS

1. A surgical instrument comprising:

a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position;

a handle assembly coupled to a proximal end of the shaft, the handle assembly comprising a button configured to be displaced when pressed by a user;

a battery assembly coupled to the handle assembly;

a sensor configured to measure a displacement or intensity of the button;

a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue;

an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and

a controller configured to:

control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy at a low level when the displacement or intensity measured by the sensor is above a first threshold but below a second threshold higher than the first threshold, and

control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy at a high level when the displacement or intensity measured by the sensor is above the second threshold.

2. The surgical instrument of claim 1, wherein the sensor is a Hall sensor.

3. The surgical instrument of claim 1, wherein the sensor is configured to measure force applied to the button and the displacement or intensity of the button is the force applied to the button.

4. The surgical instrument of claim 1, wherein the sensor is configured to be calibrated after the surgical instrument is manufactured, such that an output of the sensor is substantially proportional to the displacement or intensity of the button.

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5. The surgical instrument of claim 4, wherein the sensor is configured to be calibrated if the output of the sensor reaches maximum when the displacement or intensity of the button has not reached maximum.

6. The surgical instrument of claim 4, wherein the sensor is configured to be calibrated if the displacement or intensity of the button reaches maximum when the output of the sensor has not reached maximum.

7. A surgical instrument comprising:

a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position;

a handle assembly coupled to a proximal end of the shaft, the handle assembly comprising a button configured to be displaced when pressed by a user;

a battery assembly coupled to the handle assembly;

a sensor configured to measure a displacement or intensity of the button;

a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue;

an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and

a controller configured to:

control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy when the displacement or intensity measured by the sensor is above a first threshold but below a second threshold higher than the first threshold, and

control the RF energy output to apply RF energy and control the ultrasonic energy output to apply ultrasonic energy when the displacement or intensity measured by the sensor is above the second threshold.

8. The surgical instrument of claim 7, wherein the sensor is a Hall sensor.

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9. The surgical instrument of claim 7, wherein the sensor is configured to be calibrated after the surgical instrument is manufactured, such that an output of the sensor is substantially proportional to the displacement or intensity of the button.

10. The surgical instrument of claim 9, wherein the sensor is configured to be calibrated if the output of the sensor reaches maximum when the displacement or intensity of the button has not reached maximum.

11. The surgical instrument of claim 9, wherein the sensor is configured to be calibrated if the displacement or intensity of the button reaches maximum when the output of the sensor has not reached maximum.

12. A surgical instrument comprising:

a shaft assembly comprising a shaft and an end effector coupled to a distal end of the shaft, the end effector comprising a first jaw and a second jaw configured for pivotal movement between a closed position and an open position, wherein the first or second jaw comprising:

a first sensor configured to measure a tissue characteristic at a first location, and

a second sensor configured to measure the tissue characteristic at a second location;

a handle assembly coupled to a proximal end of the shaft;

a battery assembly coupled to the handle assembly;

a radio frequency (RF) energy output powered by the battery assembly and configured to apply RF energy to a tissue;

an ultrasonic energy output powered by the battery assembly and configured to apply ultrasonic energy to the tissue; and

a controller configured to, based at least in part on the measured tissue characteristic at the first location and the second location, control the RF energy output to apply RF energy or control the ultrasonic energy output to apply ultrasonic energy.

13. The surgical instrument of claim 12, wherein the first and second sensors are vertical pressure sensors.

14. The surgical instrument of claim 13, wherein the controller is further configured to:

apply high energy at a location with high sensor output; and

apply low energy at a location with low sensor output.

15. The surgical instrument of claim 12, wherein the first and second sensors are transverse pressure sensors.

16. The surgical instrument of claim 12, wherein the first and second sensors are temperature sensors.

17. The surgical instrument of claim 12, wherein the first and second sensors are configured to sense presence or absence of tissue at the first location and the second location.

18. The surgical instrument of claim 17, wherein the controller is further configured to:

set a first impedance threshold below which RF energy is switched to ultrasonic energy when tissue is present at both the first location and the second location; and

set a second impedance threshold below which RF energy is switched to ultrasonic energy when tissue is present at only one of the first location and the second location, wherein the first and second impedance thresholds are different.

19. The surgical instrument of claim 17, wherein the controller is further configured to:

set a first force threshold used to control application of energy when tissue is present at both the first location and the second location; and

set a second force threshold used to control application of energy when tissue is present at only one of the first location and the second location, wherein the first and second force thresholds are different.

20. The surgical instrument of claim 17, wherein the controller is further configured to:

apply energy at a location where tissue is present; and

not apply energy at a location where tissue is absent.

MassagerPriorArt0002690

Petitioner Therabody Ex-1013, 0284

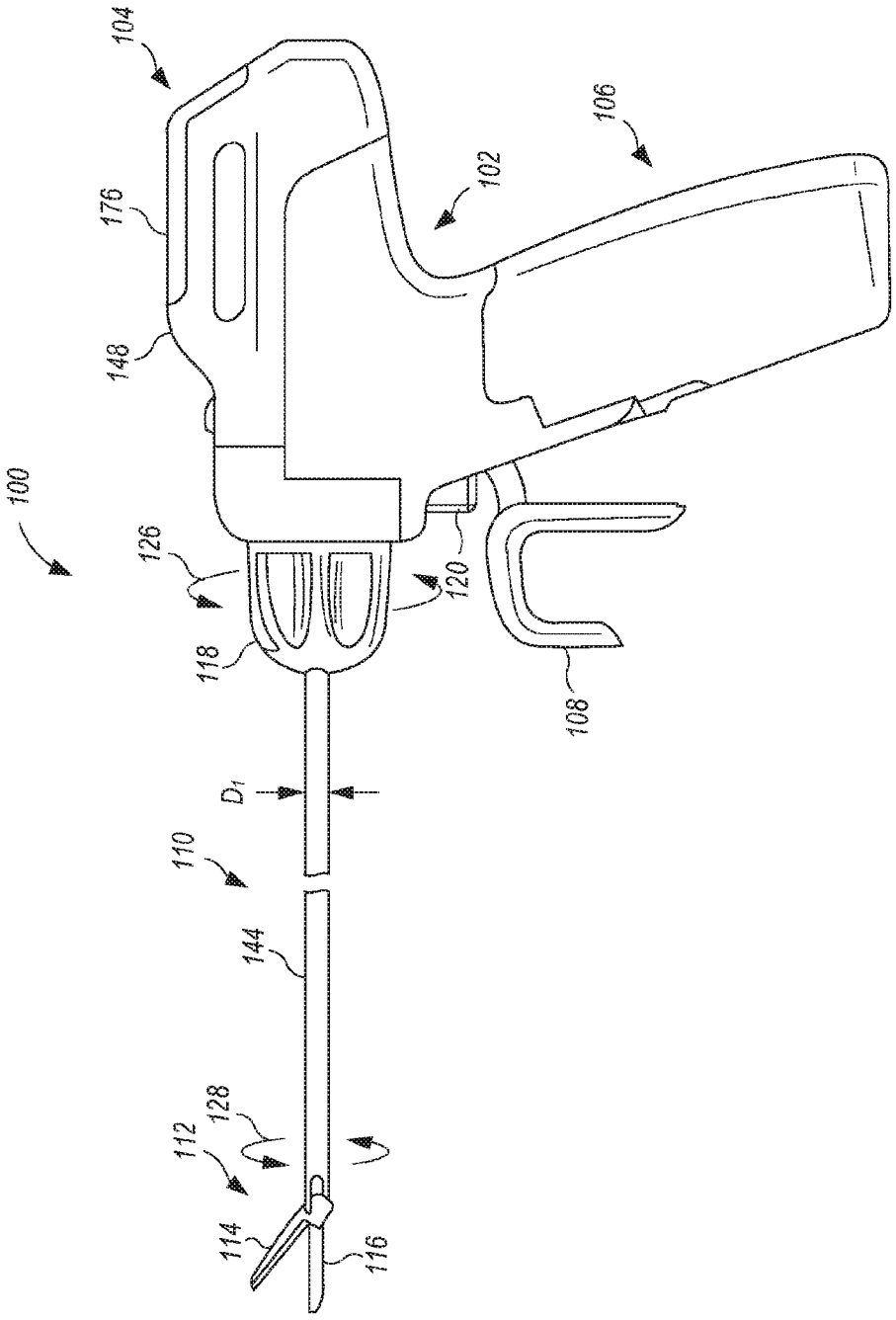

104
106
102
176
148
100
126
120
118
108
D_1
110
144
112
128
114
116

FIG. 1

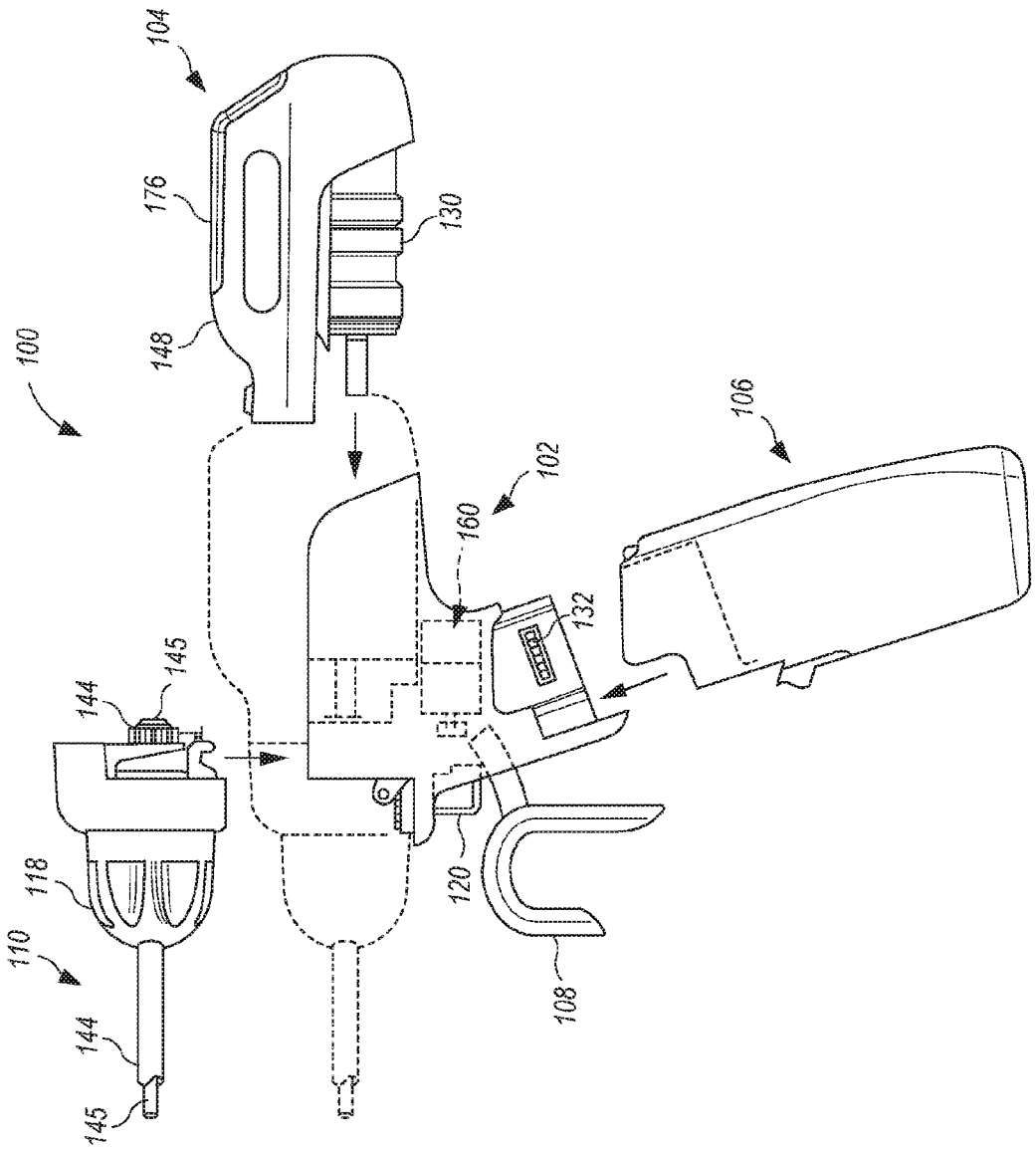

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100
106
102
160
132
145
144
118
110
120
108
144
145

FIG. 2

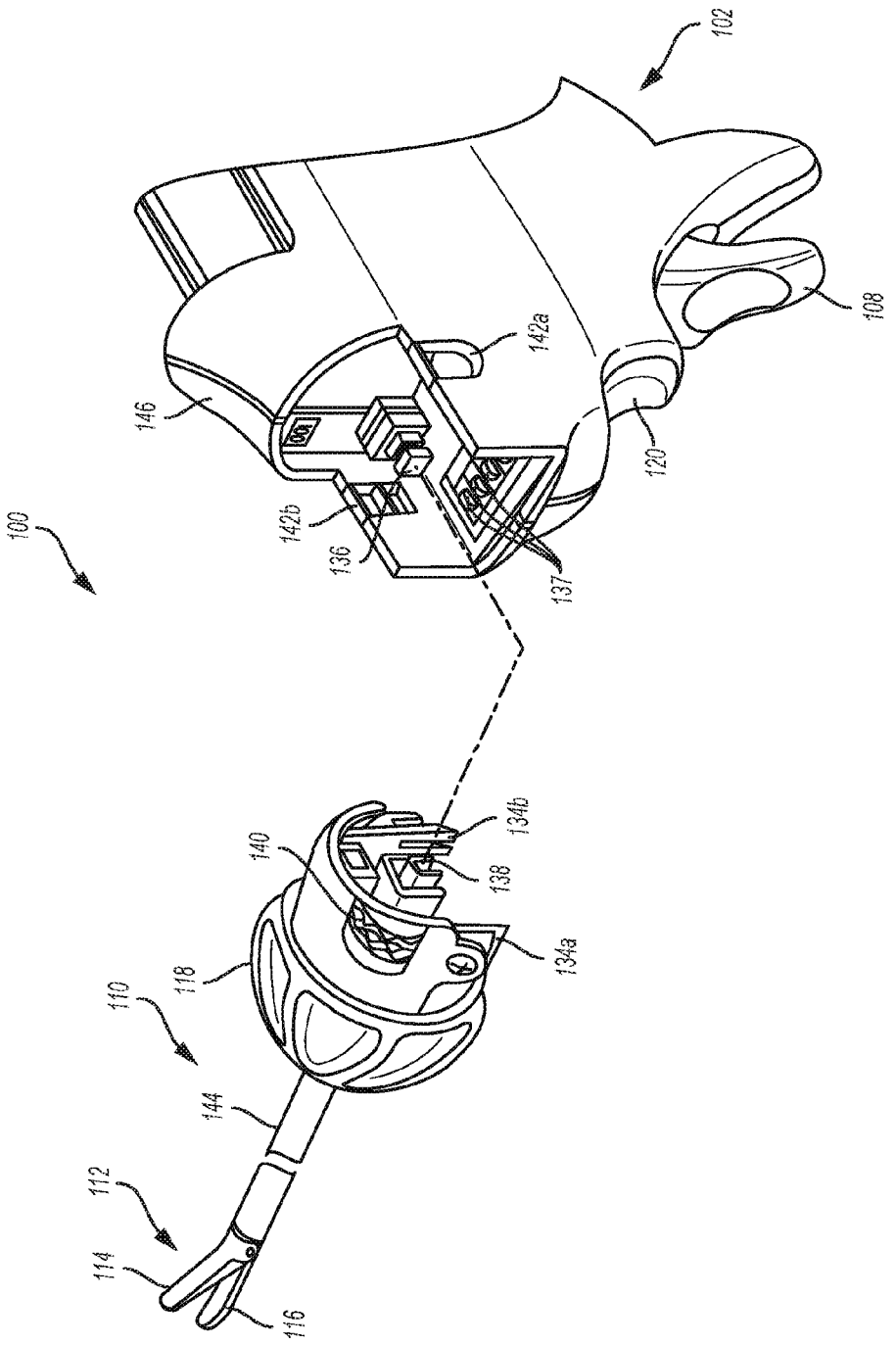

102
108
142a
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142b
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137
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140
134b
138
134a
110
118
144
112
114
116

FIG. 3

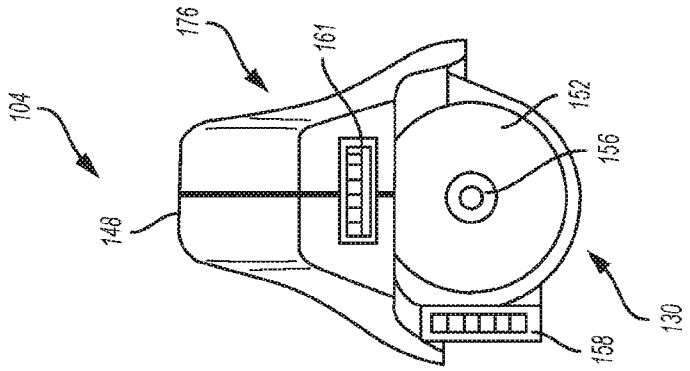

176
161
104
152
156
148
130
158

FIG. 5

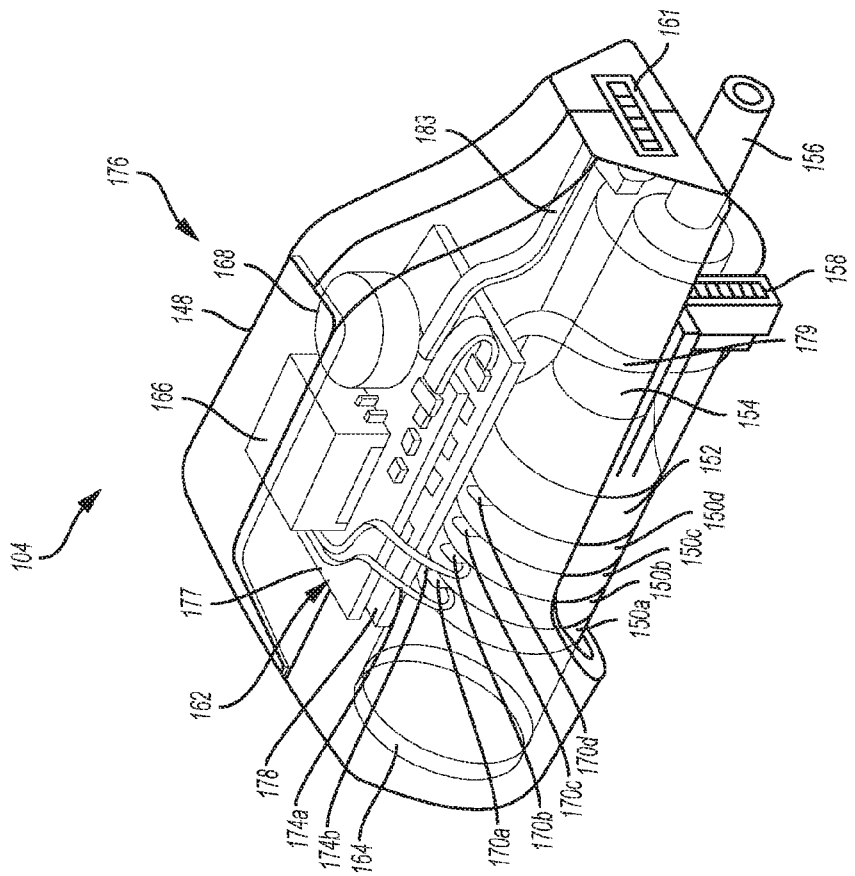

161
183
156
176
168
158
148
179
166
154
152
150d
150c
104
150b
177
150a
162
178
170d
170c
174a
170b
174b
164
170a

FIG. 4

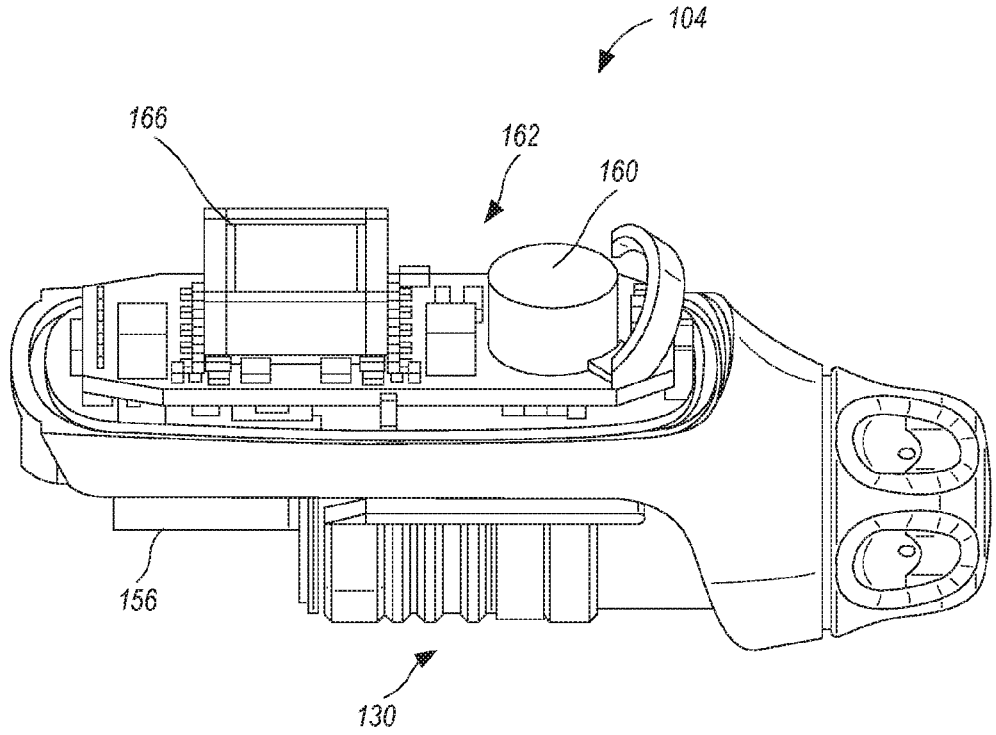


FIG. 6

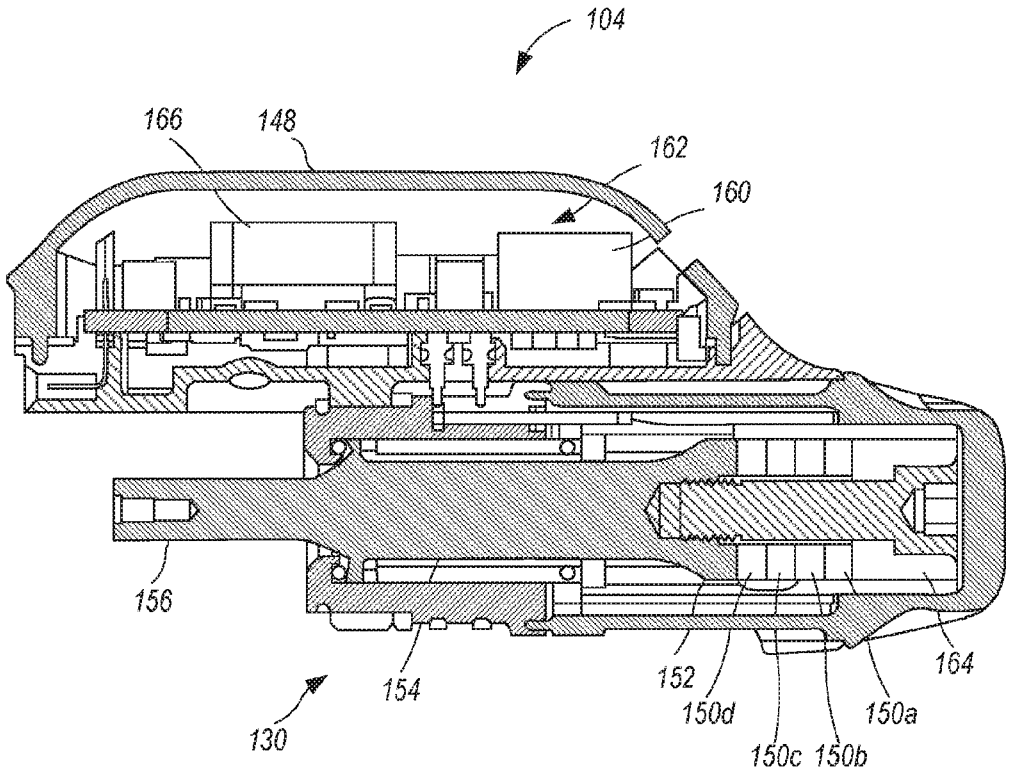


FIG. 7

Petitioner Therabody Ex-1013, 0289

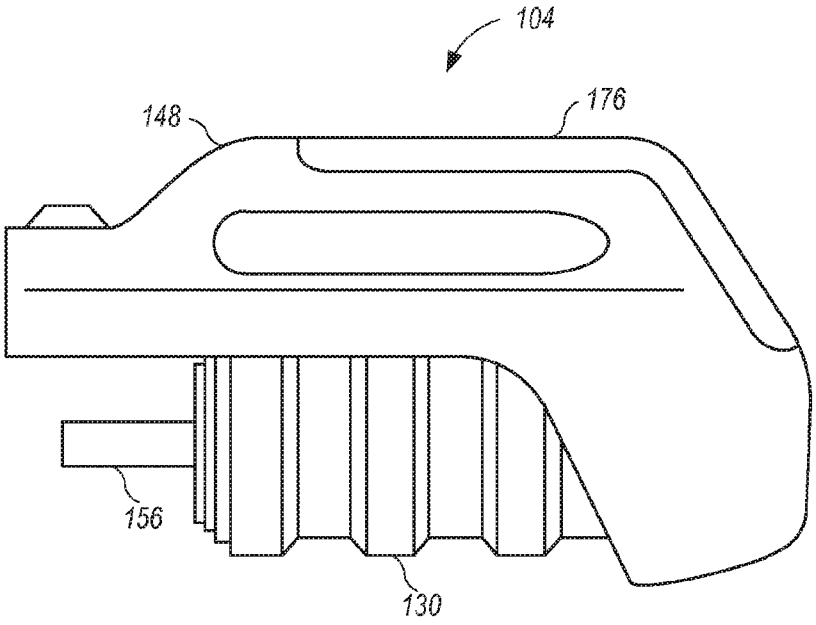


FIG. 8

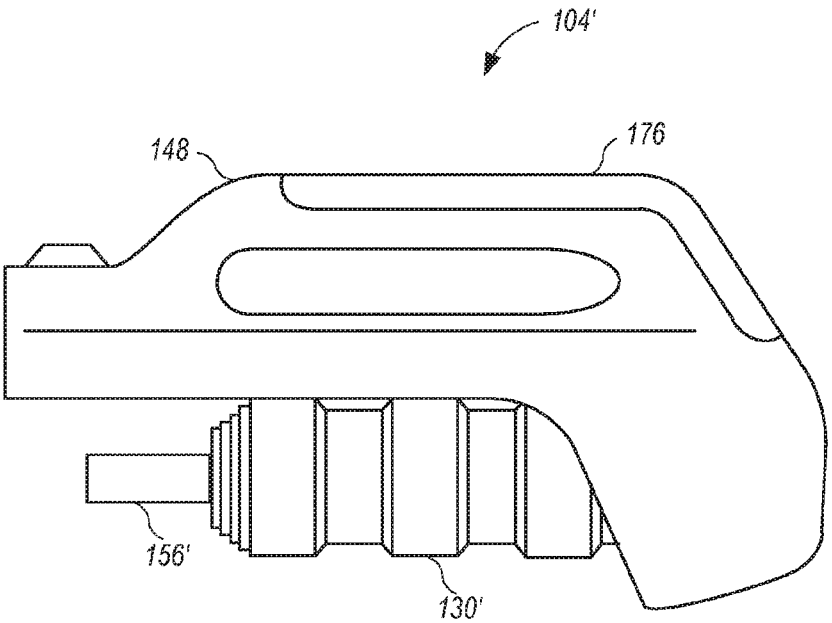


FIG. 9

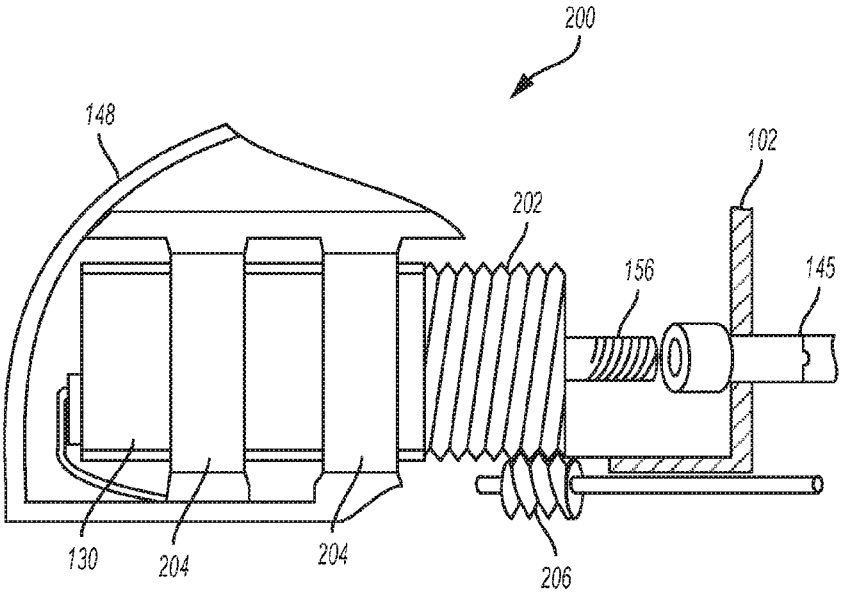


FIG. 10A

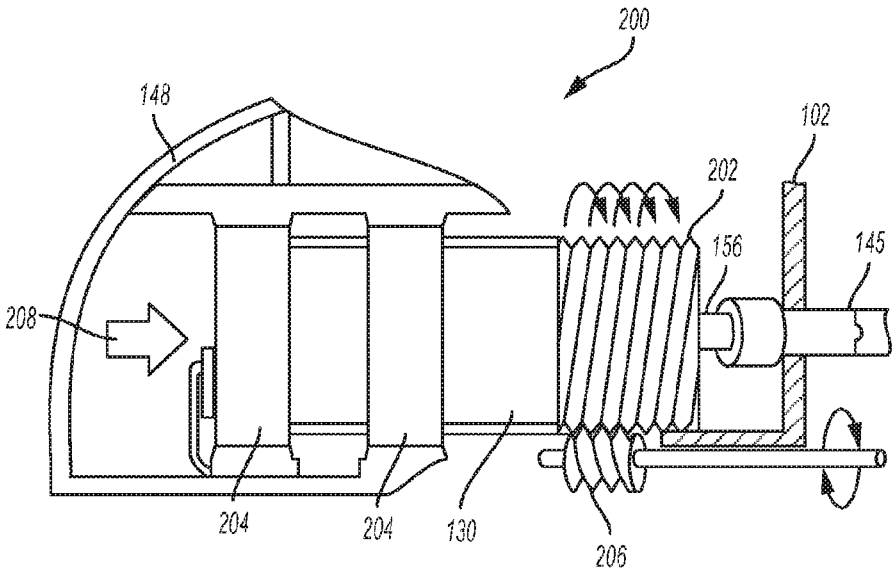


FIG. 10B

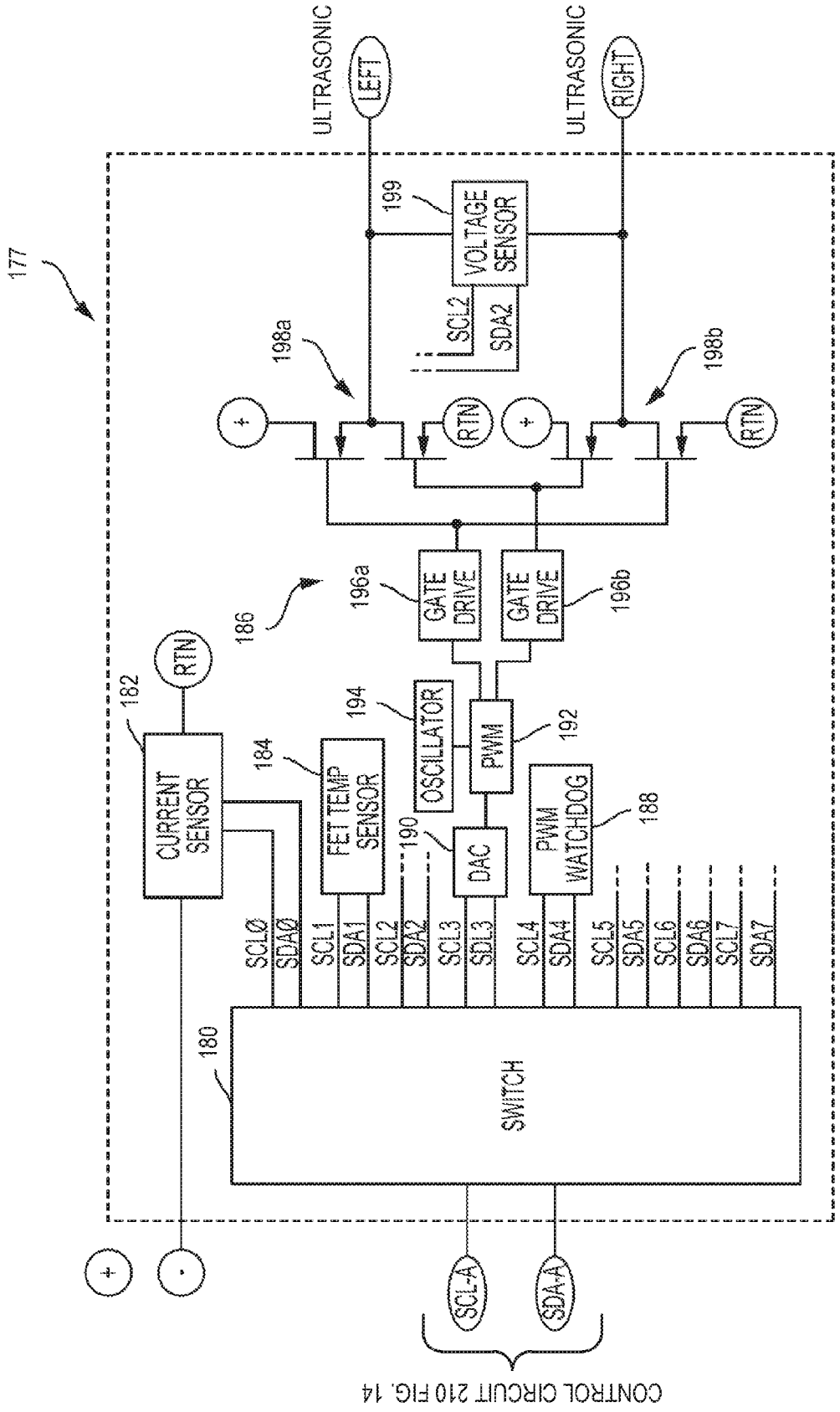


FIG. 11

Petitioner Therabody Ex-1013, 0292

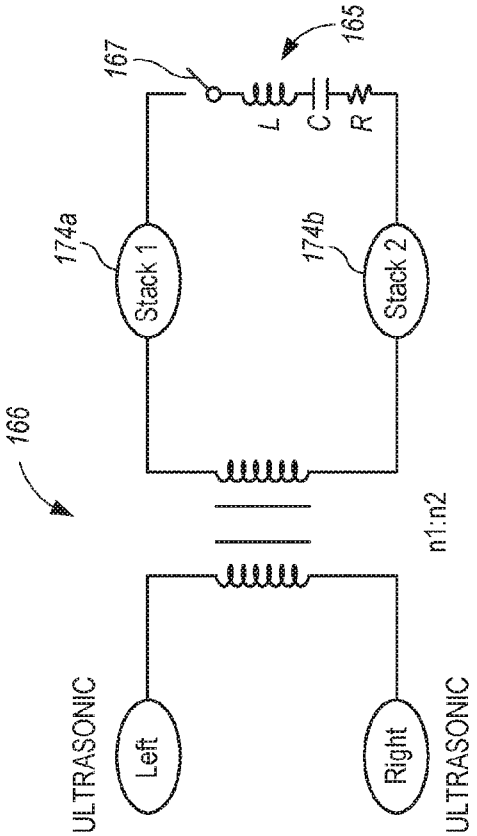


FIG. 13

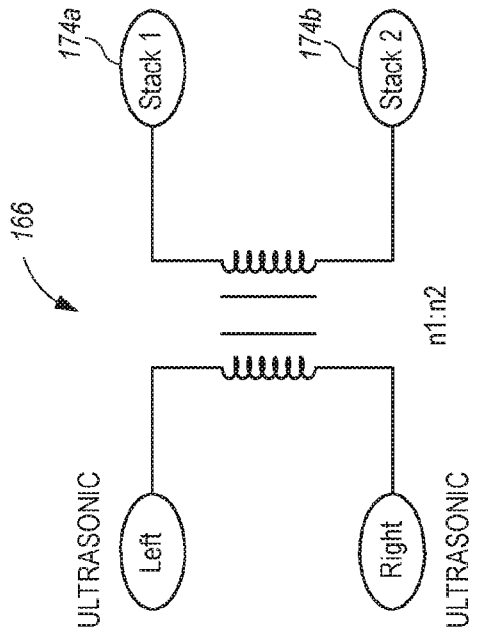


FIG. 12

Petitioner Therabody Ex-1013, 0293

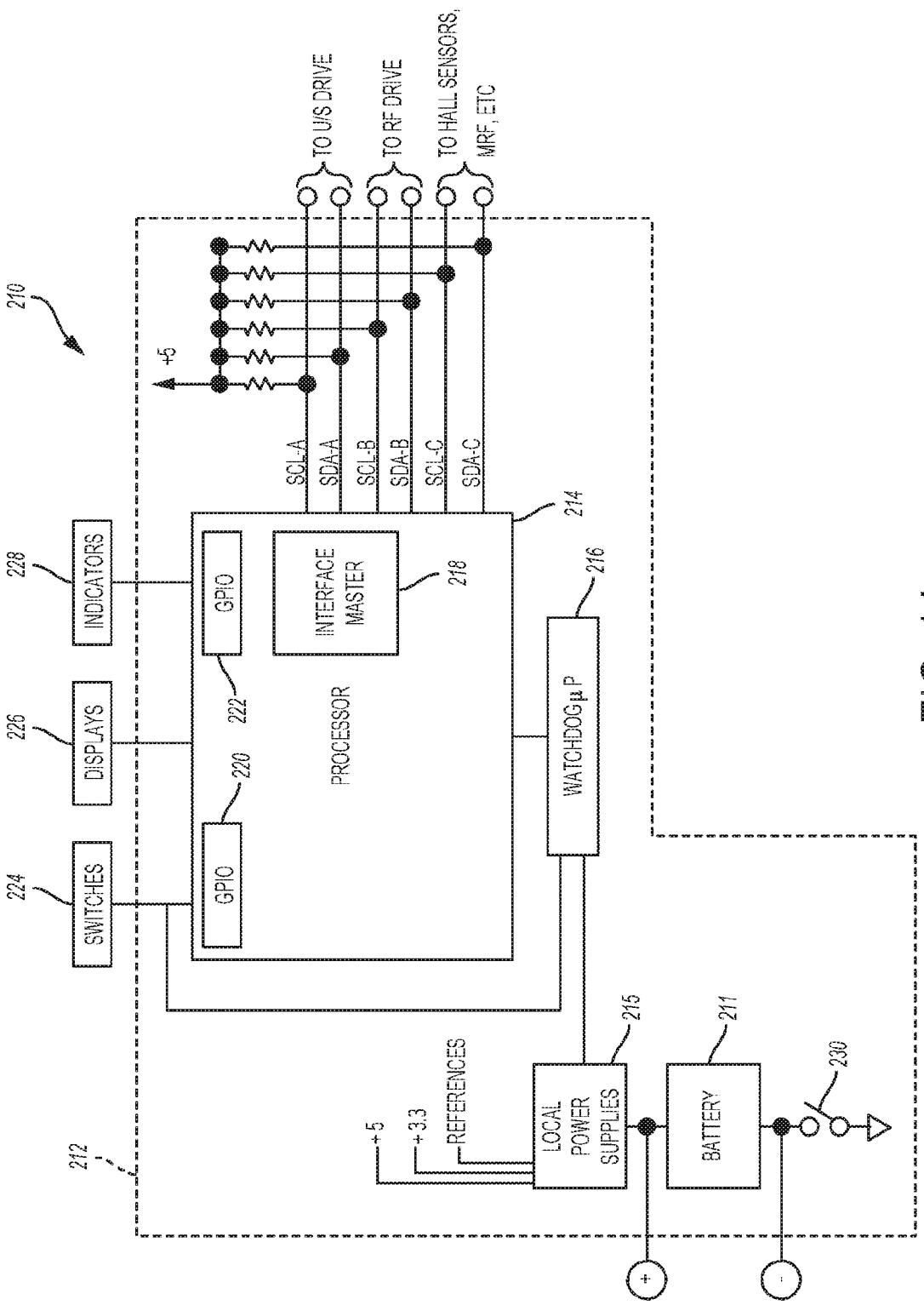


FIG. 14

MassagerPriorArt0002700

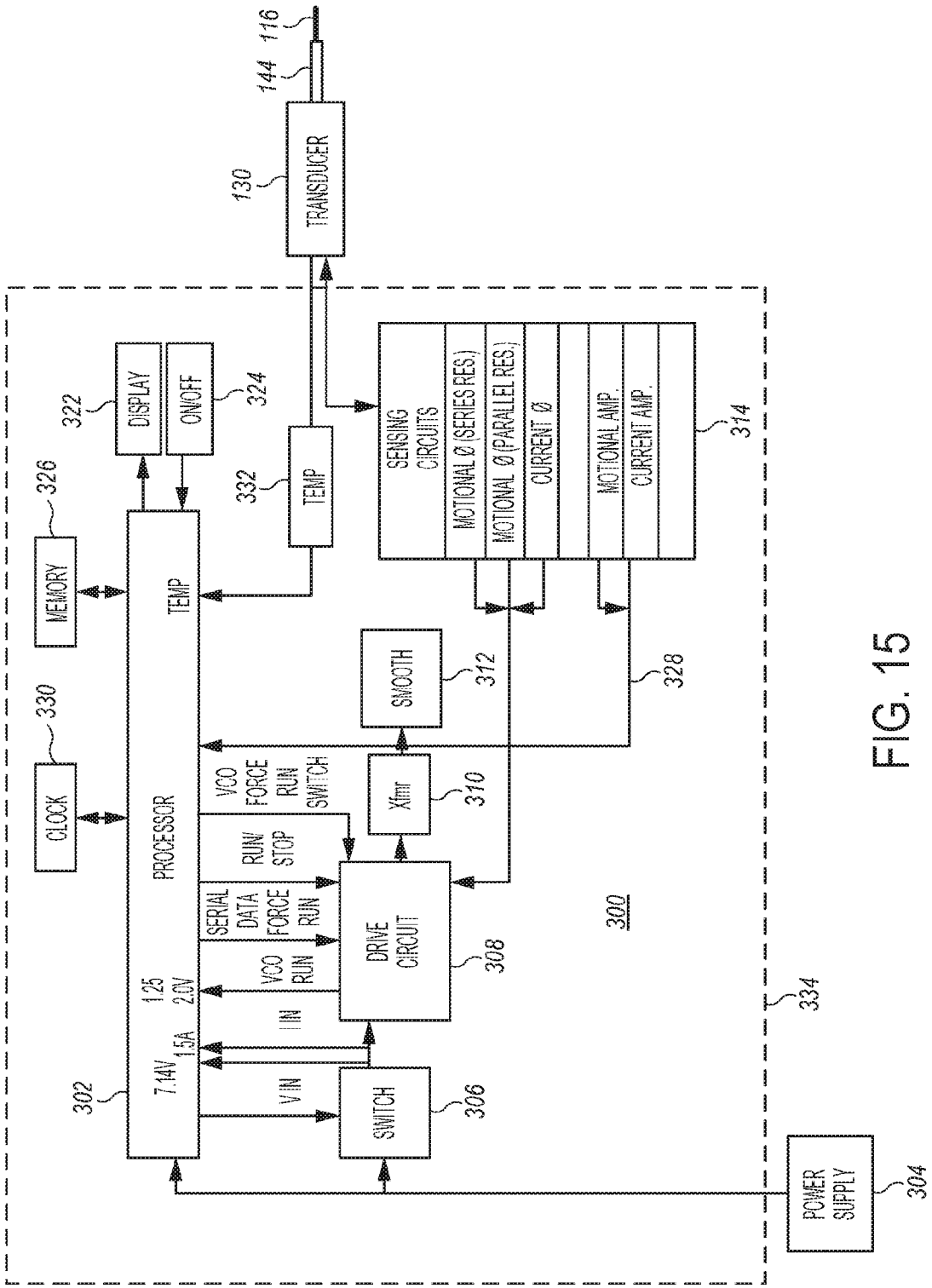


FIG. 15

MassagerPriorArt0002701

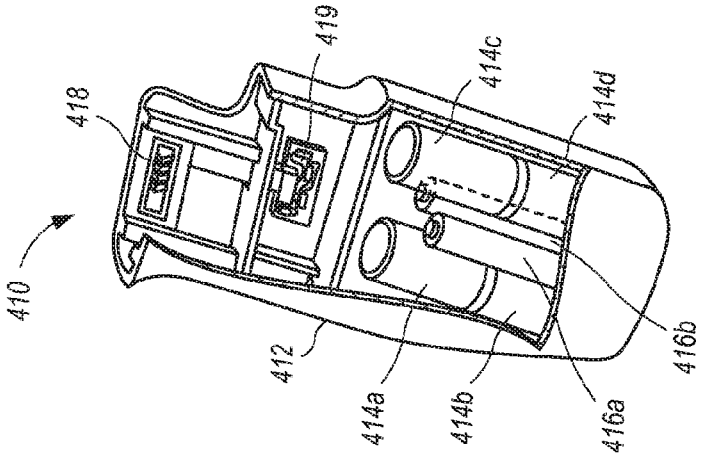

410
418
419
414c
414d
412
414a
414b
416a
416b

FIG. 17

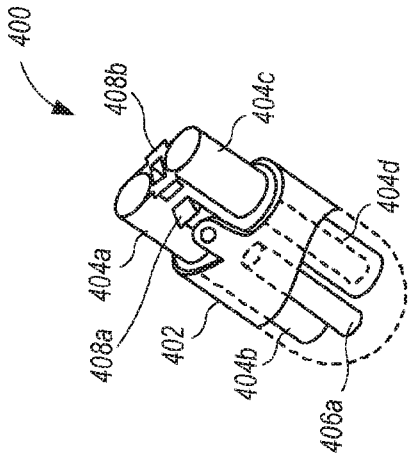

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408b
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404d
404a
408a
402
404b
406a

FIG. 16

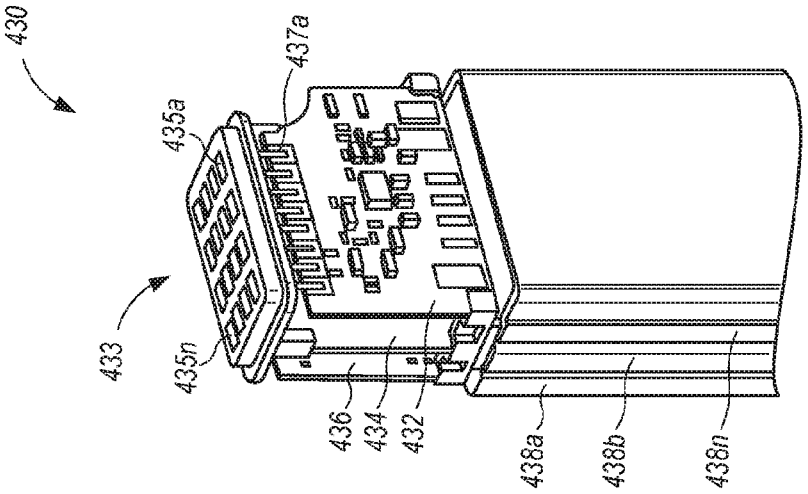

430
437a
435a
433
435n
436
434
432
438a
438b
438n

FIG. 19

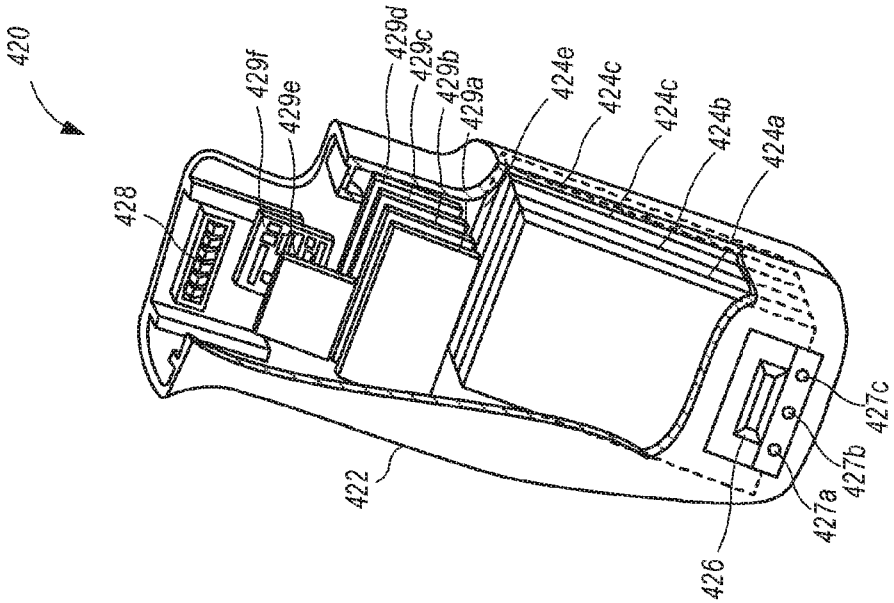

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429f
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424e
424c
424c
424b
424a
428
422
426
427a
427b
427c

FIG. 18

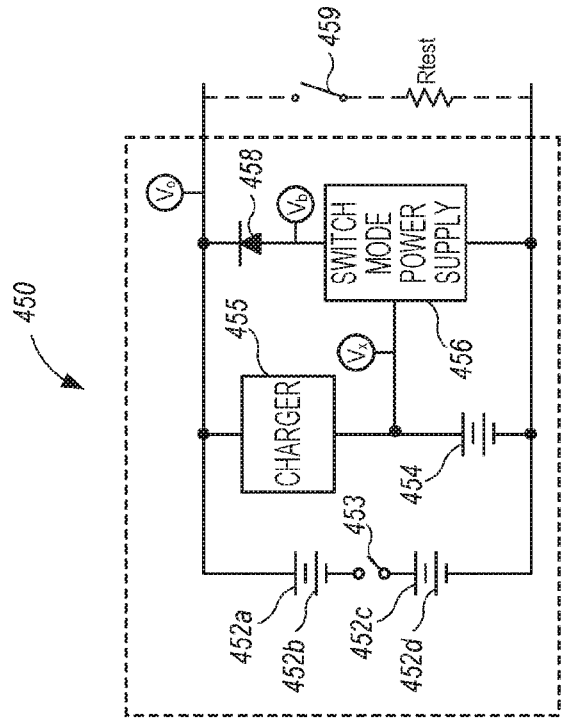


FIG. 21

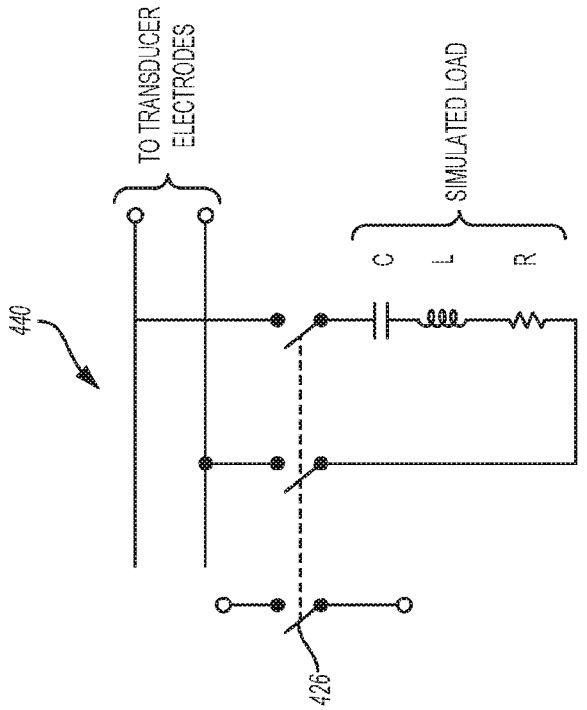


FIG. 20

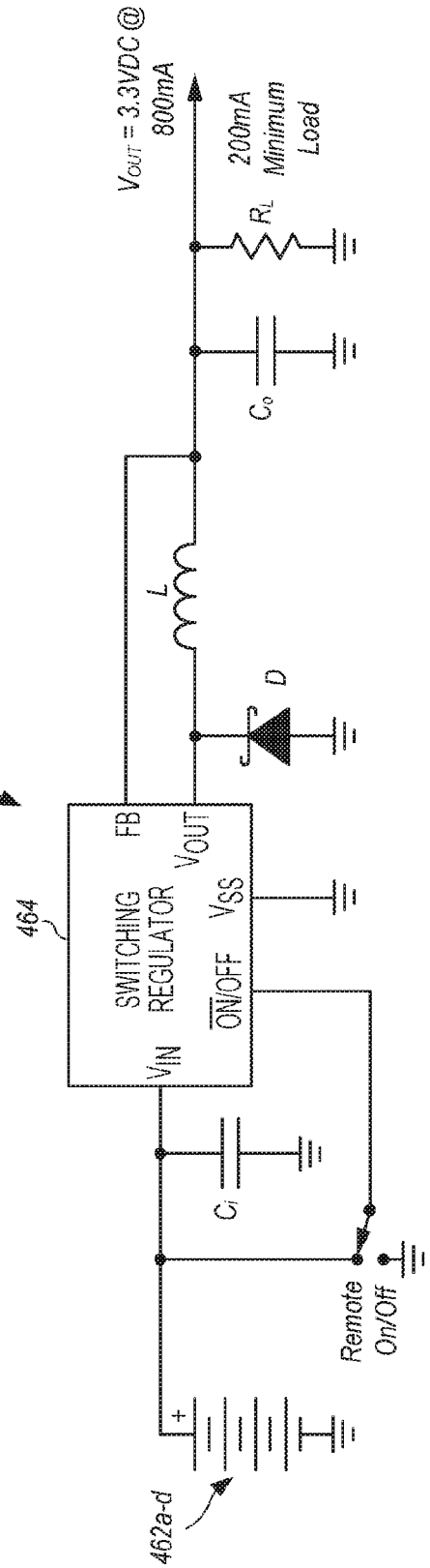


FIG. 22

MassagerPriorArt0002704

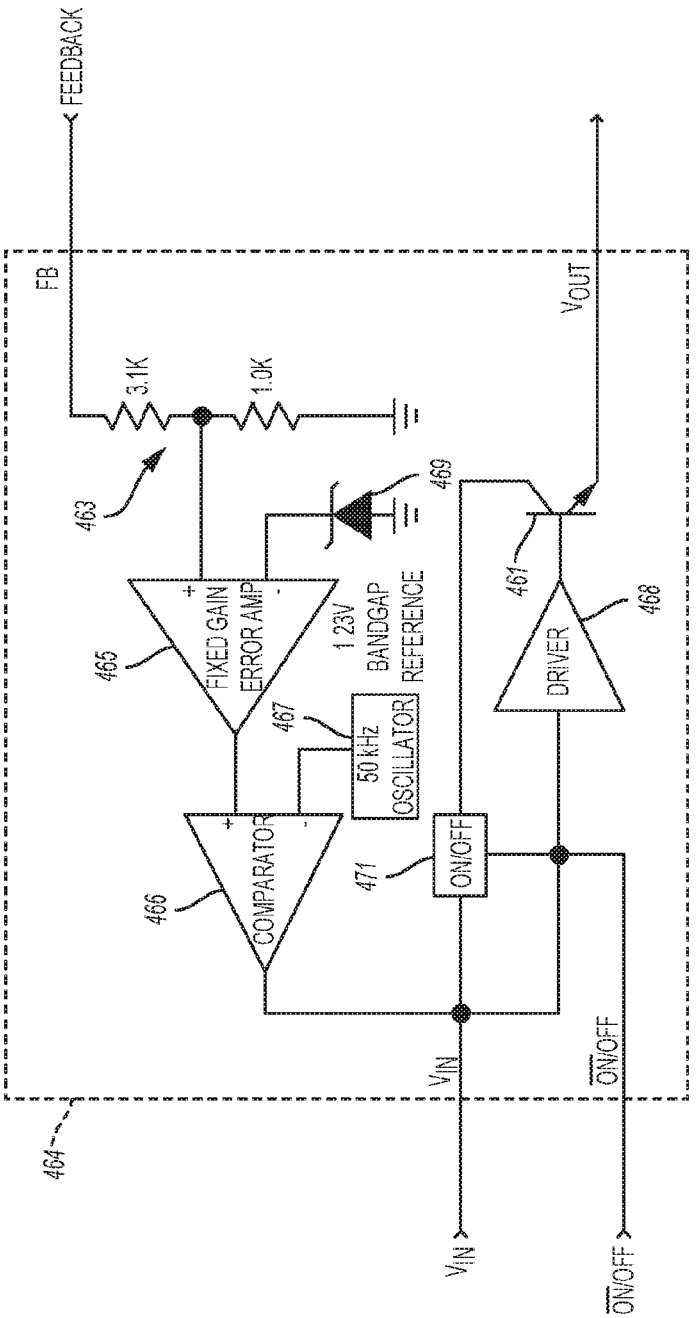

FEEDBACK
FB
3.1K
1.0K
463
469
461
VOUT
FIXED GAIN ERROR AMP
1.23V BANDGAP REFERENCE
465
467
50 kHz OSCILLATOR
DRIVER
468
COMPARATOR
466
471
ON/OFF
VIN
ON/OFF
464

FIG. 23

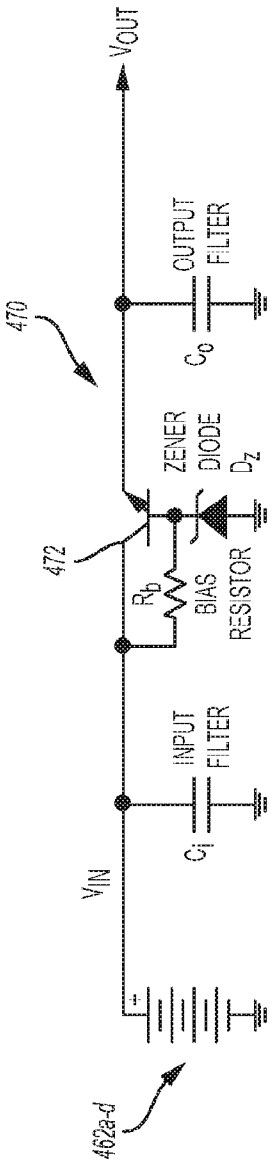

VOUT
470
OUTPUT FILTER
C_o
ZENER DIODE D_Z
472
R_b
BIAS RESISTOR
INPUT FILTER
C_I
VIN
462a-d

FIG. 24

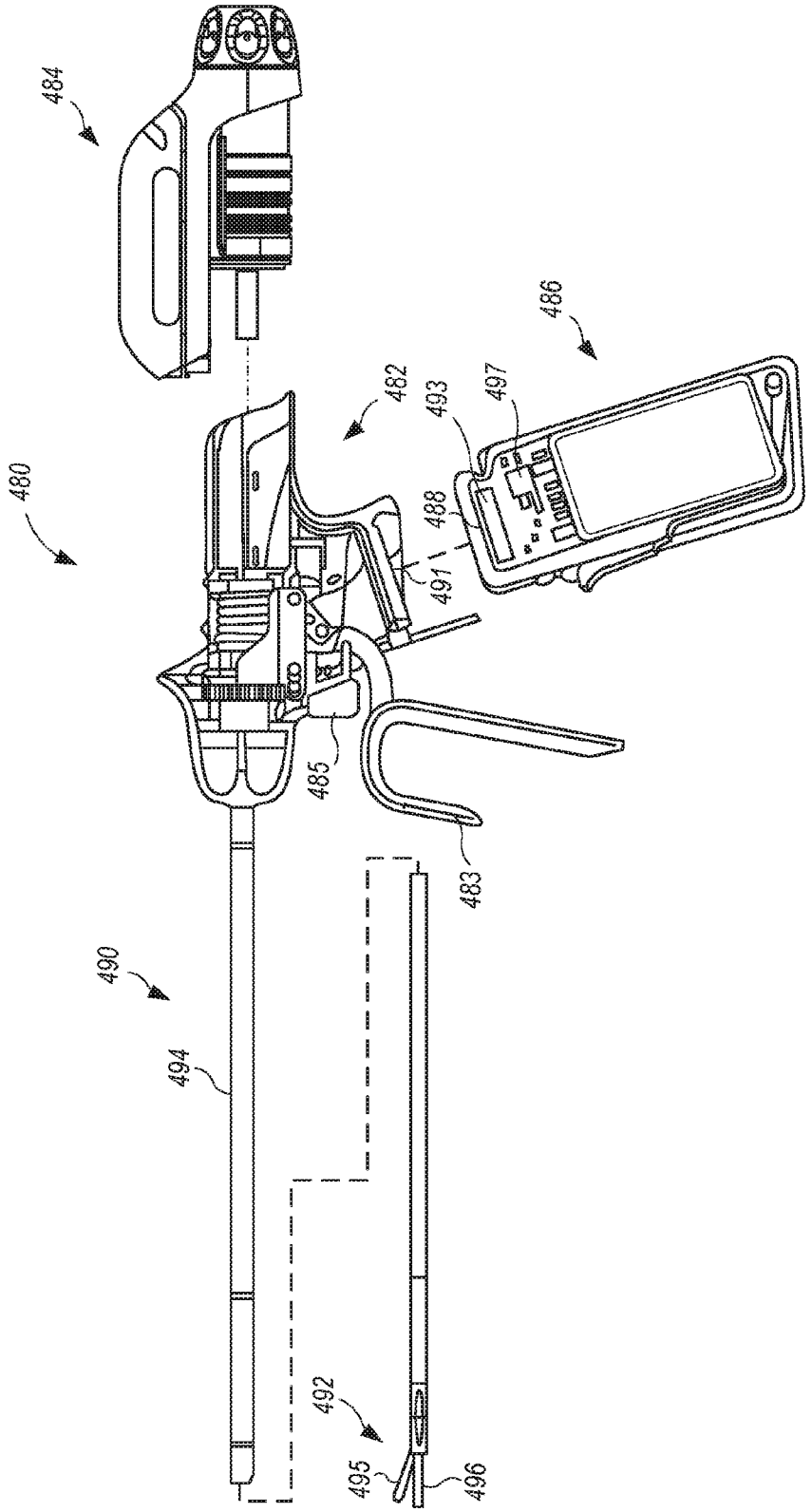


FIG. 25

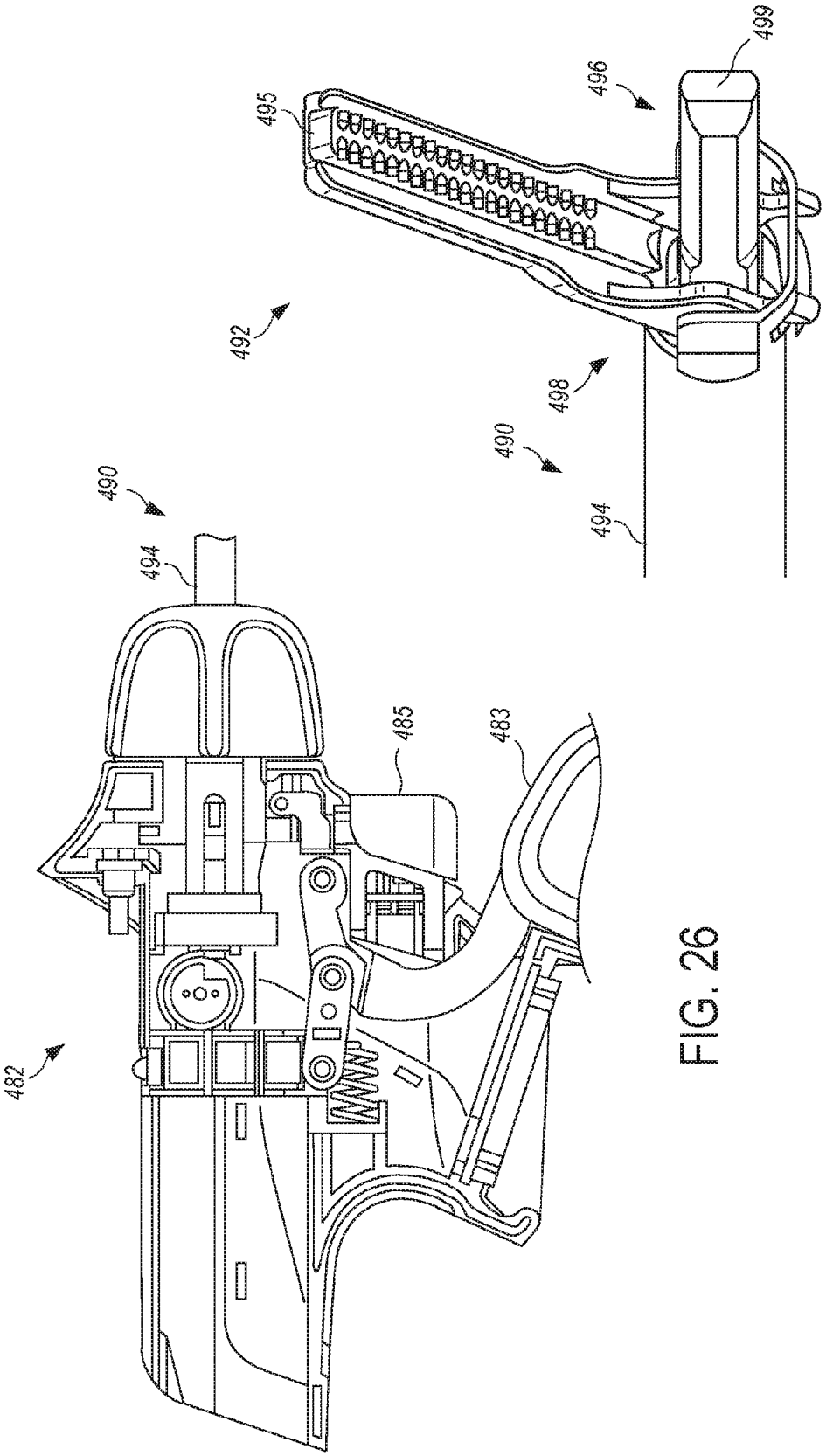


FIG. 27

FIG. 26

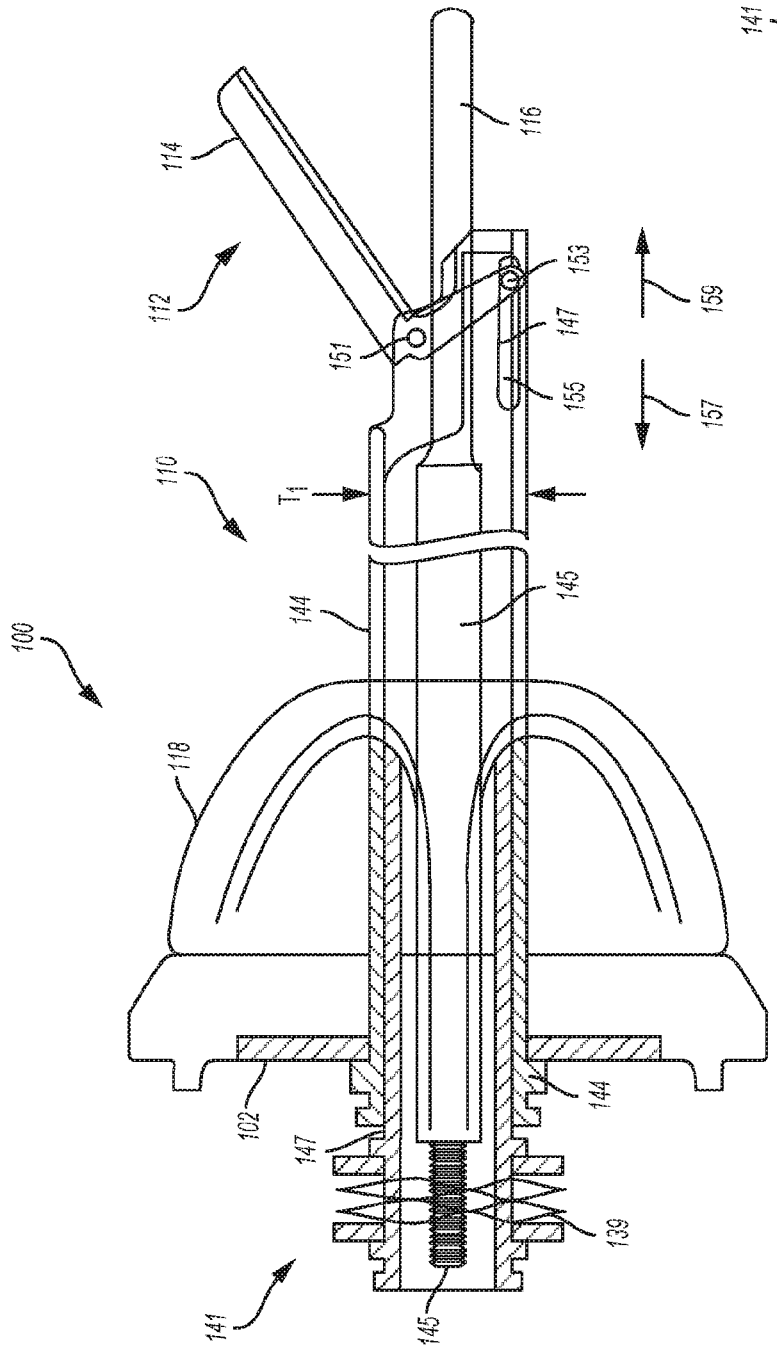

100
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153
155
157
159
T_1
102
139

FIG. 28

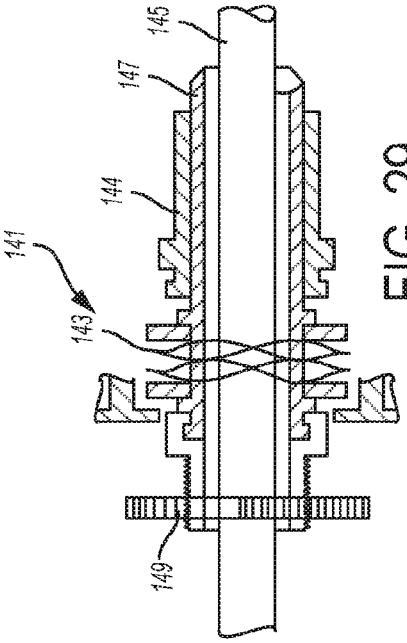

141
143
144
145
147
149

FIG. 29

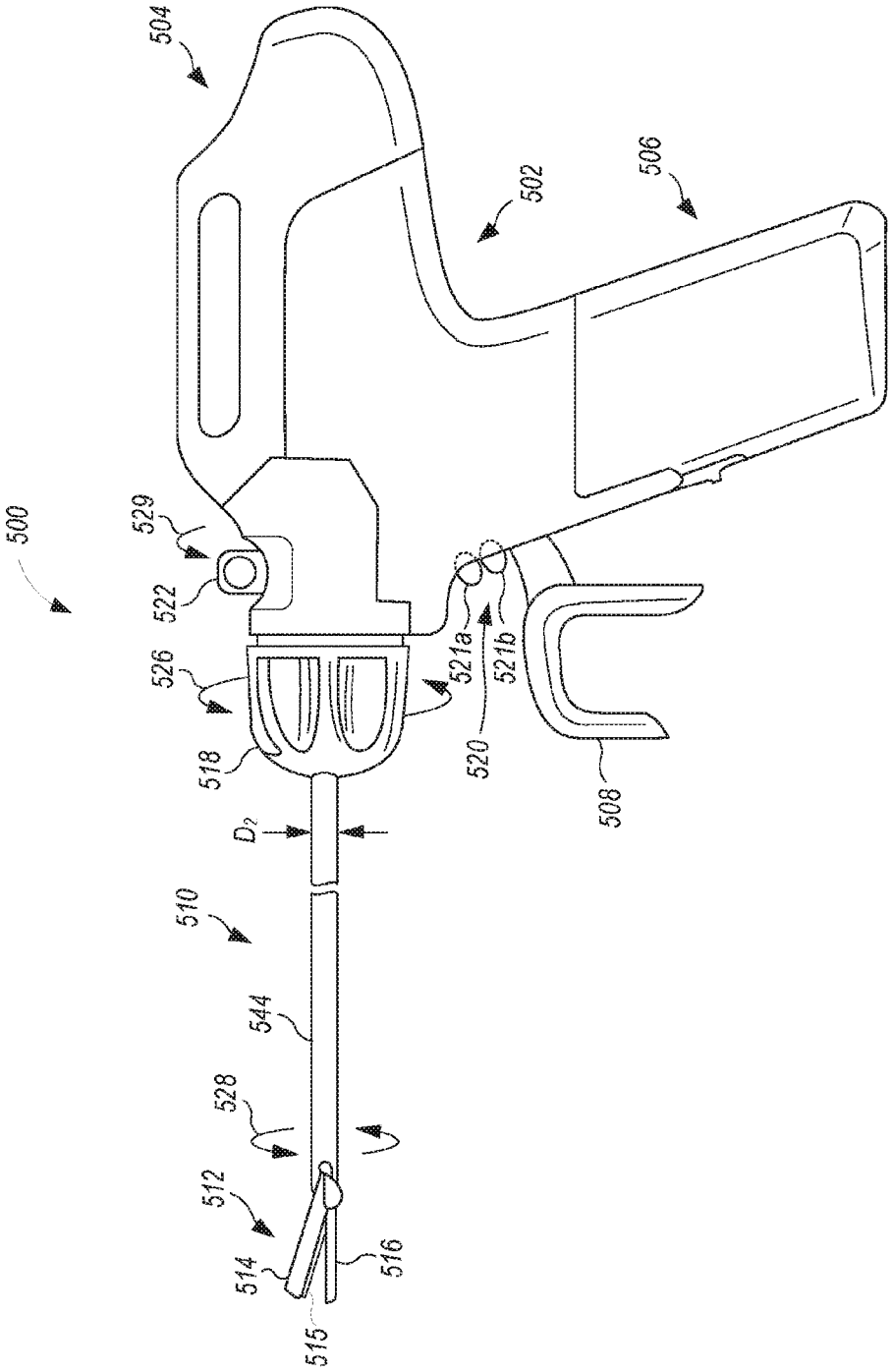

500
504
502
506
529
522
526
518
520
521a
521b
508
D_2
510
544
528
512
514
516
515

FIG. 30

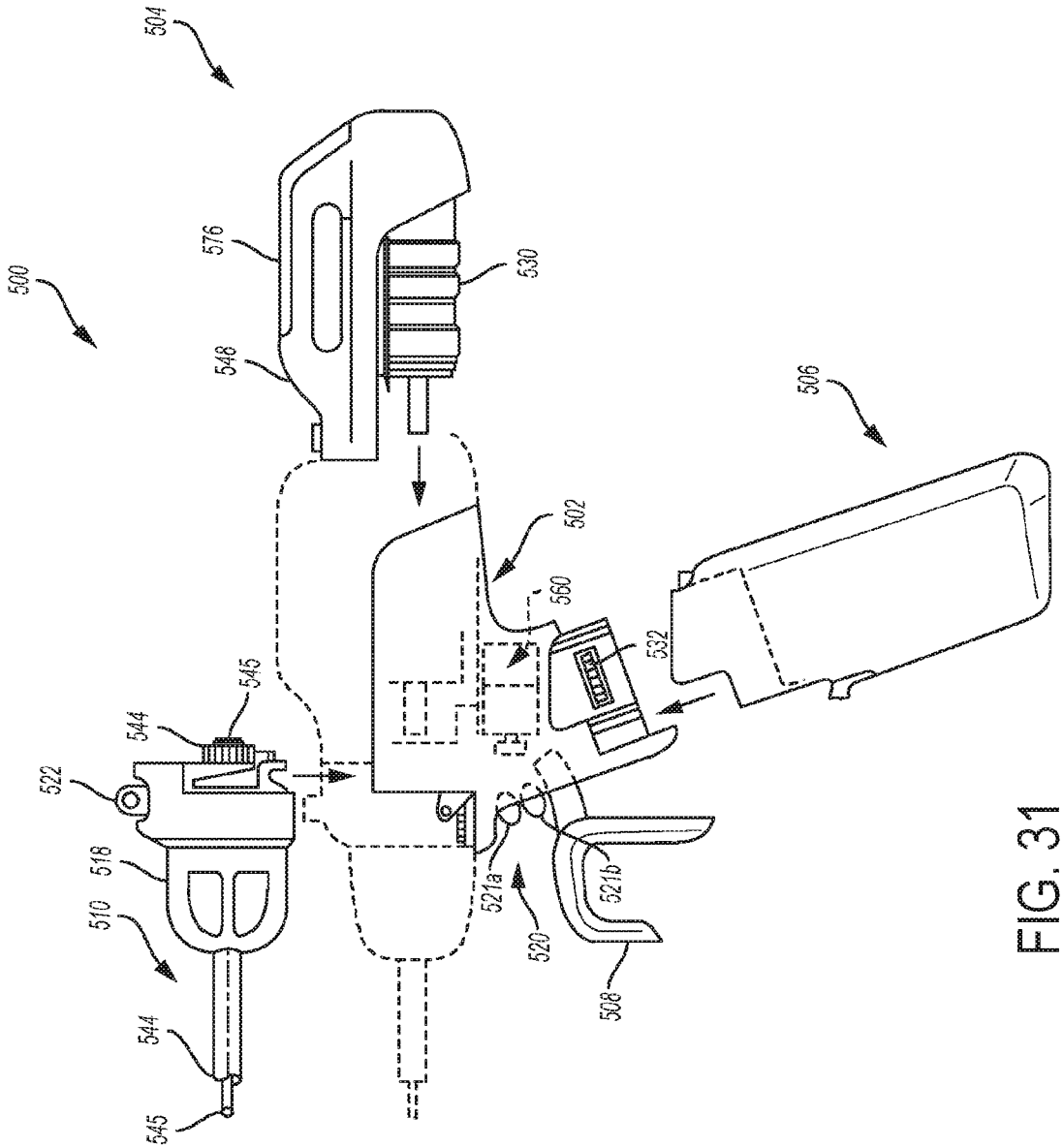

504
500
576
530
548
506
502
560
532
545
544
522
518
510
521a
521b
520
508
544
545

FIG. 31

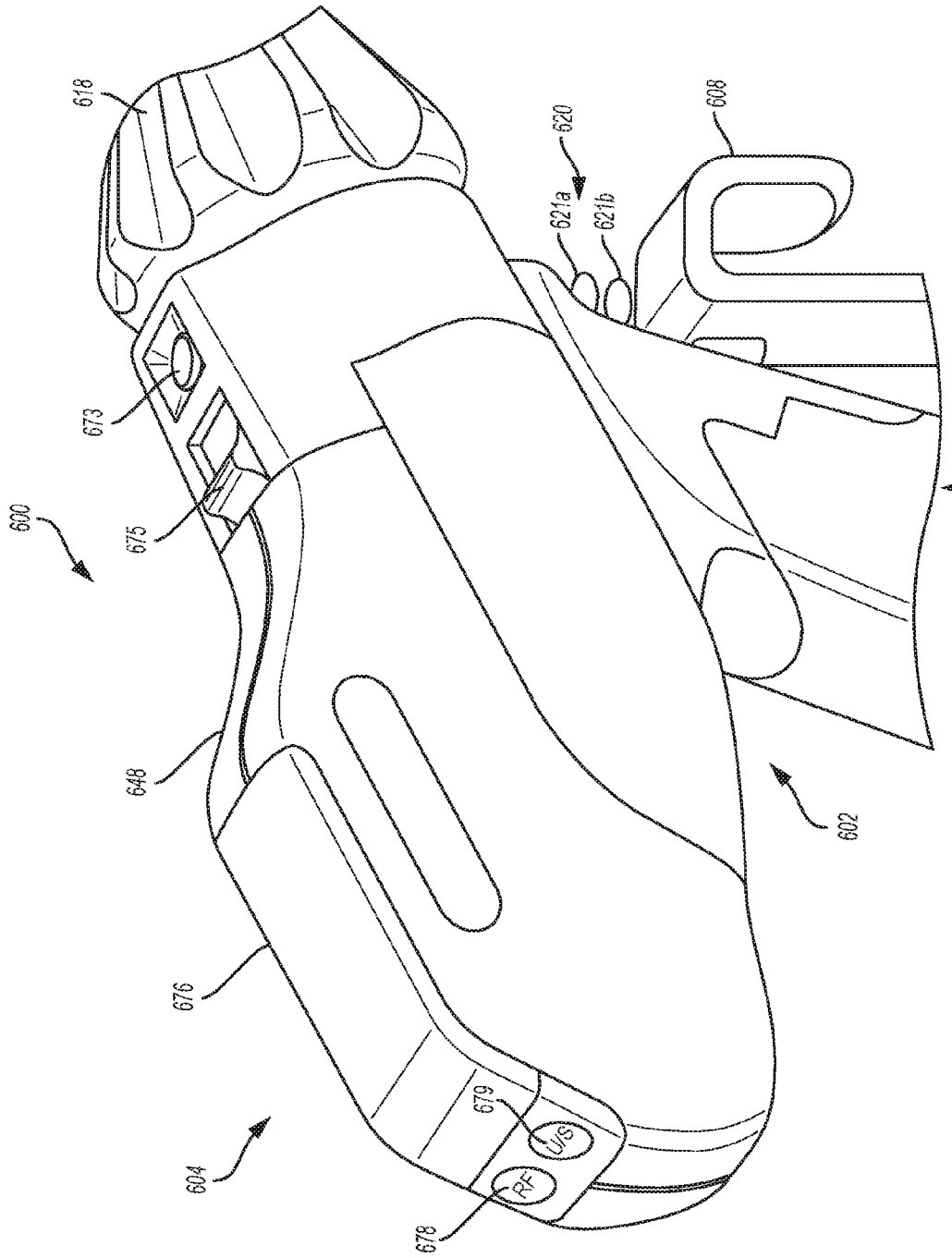

618
620
608
621a
621b
673
606
600
675
648
602
676
679
604
678
RF
U/S

FIG. 32

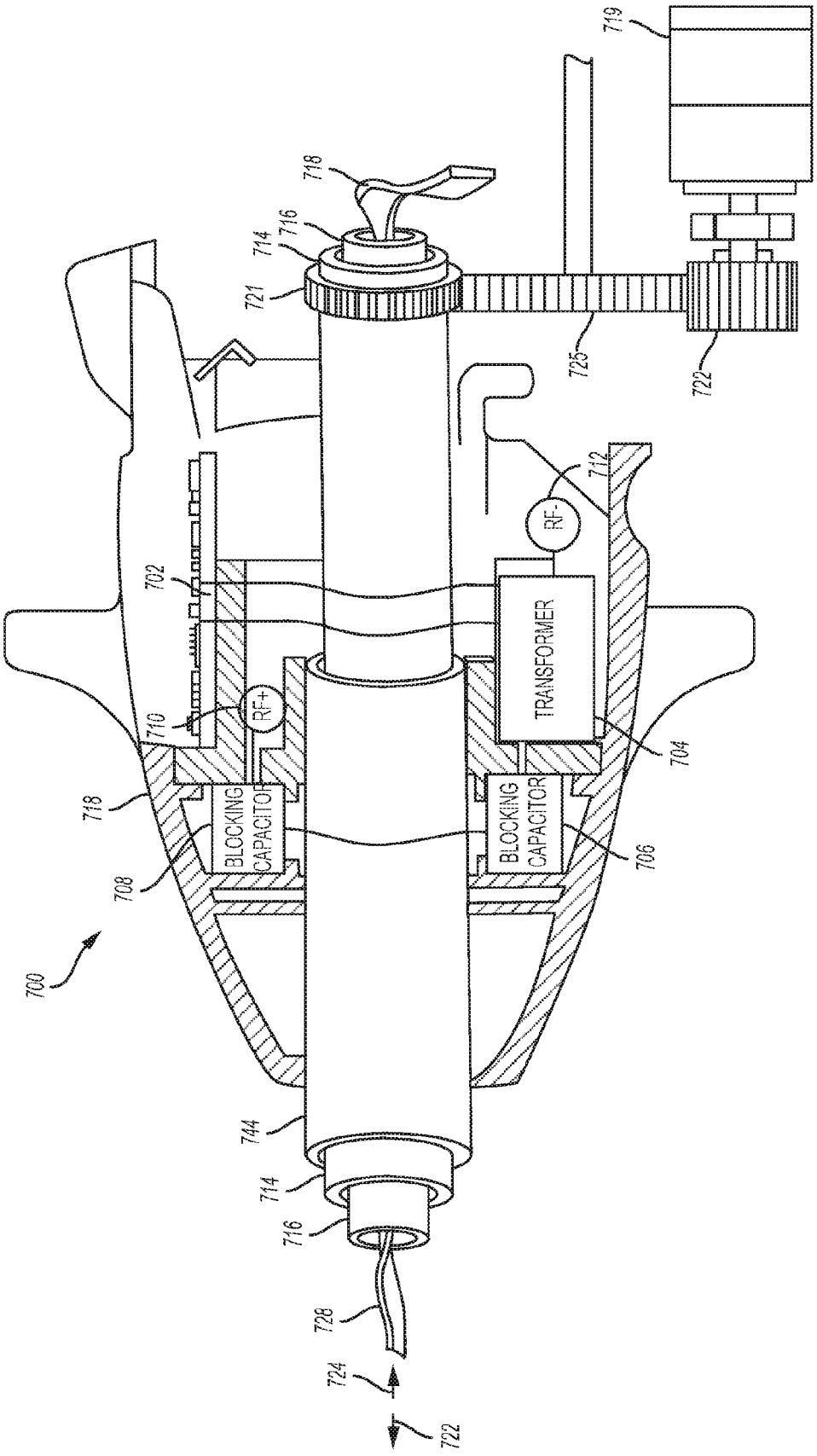


FIG. 33

Petitioner Therabody Ex-1013, 0306

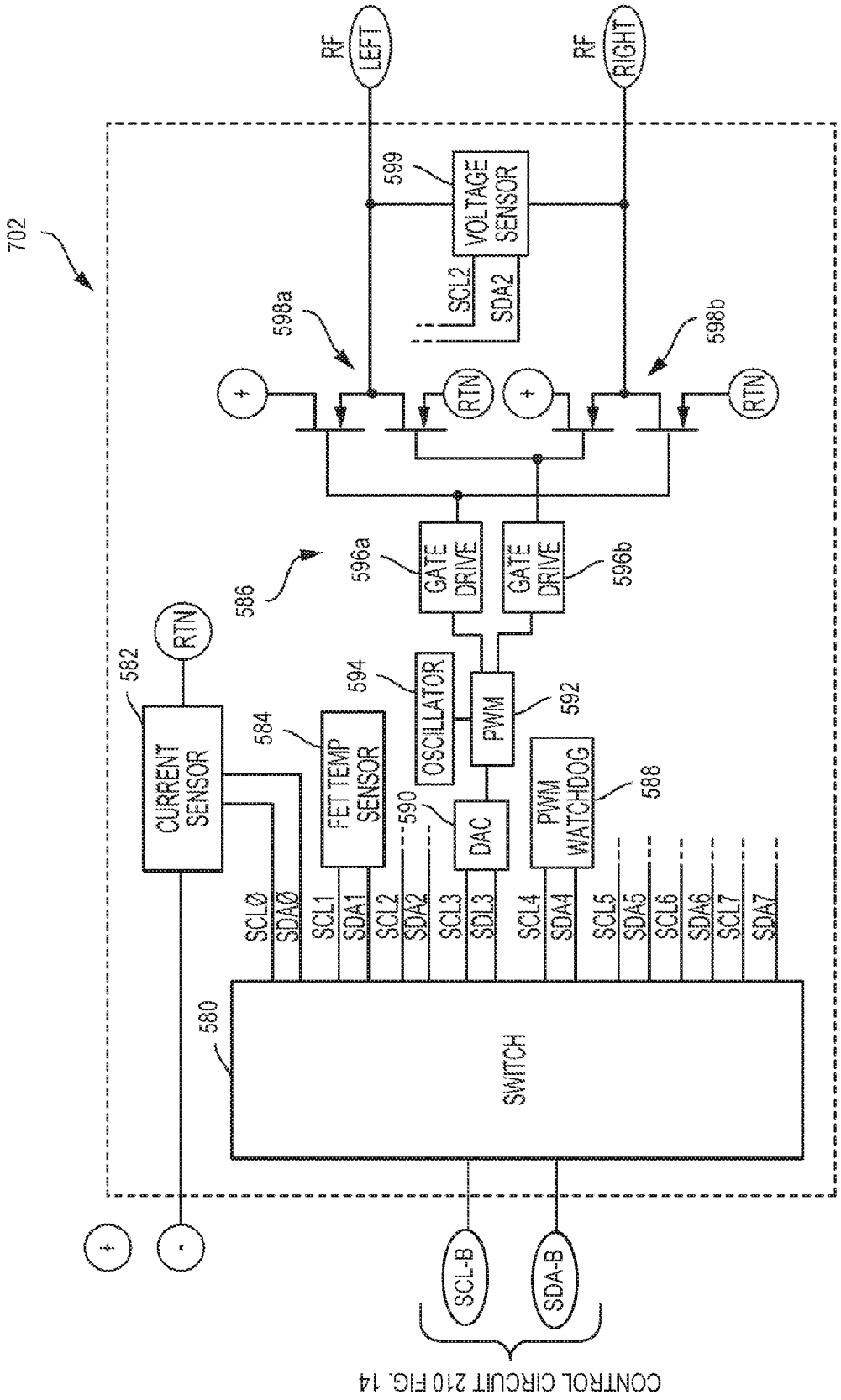


FIG. 34

Petitioner Therabody Ex-1013, 0307

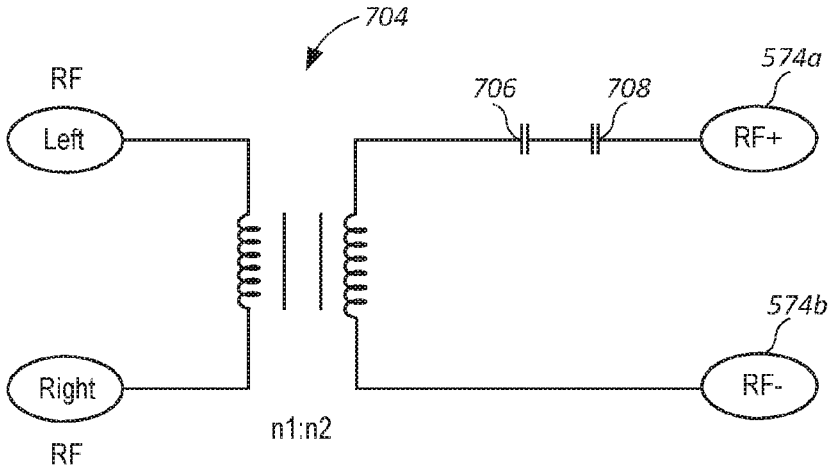


FIG. 35

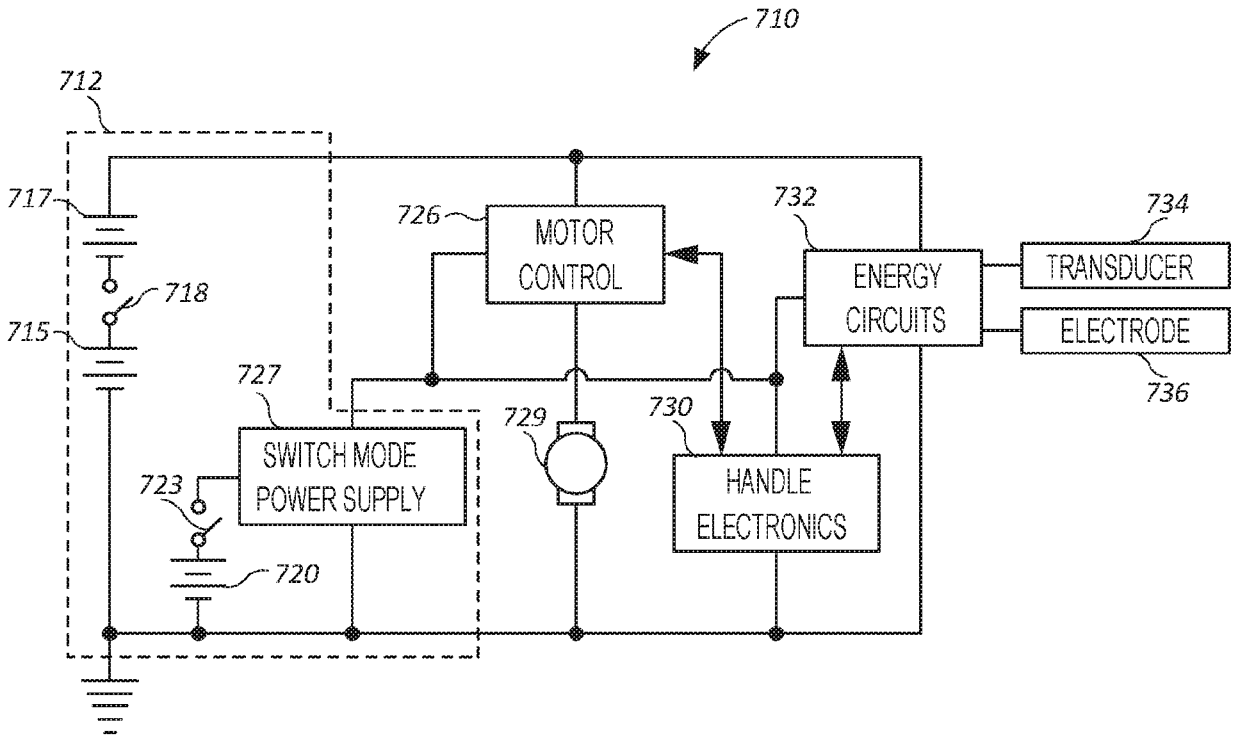


FIG. 36

Petitioner Therabody Ex-1013, 0308

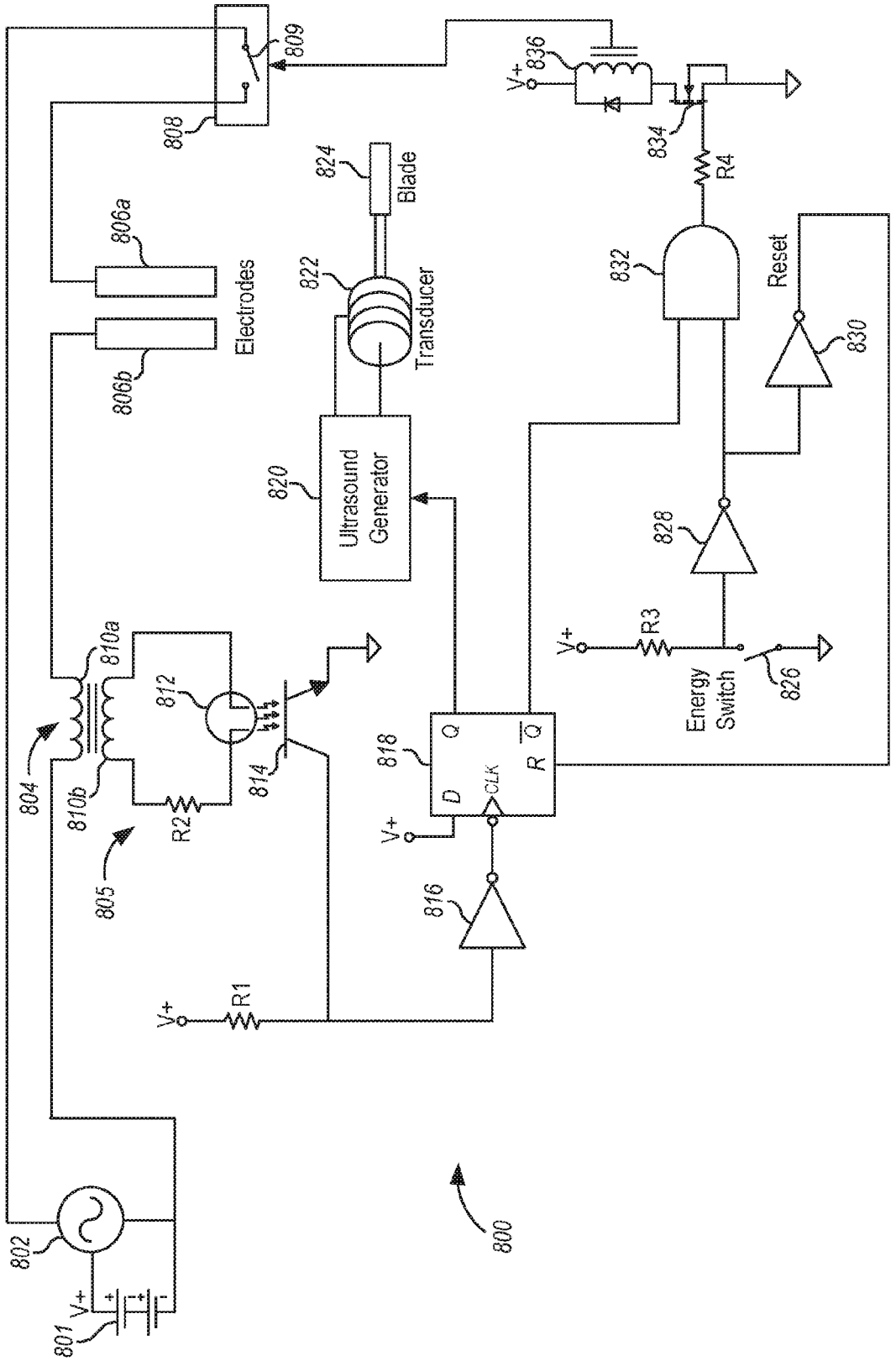


FIG. 37

Petitioner Therabody Ex-1013, 0309

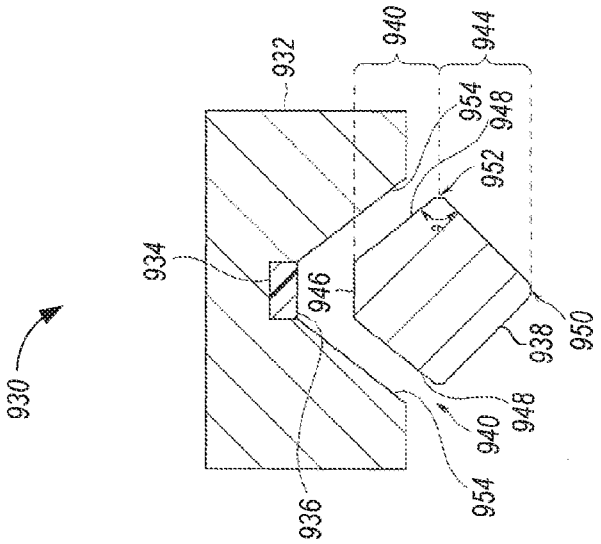

930
932
940
944
954
948
952
934
946
938
950
948
940
954
936

FIG. 39

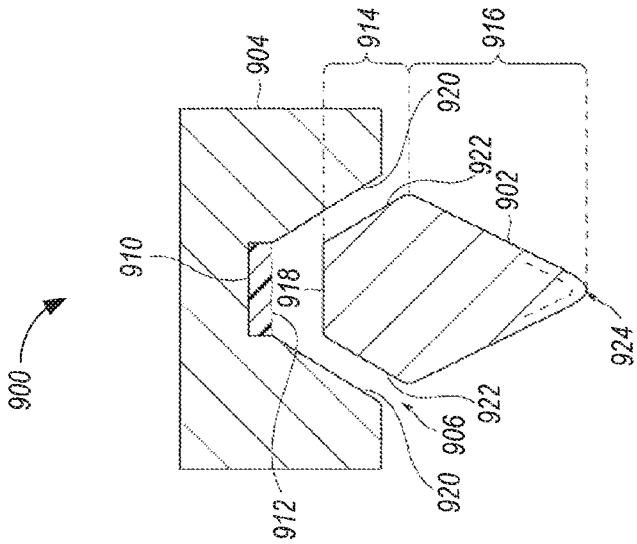

900
904
914
916
920
922
902
910
918
924
922
906
920
912

FIG. 38

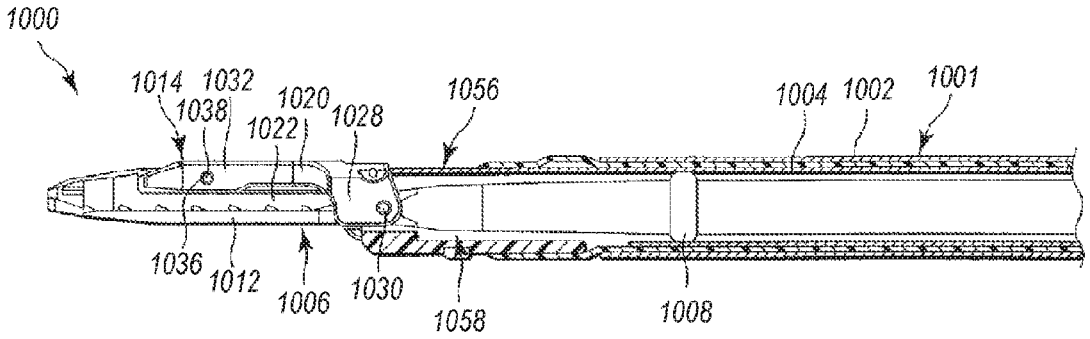


FIG. 40

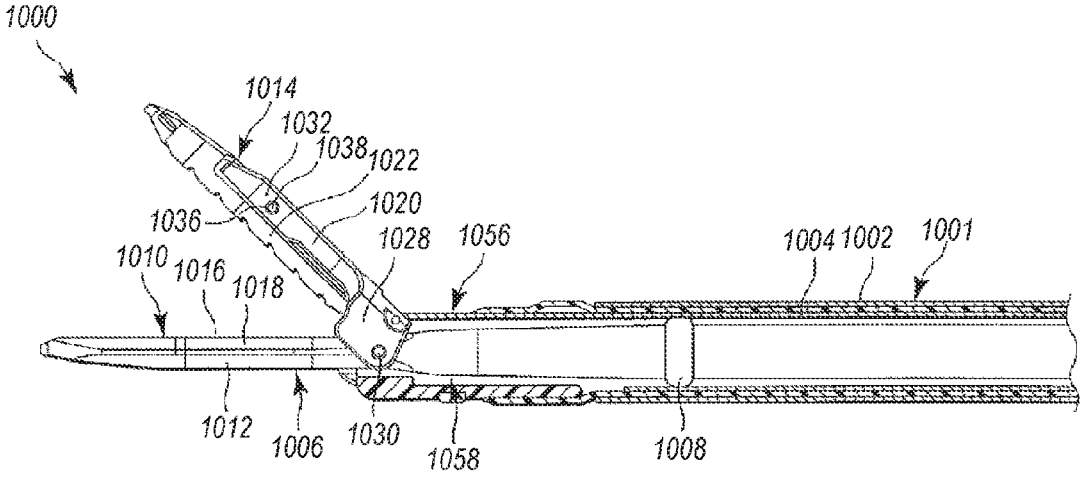


FIG. 41

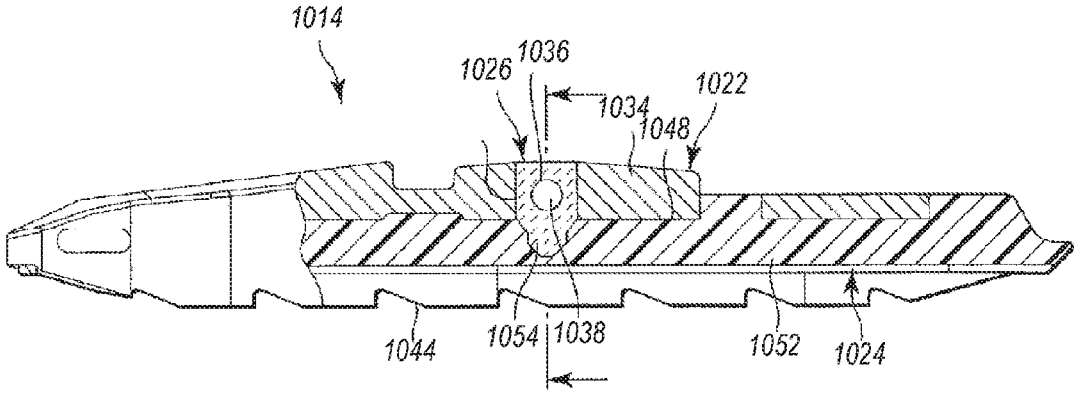


FIG. 42

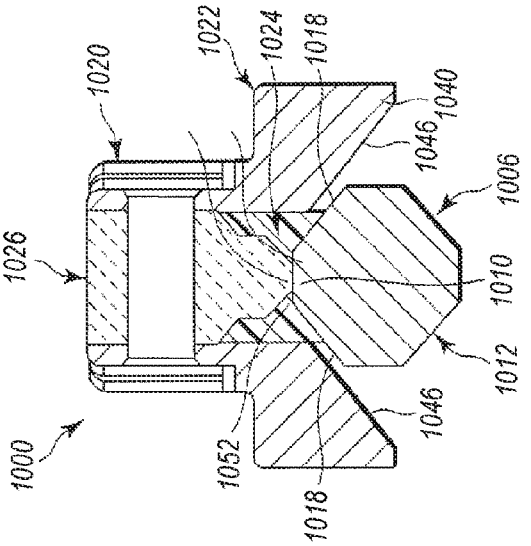

1020
1022
1024
1018
1040
1046
1006
1026
1010
1012
1046
1000
1052
1018

FIG. 44

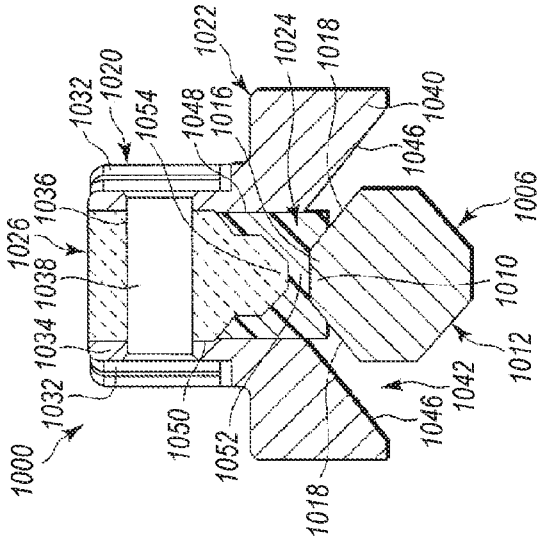

1022
1024
1018
1020
1032
1054
1048
1016
1040
1046
1036
1006
1026
1038
1010
1034
1012
1032
1042
1046
1000
1050
1052
1018

FIG. 43

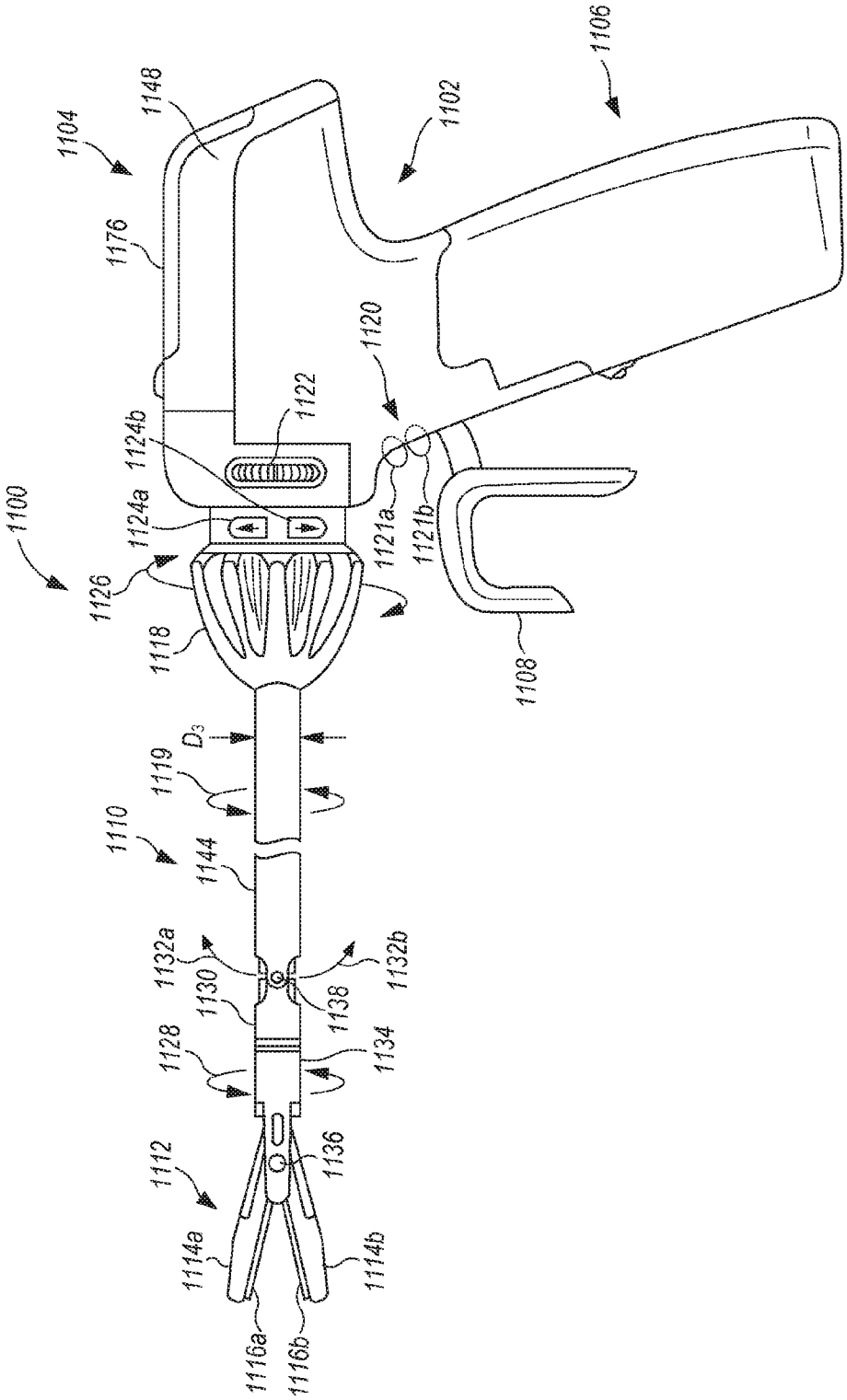

1106
1148
1104
1102
1176
1120
1122
1124b
1124a
1121a
1121b
1100
1126
1118
1108
D_3
1119
1110
1144
1132a
1132b
1130
1138
1128
1134
1112
1136
1114a
1114b
1116a
1116b

FIG. 45

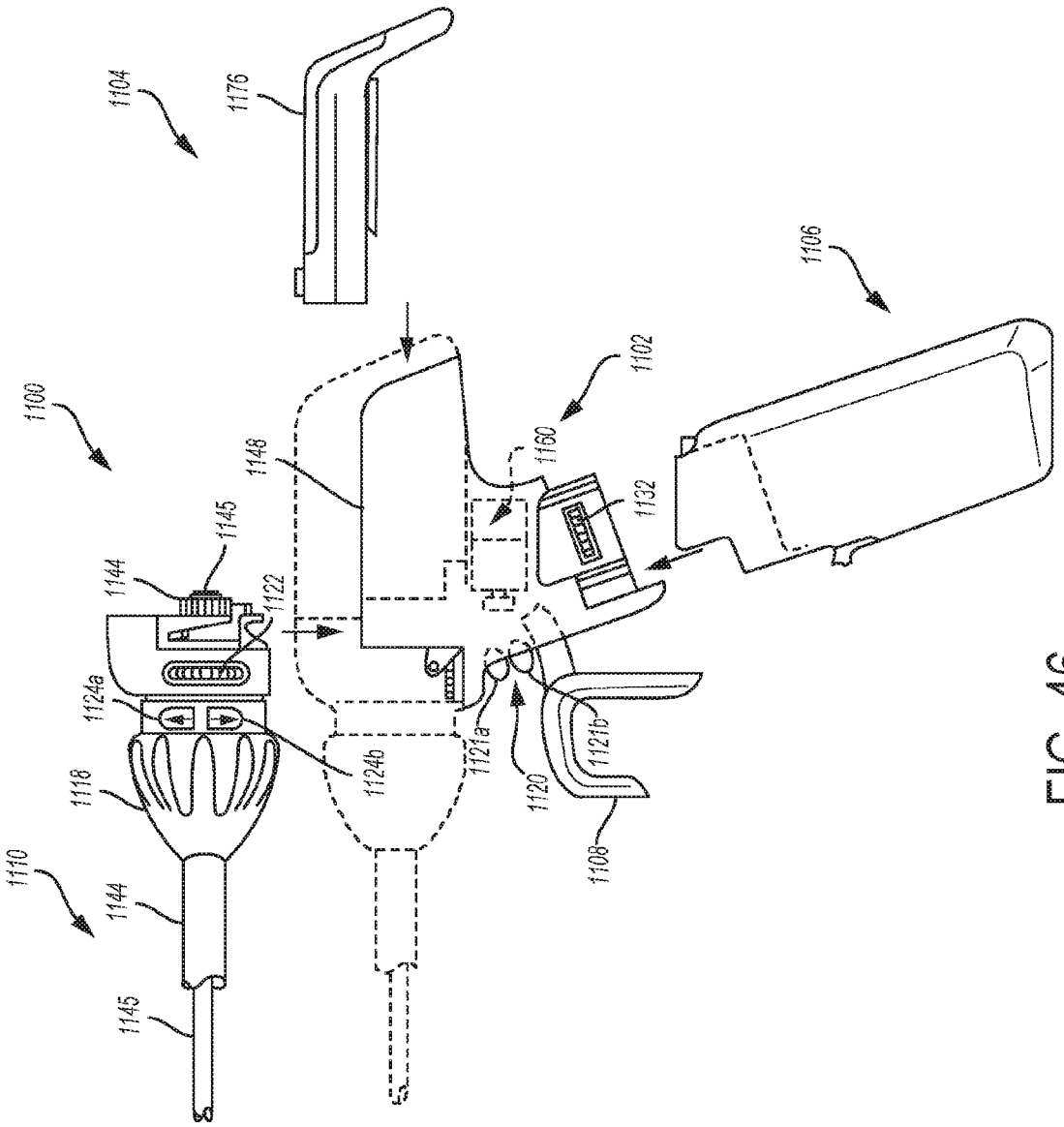

1104
1176
1106
1100
1102
1148
1160
1132
1145
1144
1122
1124a
1124b
1121a
1121b
1120
1118
1108
1110
1144
1145

FIG. 46

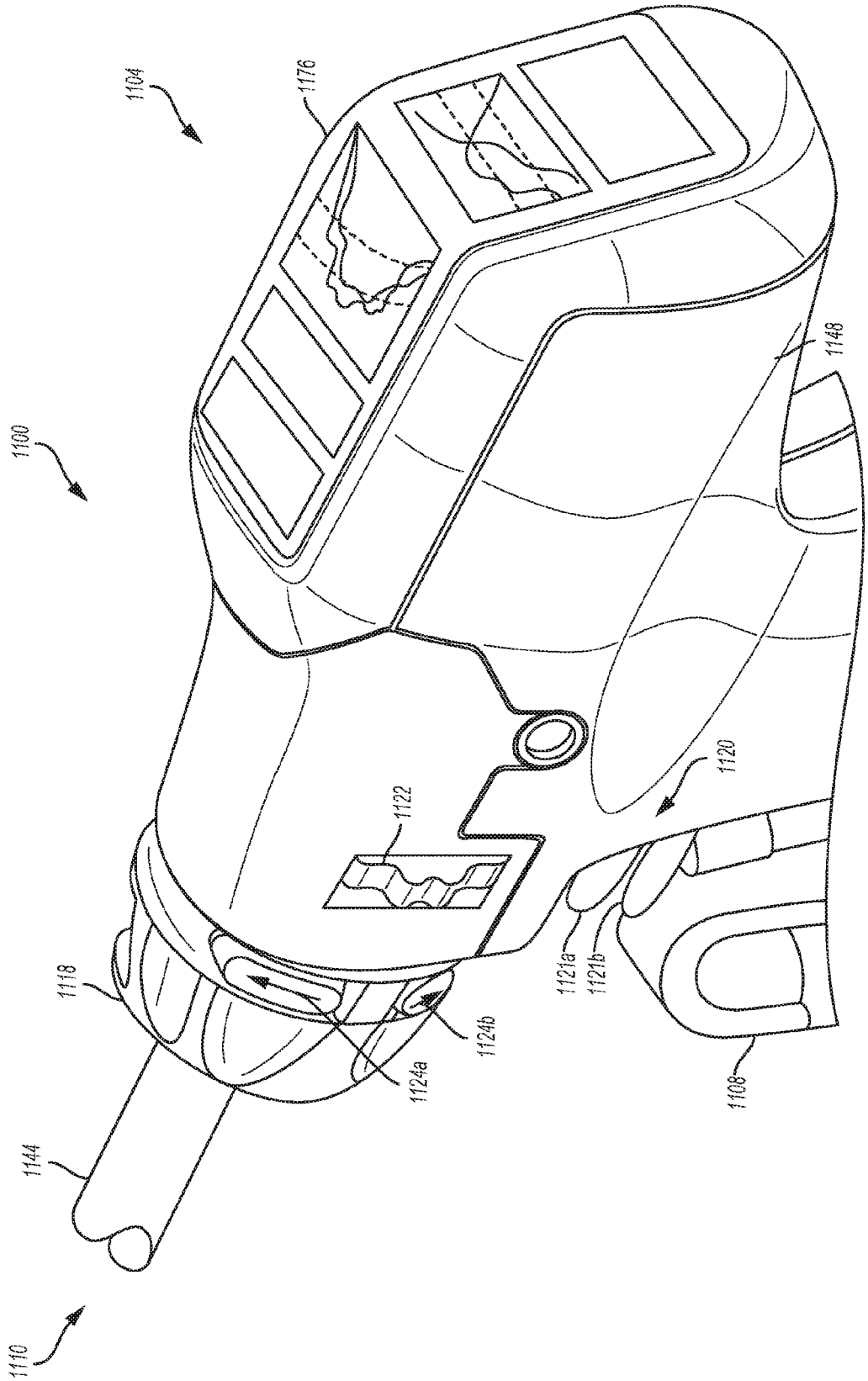

1104
1176
1148
1100
1102
1120
1122
1121a
1121b
1118
1124b
1124a
1108
1144
1110

FIG. 47

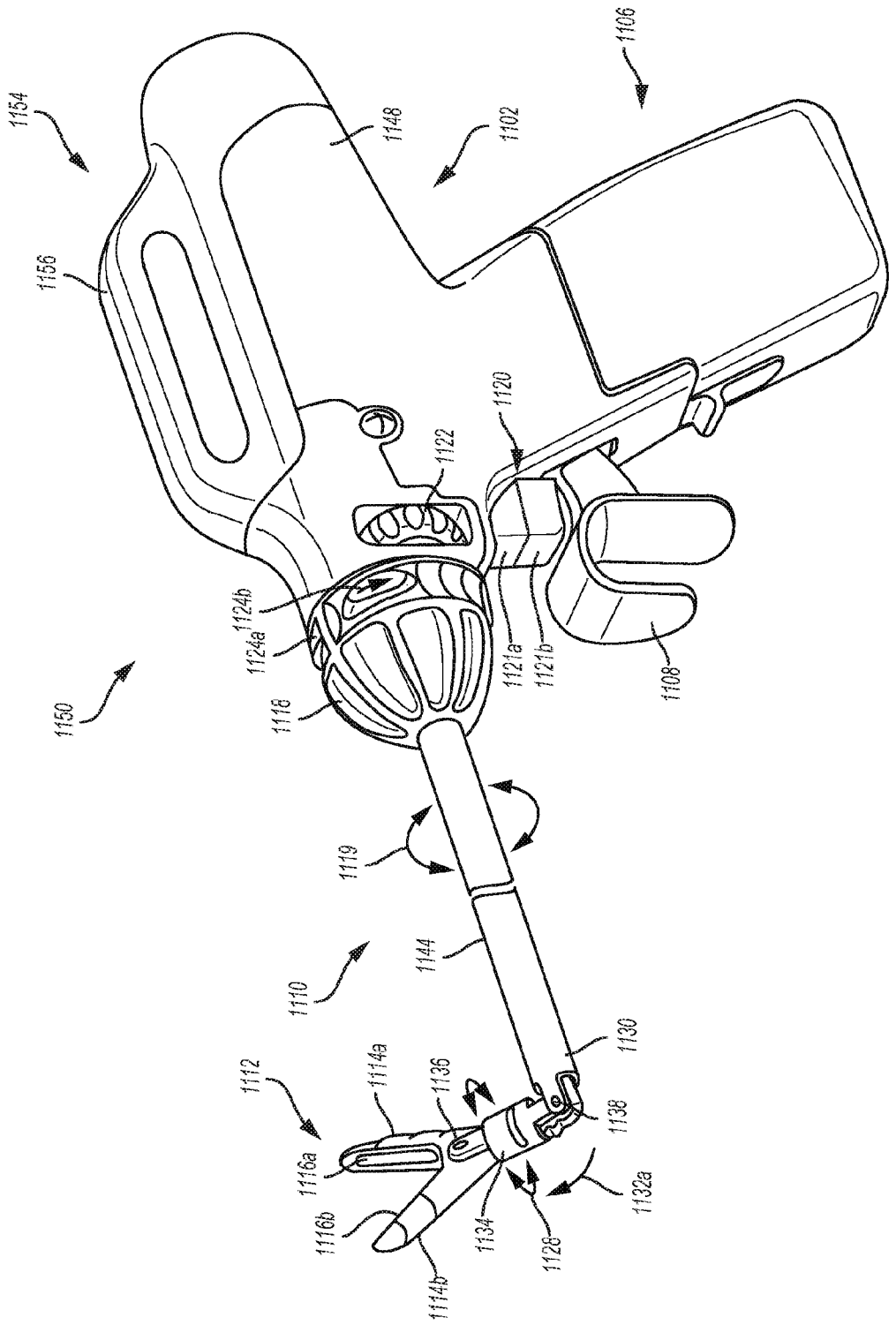

1154
1148
1102
1106
1156
1120
1122
1124b
1124a
1121a
1121b
1108
1150
1118
1119
1144
1110
1130
1112
1114a
1136
1138
1116a
1132a
1116b
1134
1128
1114b

FIG. 48

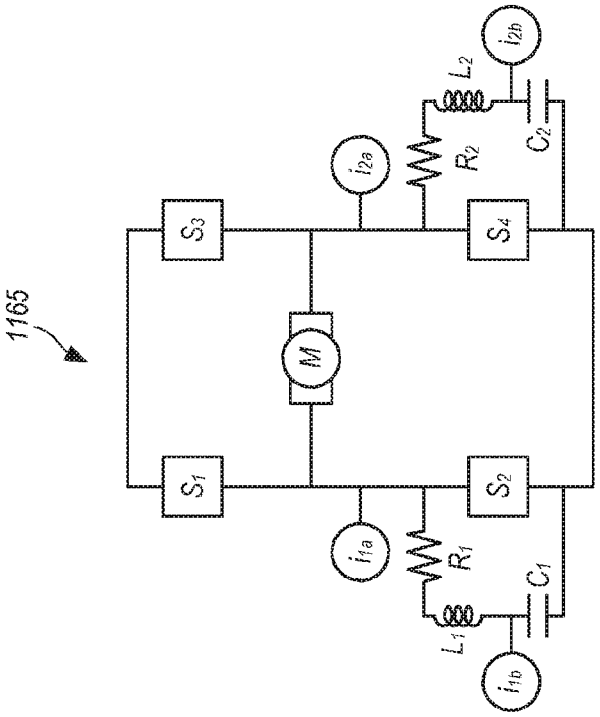

1165
M
S1
S2
S3
S4
R1
R2
C1
C2
L1
L2
i1a
i1b
i2a
i2b

FIG. 50

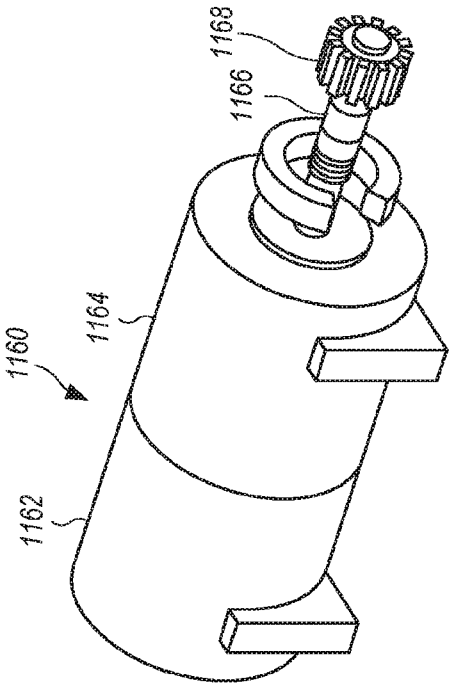

1160
1162
1164
1166
1168

FIG. 49

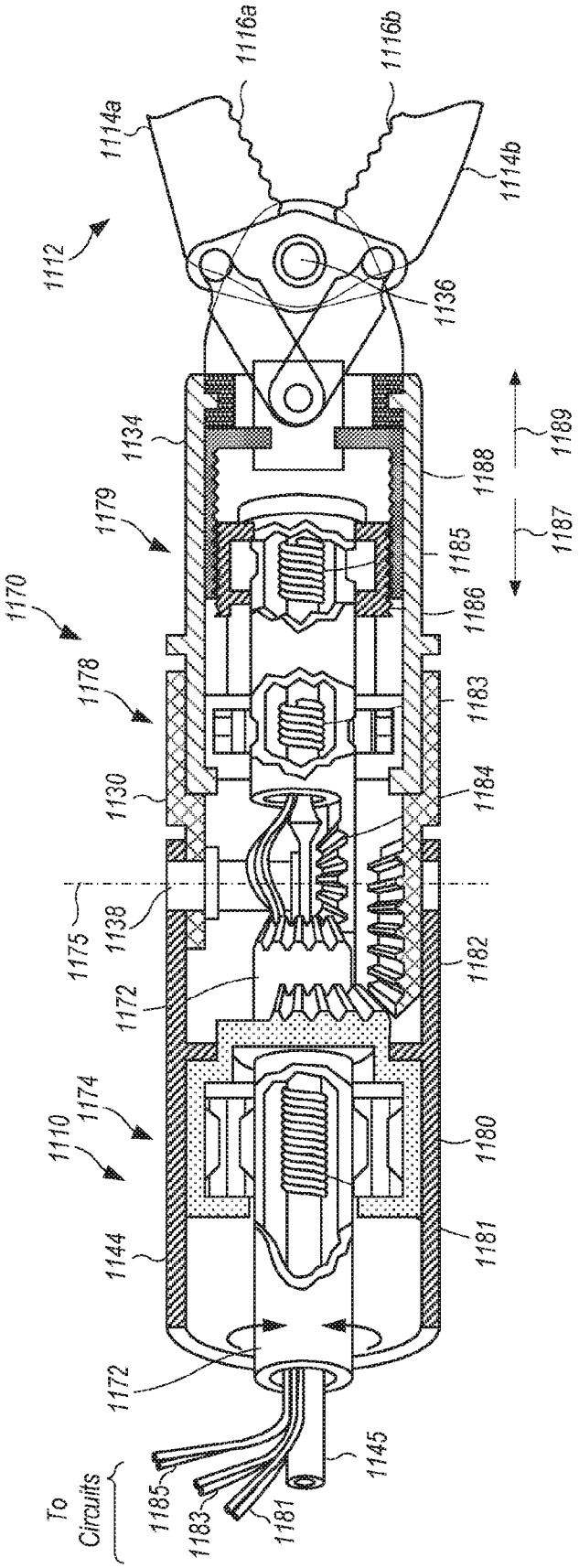


FIG. 51

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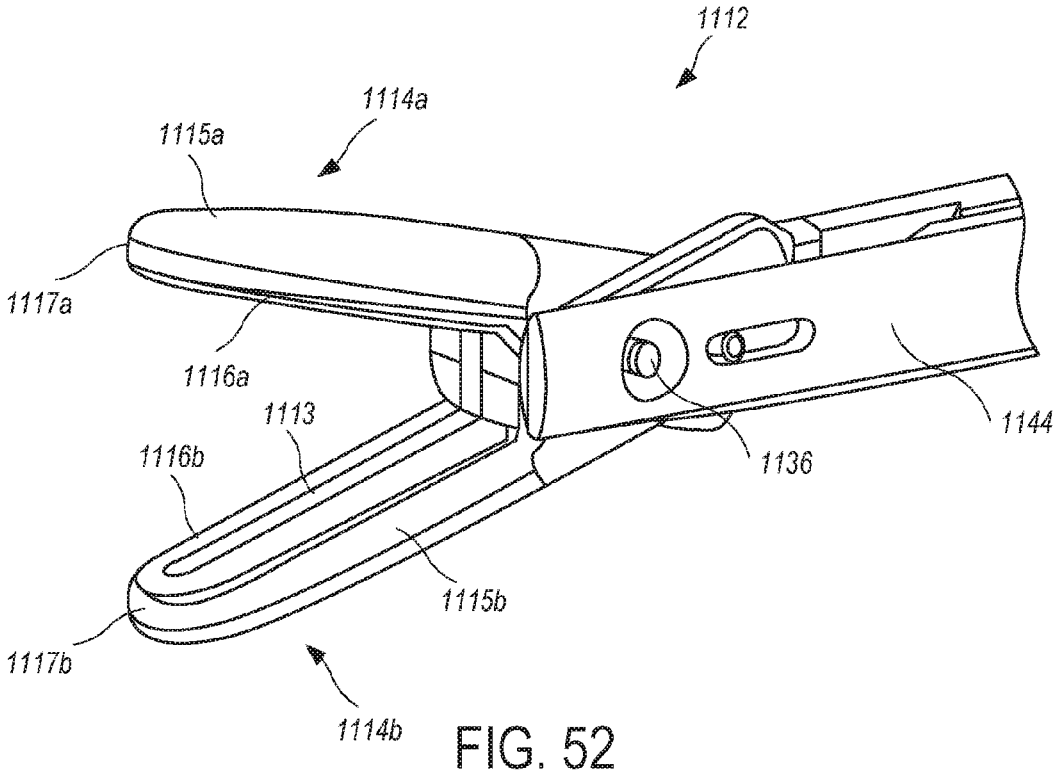

1112
1114a
1115a
1117a
1116a
1113
1116b
1136
1144
1115b
1117b
1114b

FIG. 52

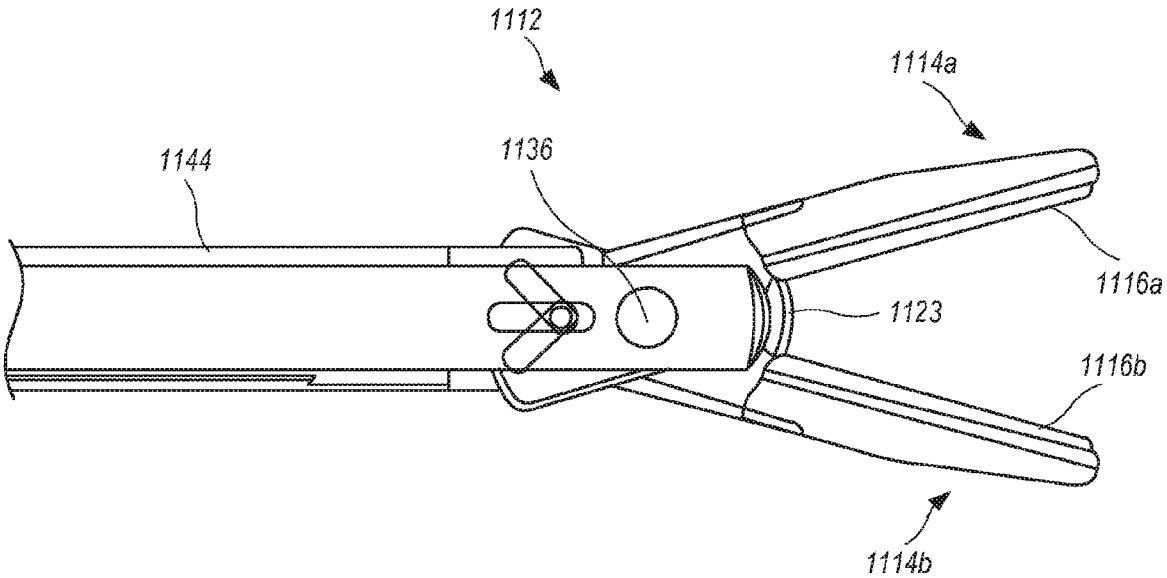

1112
1114a
1144
1136
1116a
1123
1116b
1114b

FIG. 53

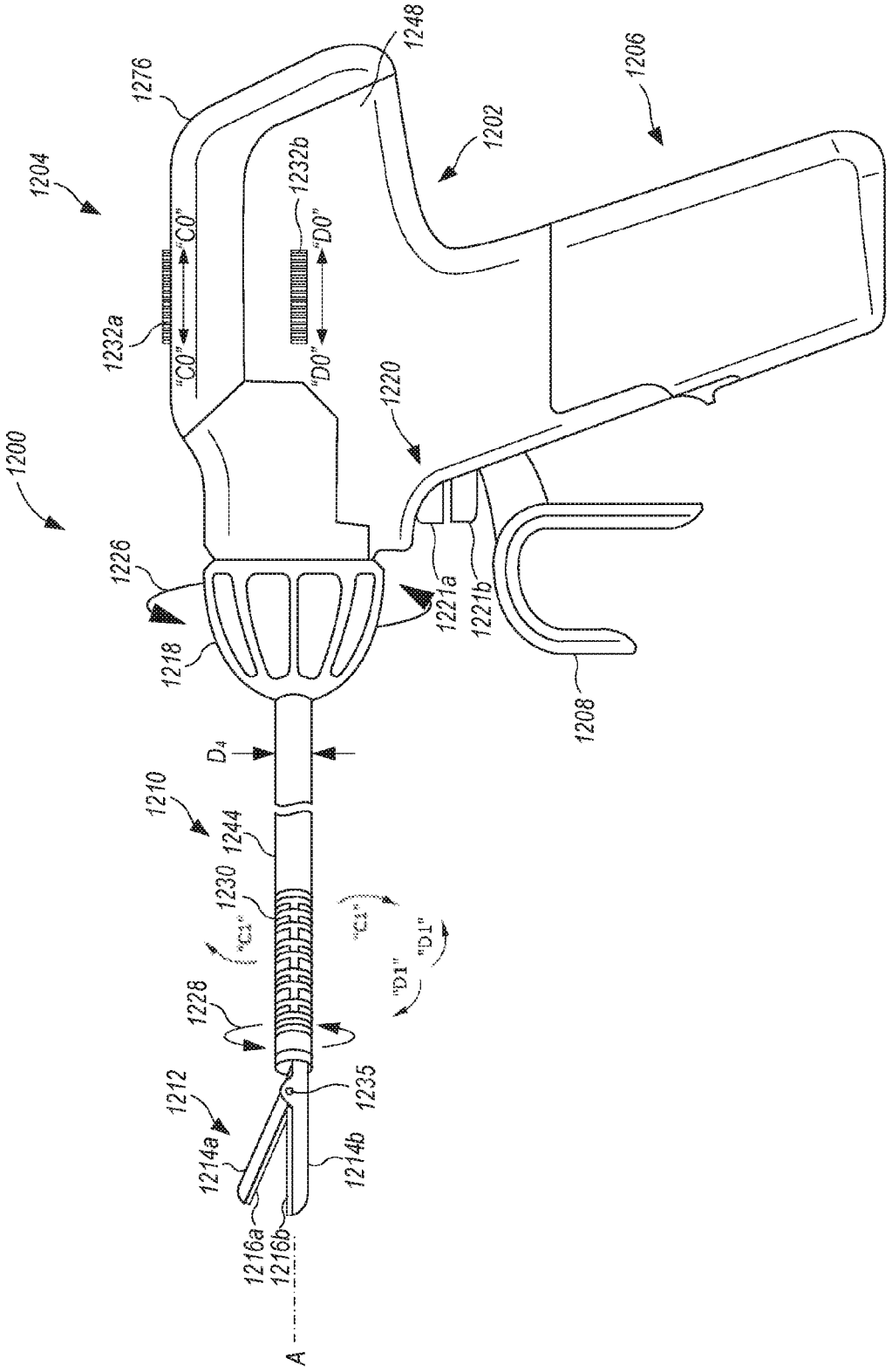

1200
1202
1204
1206
1208
1210
1212
1214a
1214b
1216a
1216b
1218
1220
1221a
1221b
1226
1228
1230
1232a
1232b
1235
1244
1248
1276
"C0"
"C0"
"D0"
"D0"
"C1"
"C1"
"D1"
"D1"
D4
A

FIG. 54

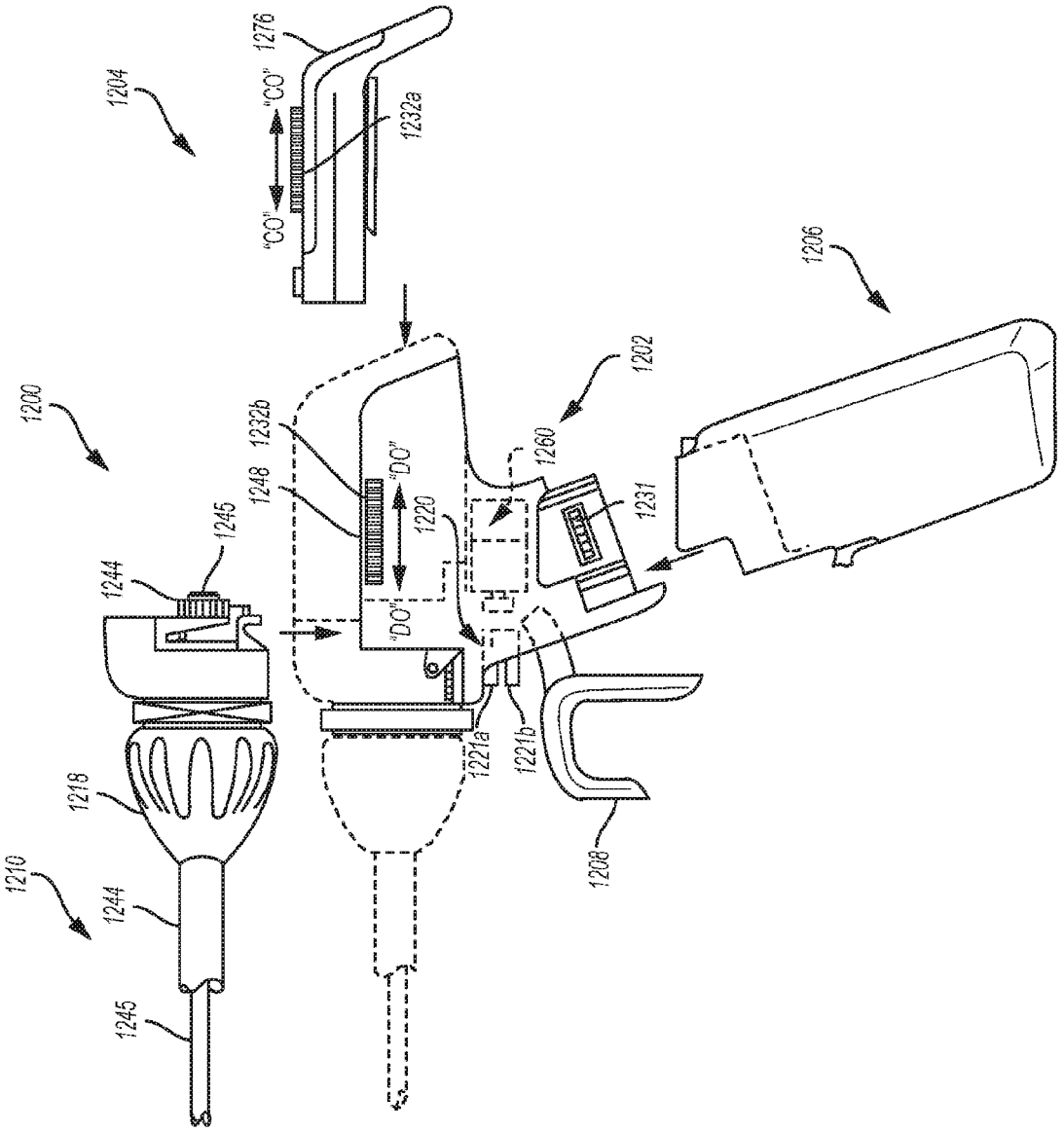

1276
"CO"
1232a
"CO"
1204
1206
1202
1200
1232b
"DO"
1260
1248
1220
1231
1245
1244
"DO"
1221a
1221b
1218
1208
1210
1244
1245

FIG. 55

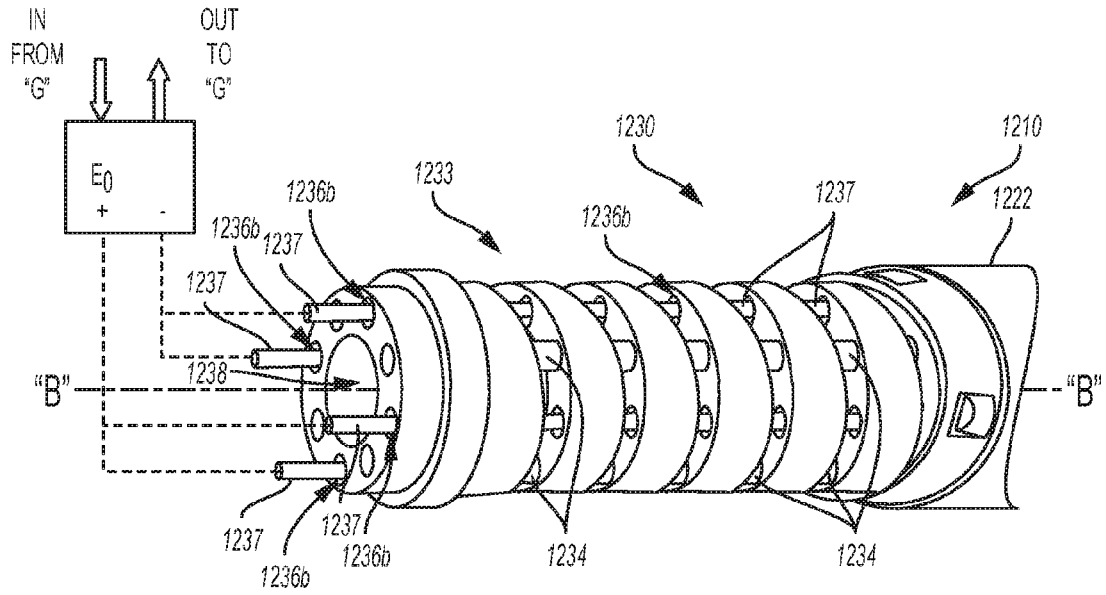

IN
FROM
"G"
OUT
TO
"G"
E_0
+
-
1230
1210
1233
1236b
1237
1222
1238
"B"
1234

FIG. 56

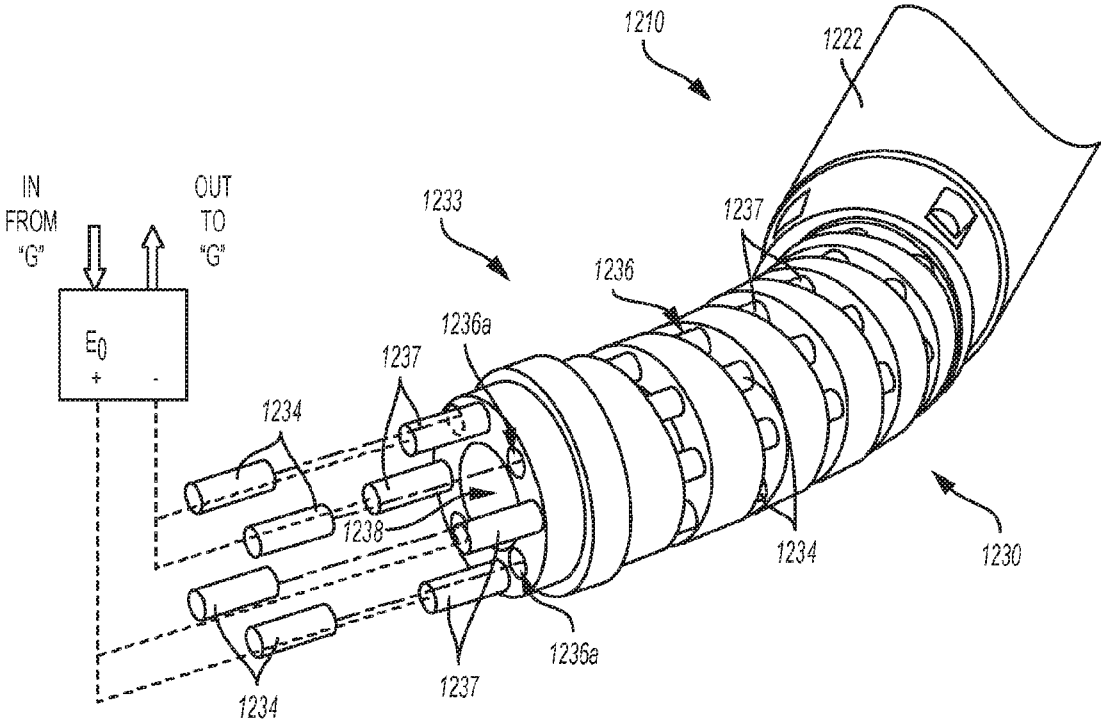

IN
FROM
"G"
OUT
TO
"G"
E_0
+
-
1210
1222
1233
1237
1236
1236a
1234
1238
1230
"B"

FIG. 57

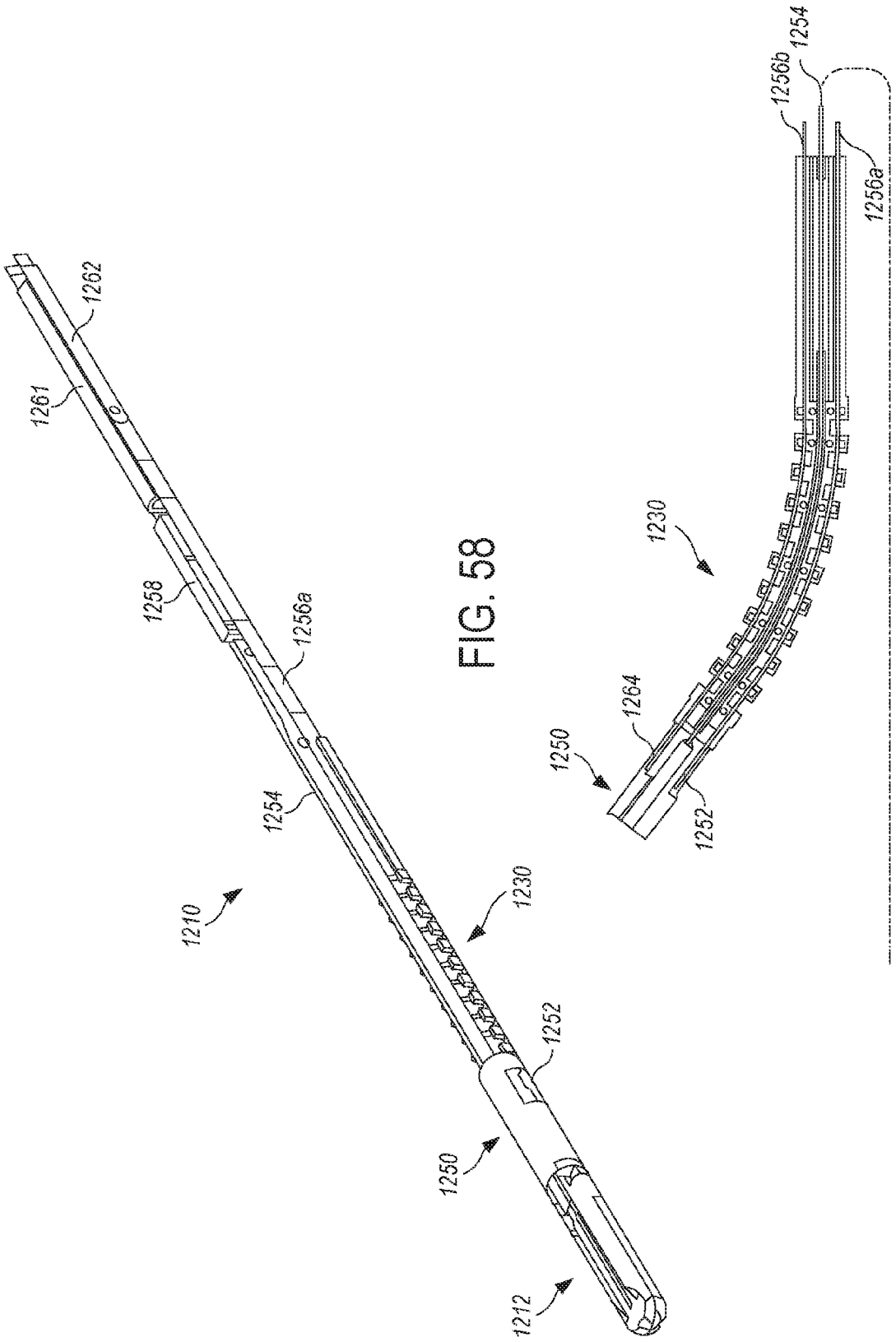


FIG. 58

FIG. 59

MassagerPriorArt0002729

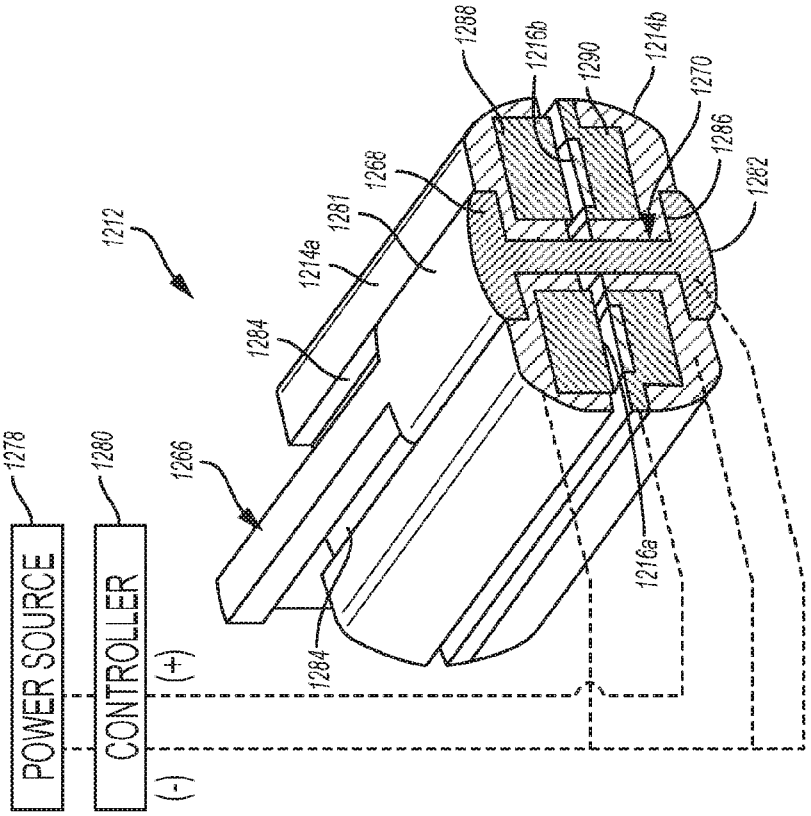


FIG. 61

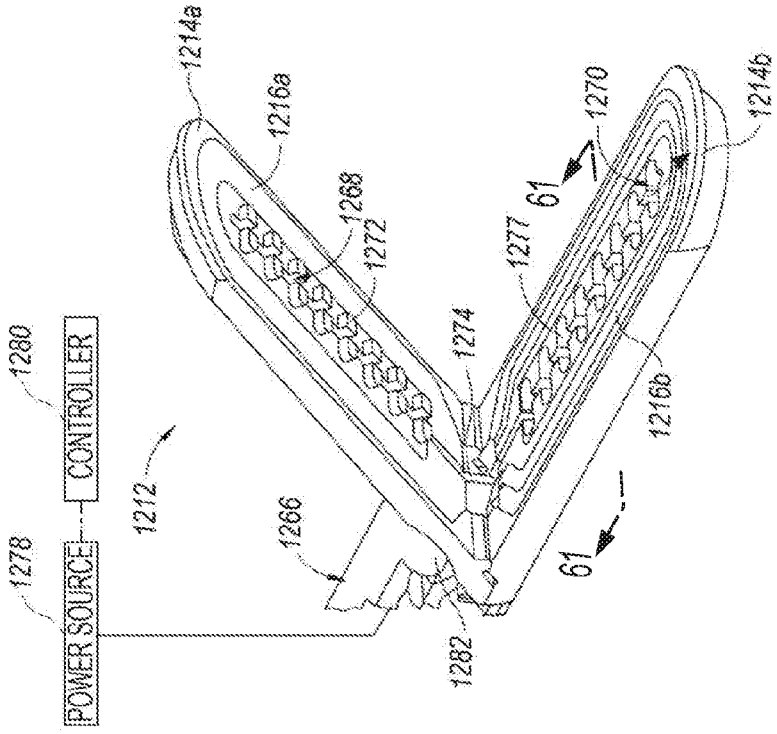


FIG. 60

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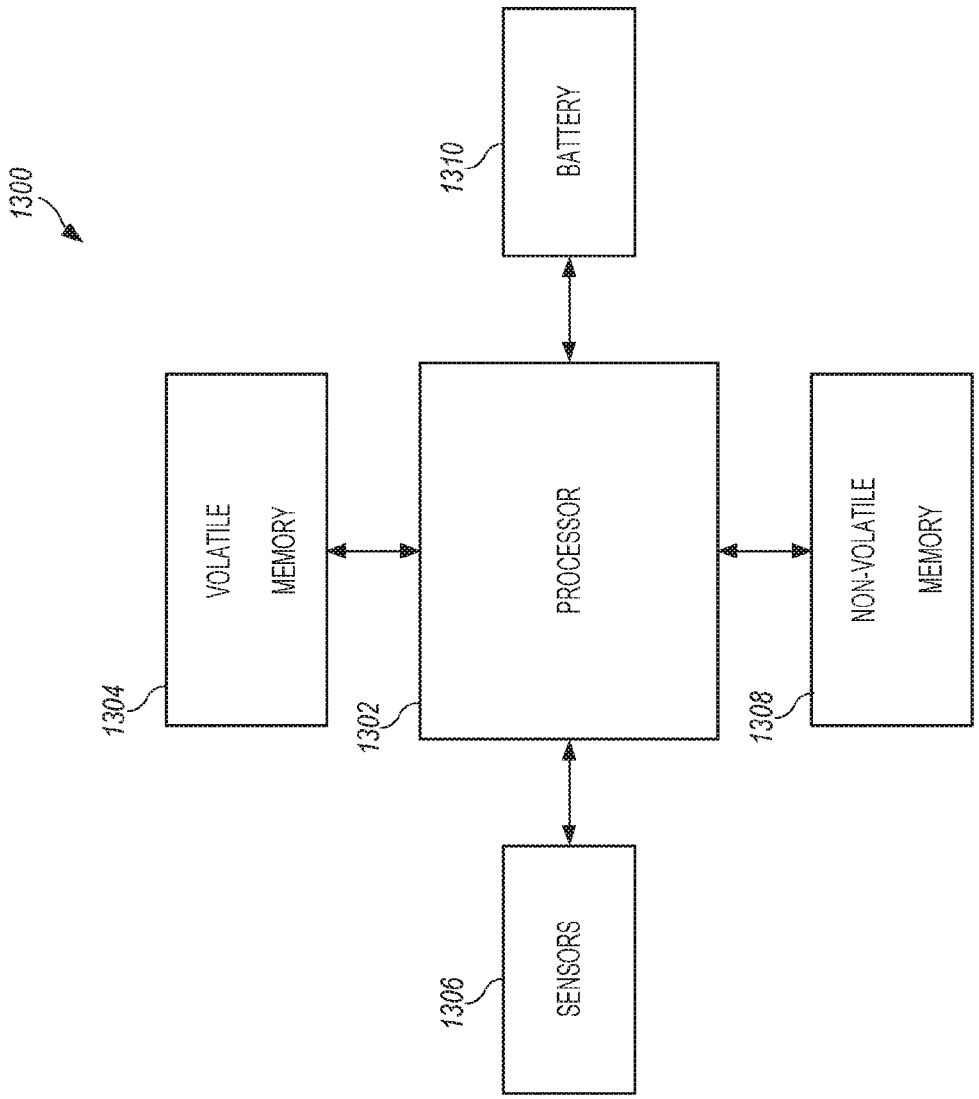

1300
1310
BATTERY
VOLATILE MEMORY
PROCESSOR
NON-VOLATILE MEMORY
1304
1302
1308
SENSORS
1306

FIG. 62

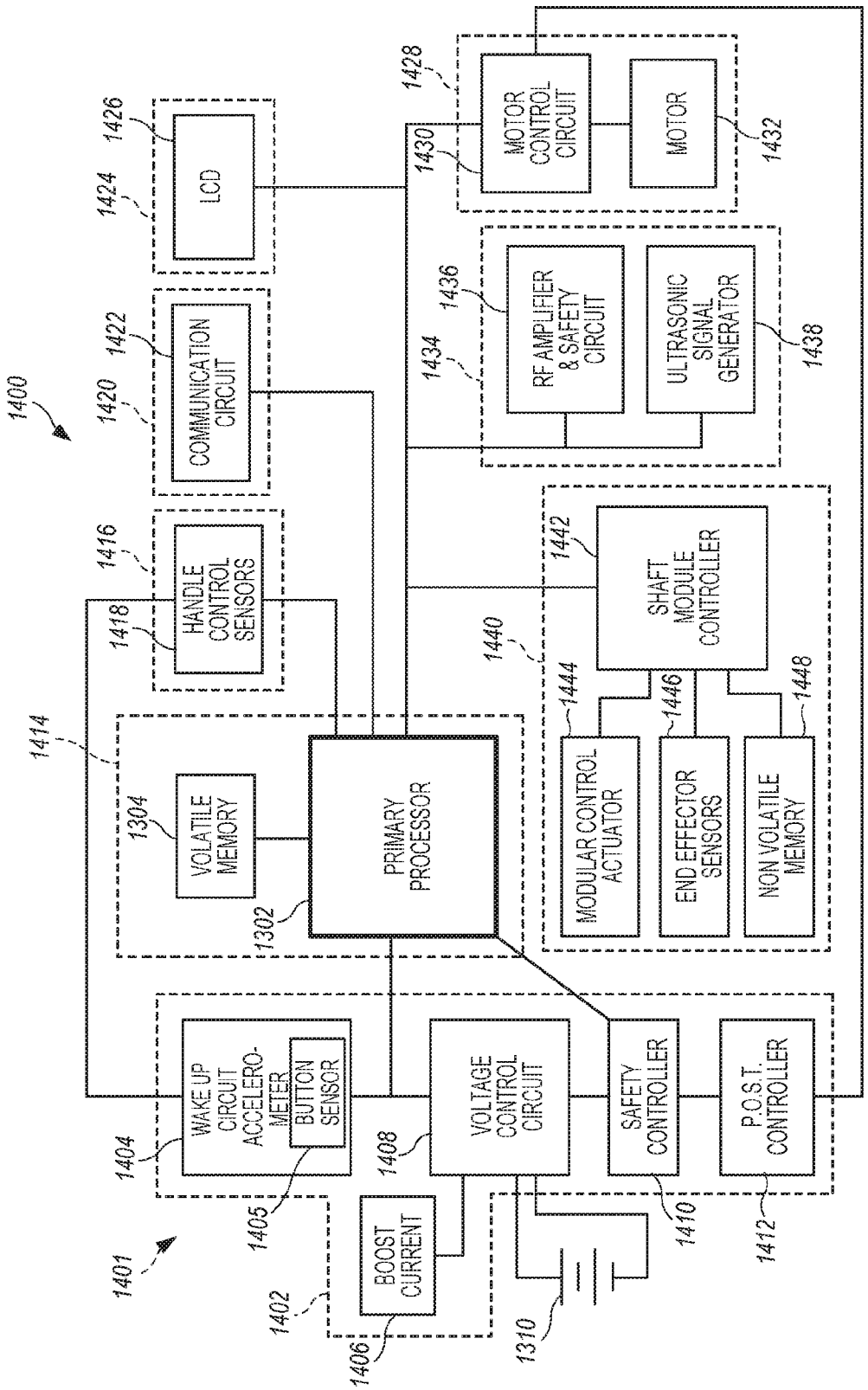


FIG. 63

MassagerPriorArt0002732

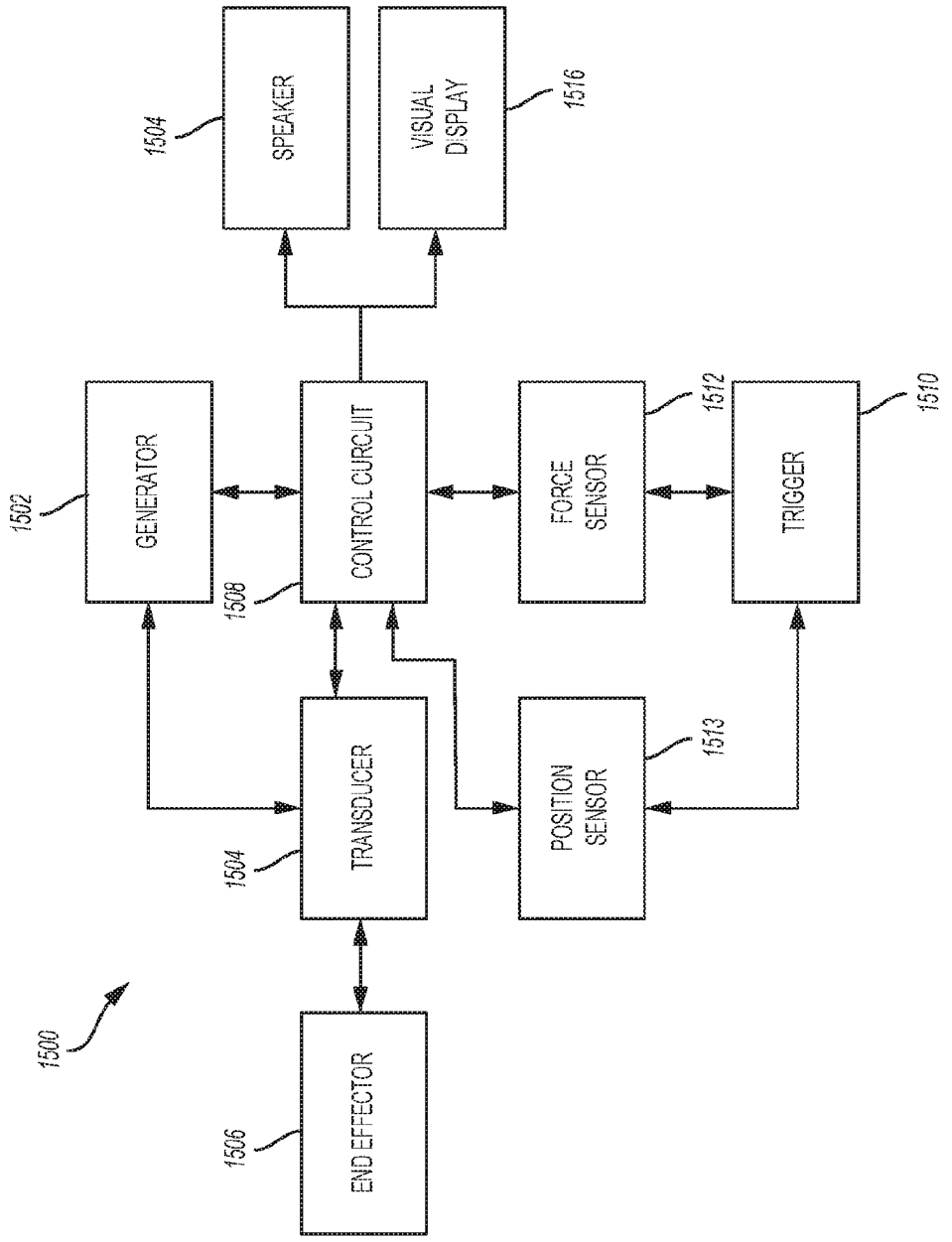

1504
SPEAKER
VISUAL DISPLAY
1516
1502
GENERATOR
CONTROL CURCUIT
1508
FORCE SENSOR
1512
TRIGGER
1510
TRANSDUCER
1504
POSITION SENSOR
1513
1500
END EFFECTOR
1506

FIG. 64

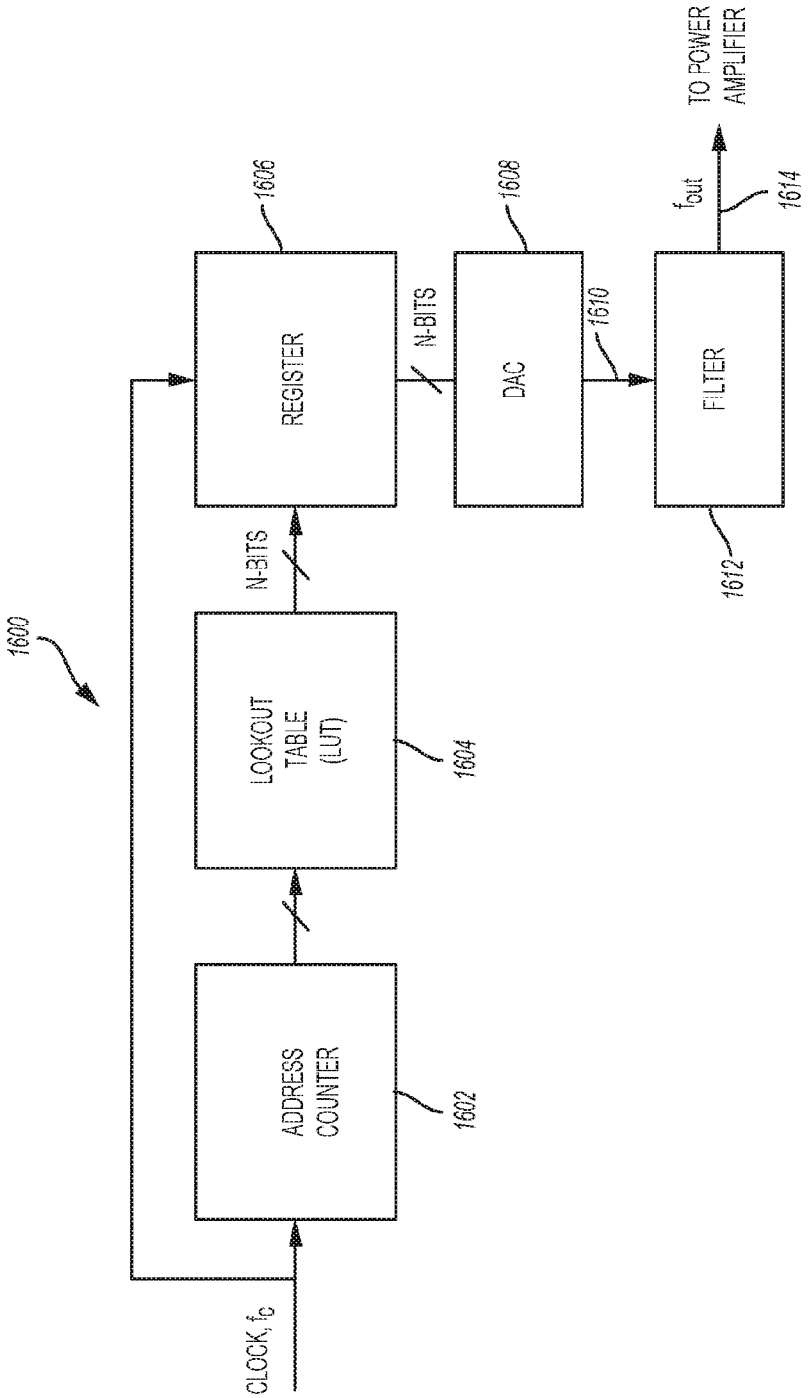

1600
CLOCK, f_c
ADDRESS COUNTER
1602
LOOKOUT TABLE (LUT)
1604
N-BITS
REGISTER
1606
N-BITS
DAC
1608
1610
FILTER
1612
f_{out}
1614
TO POWER AMPLIFIER

FIG. 65

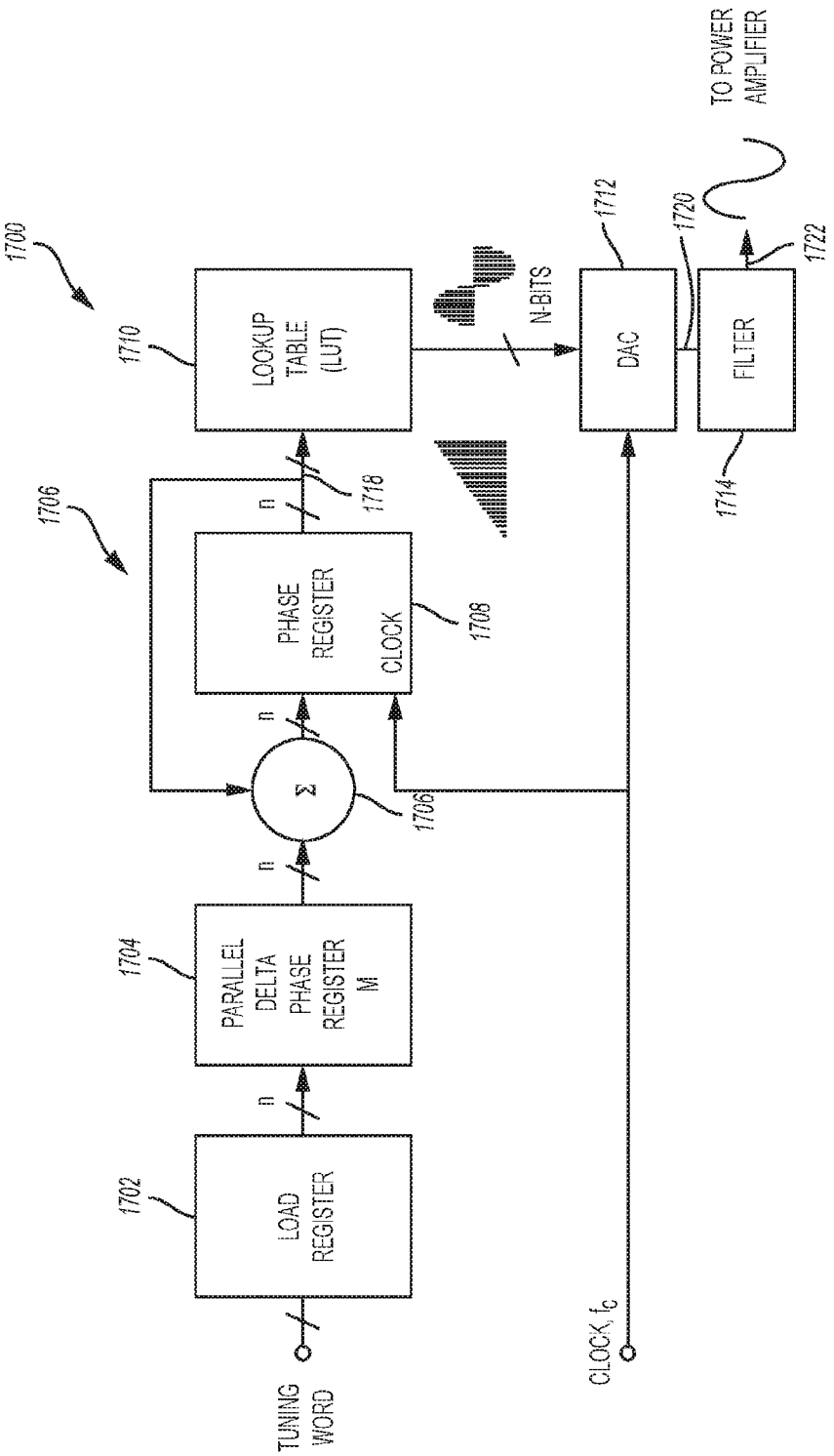

1700
1710
LOOKUP TABLE (LUT)
N-BITS
1712
DAC
1720
TO POWER AMPLIFIER
1722
FILTER
1714
1706
1718
n
PHASE REGISTER
CLOCK
1708
n
Σ
1706
n
1704
PARALLEL DELTA PHASE REGISTER M
n
1702
LOAD REGISTER
TUNING WORD
CLOCK, f_C

FIG. 66

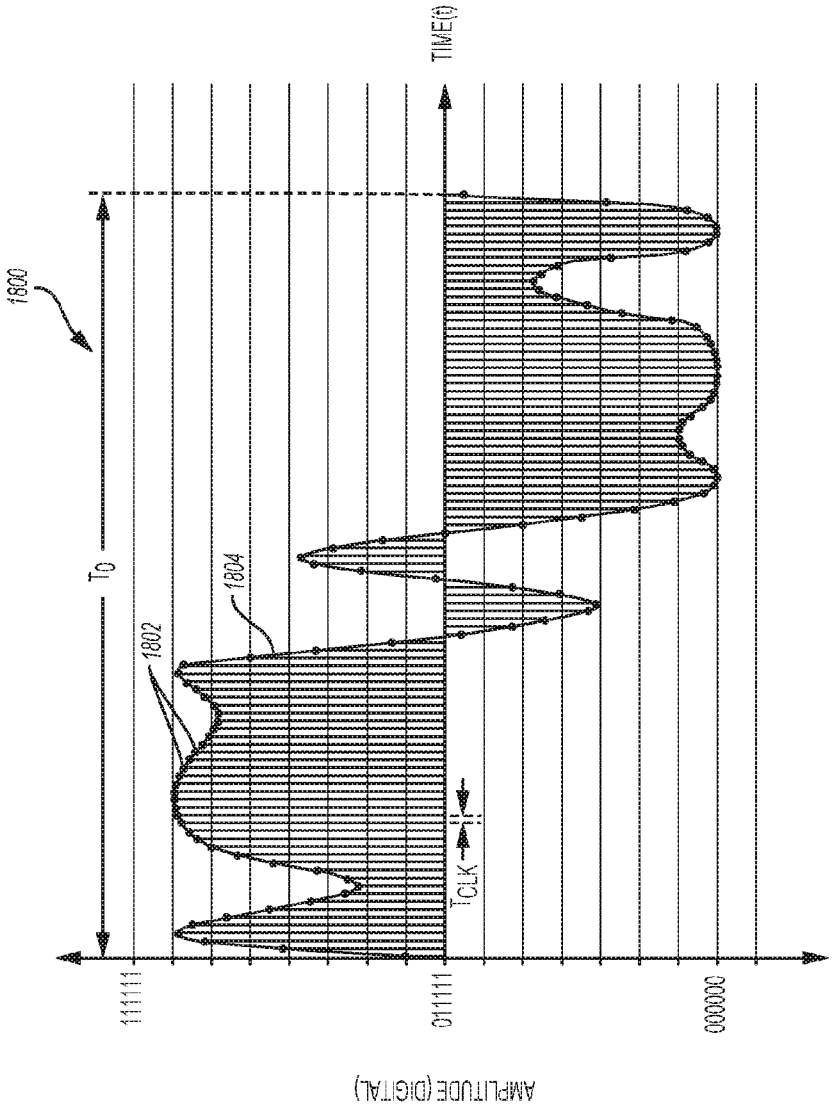

TIME(t)
1800
To
1802
1804
TCLK
111111
011111
000000
AMPLITUDE (DIGITAL)

FIG. 67

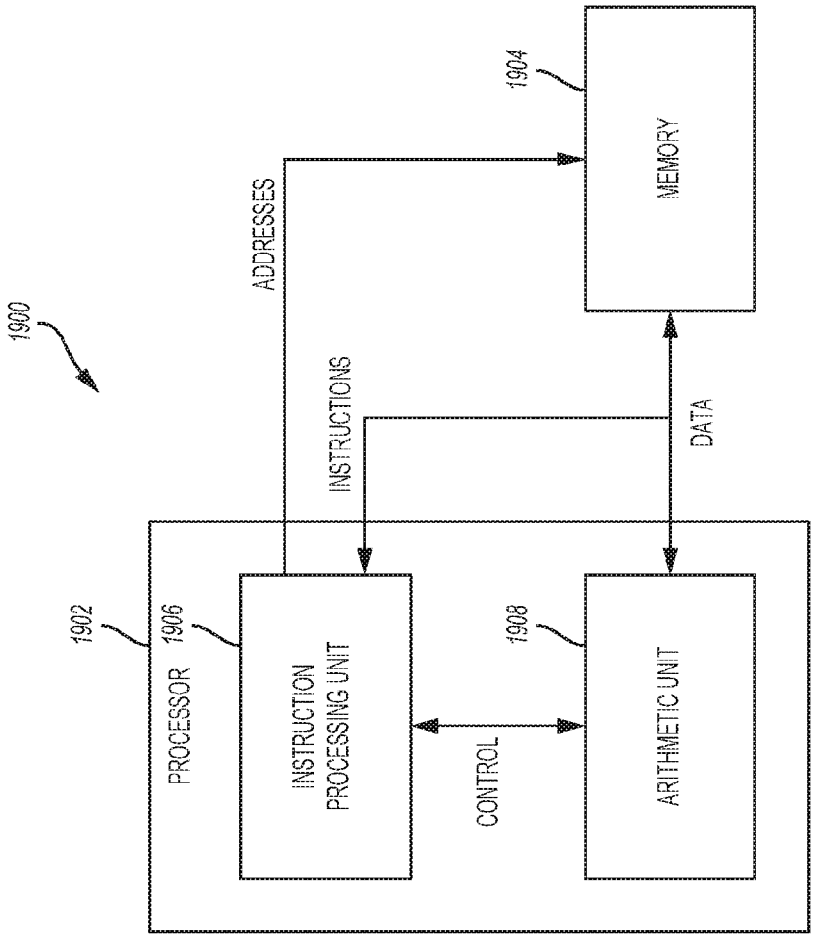

1900
1904
MEMORY
ADDRESSES
INSTRUCTIONS
DATA
1902
PROCESSOR
1906
INSTRUCTION PROCESSING UNIT
1908
ARITHMETIC UNIT
CONTROL

FIG. 68A

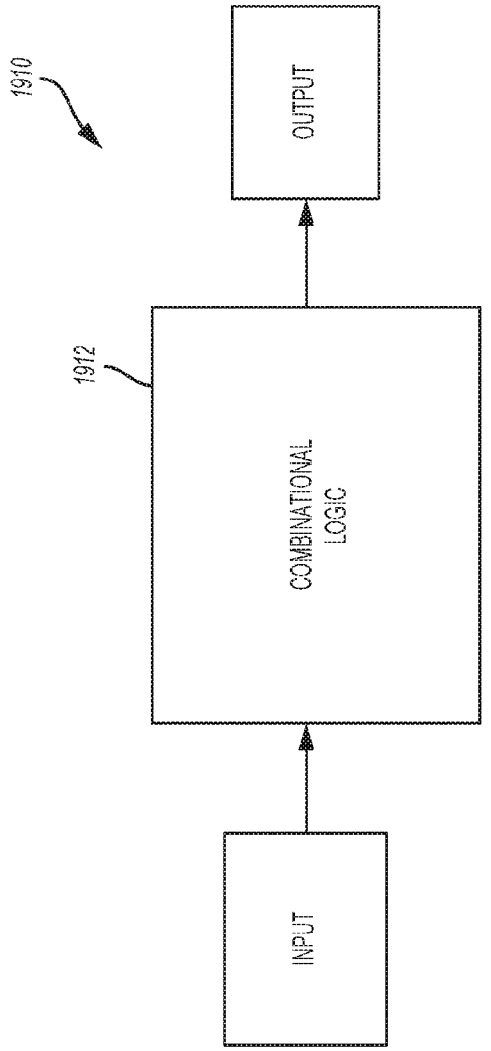


FIG. 68B

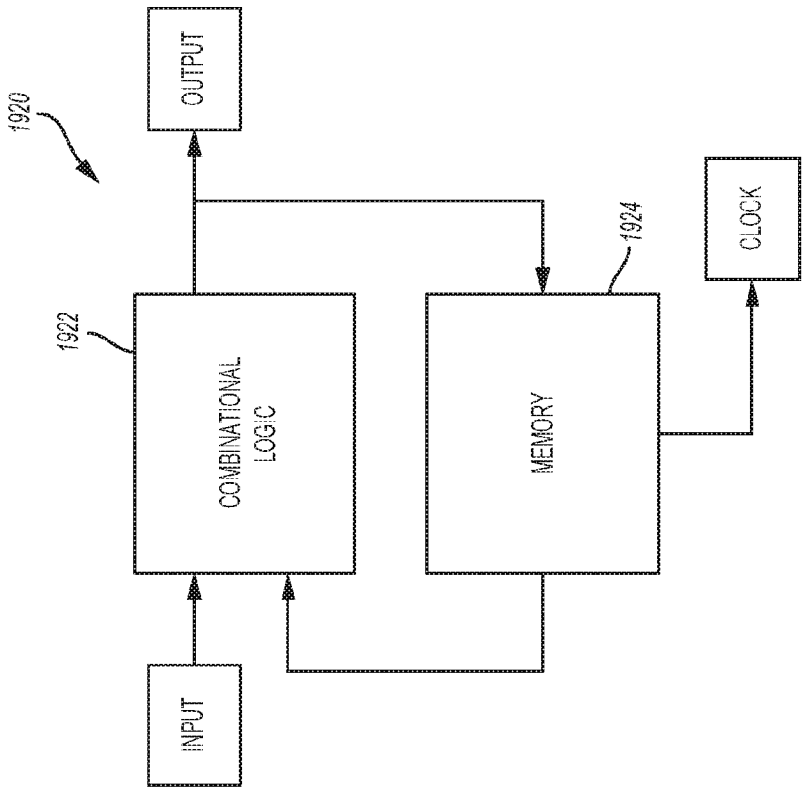

1920
OUTPUT
1922
COMBINATIONAL LOGIC
1924
MEMORY
CLOCK
INPUT

FIG. 68C

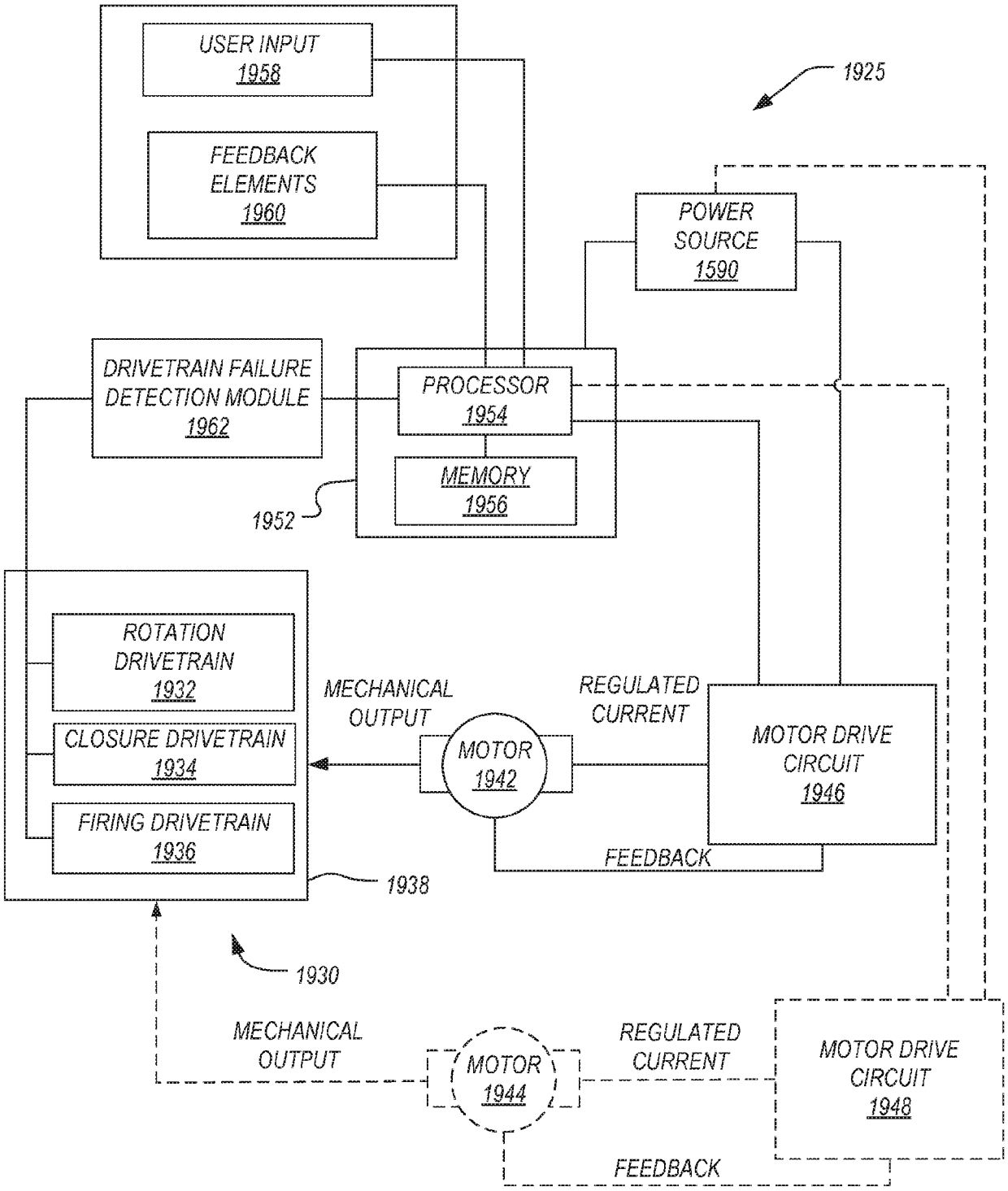


FIG. 69

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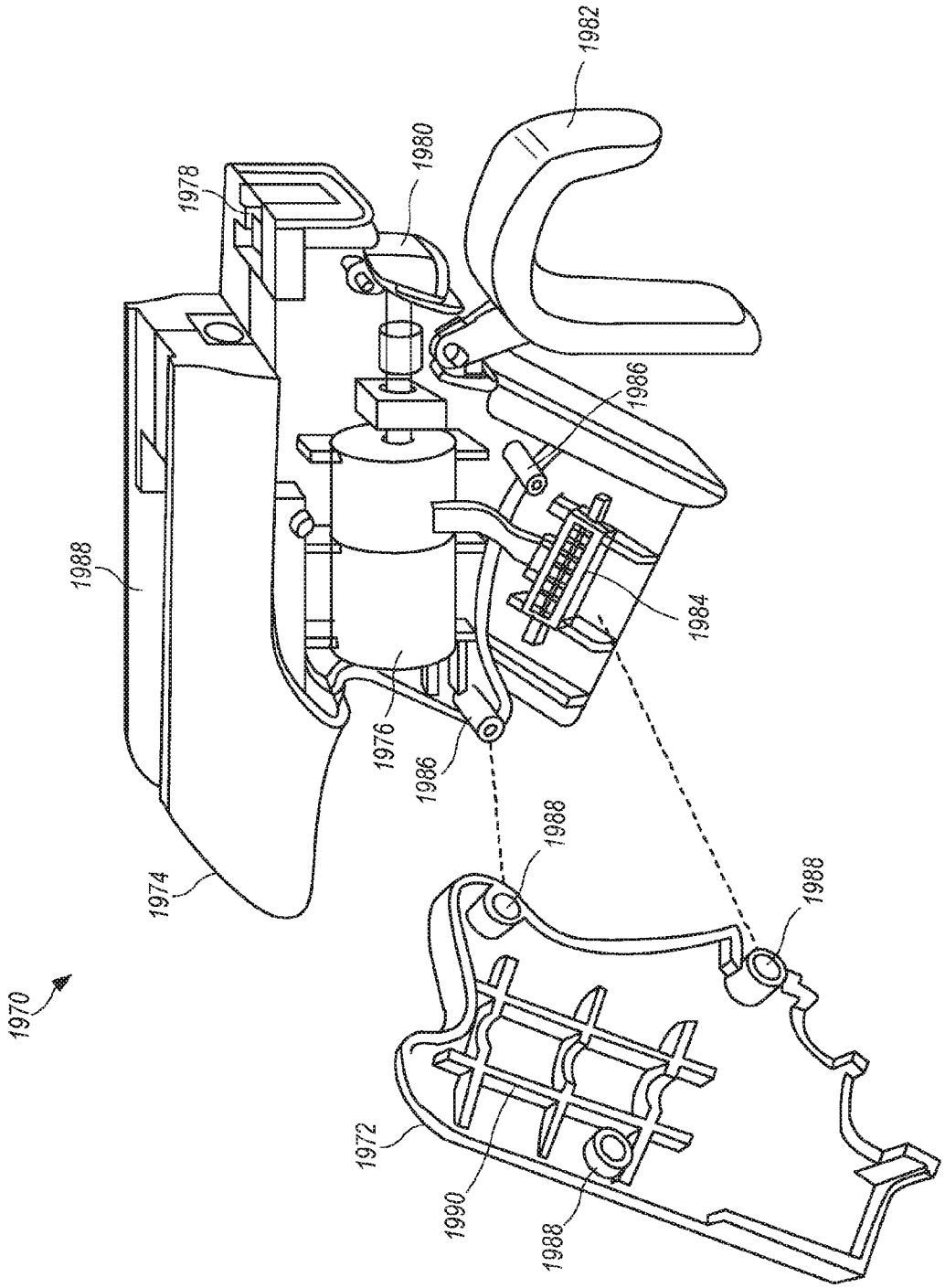

1982
1980
1978
1986
1988
1984
1976
1986
1988
1974
1988
1988
1970
1972
1990
1988

FIG. 70

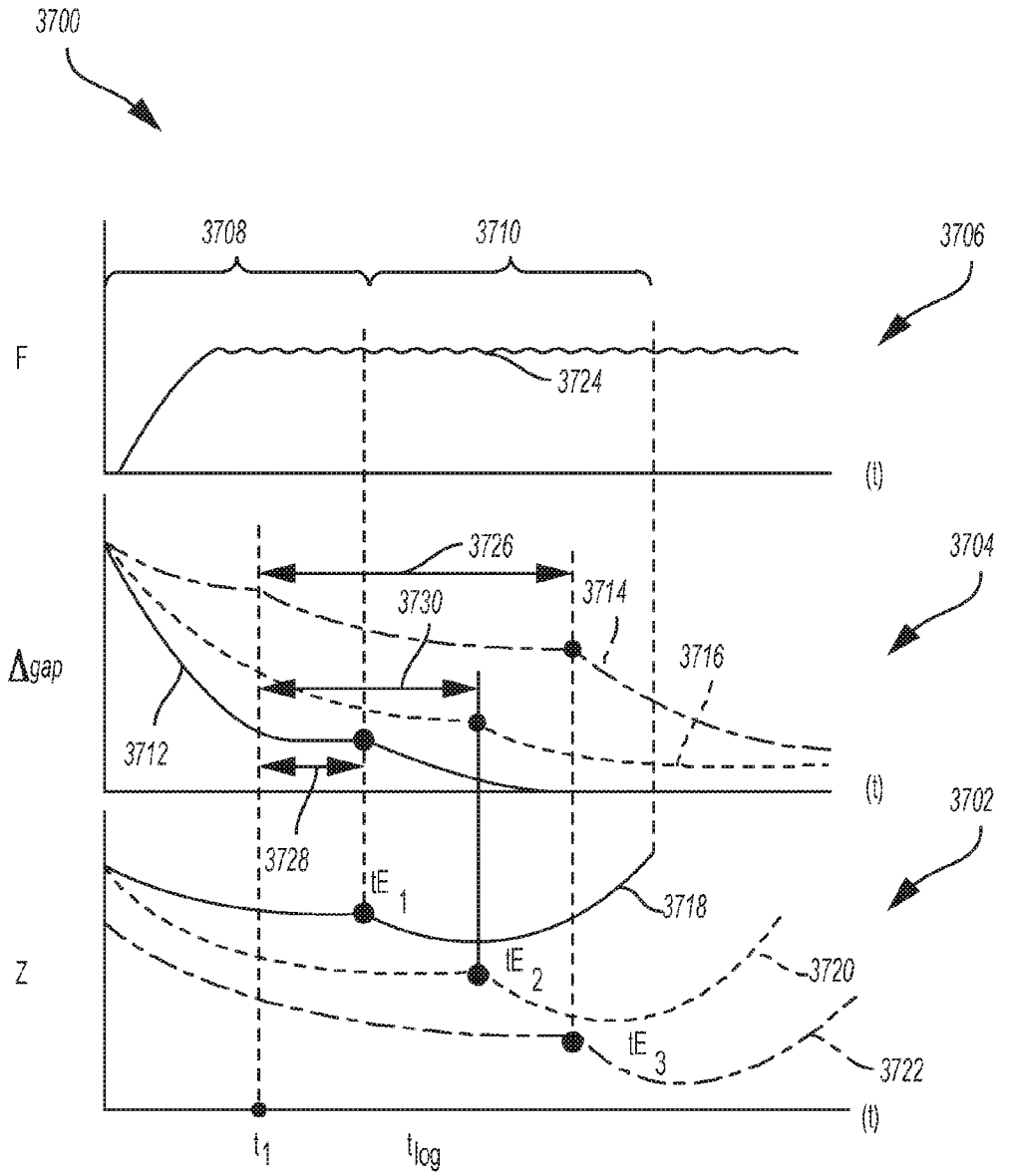

3700
3708
3710
3706
F
3724
(t)
3726
3704
3714
3730
3716
Δgap
3712
(t)
3728
3702
tE 1
3718
Z
tE 2
3720
tE 3
3722
(t)
t1
tlog

FIG. 71

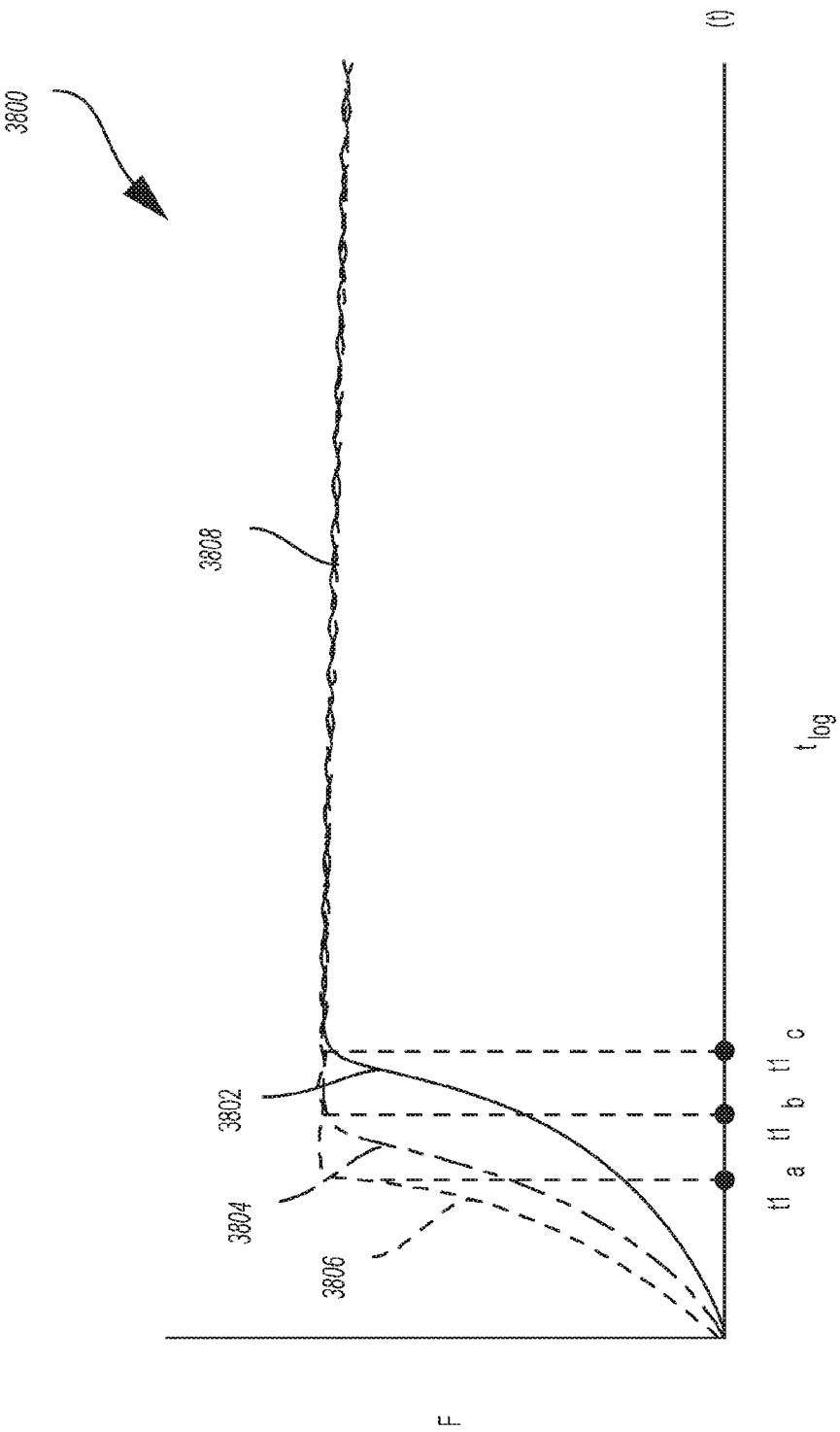


FIG. 72

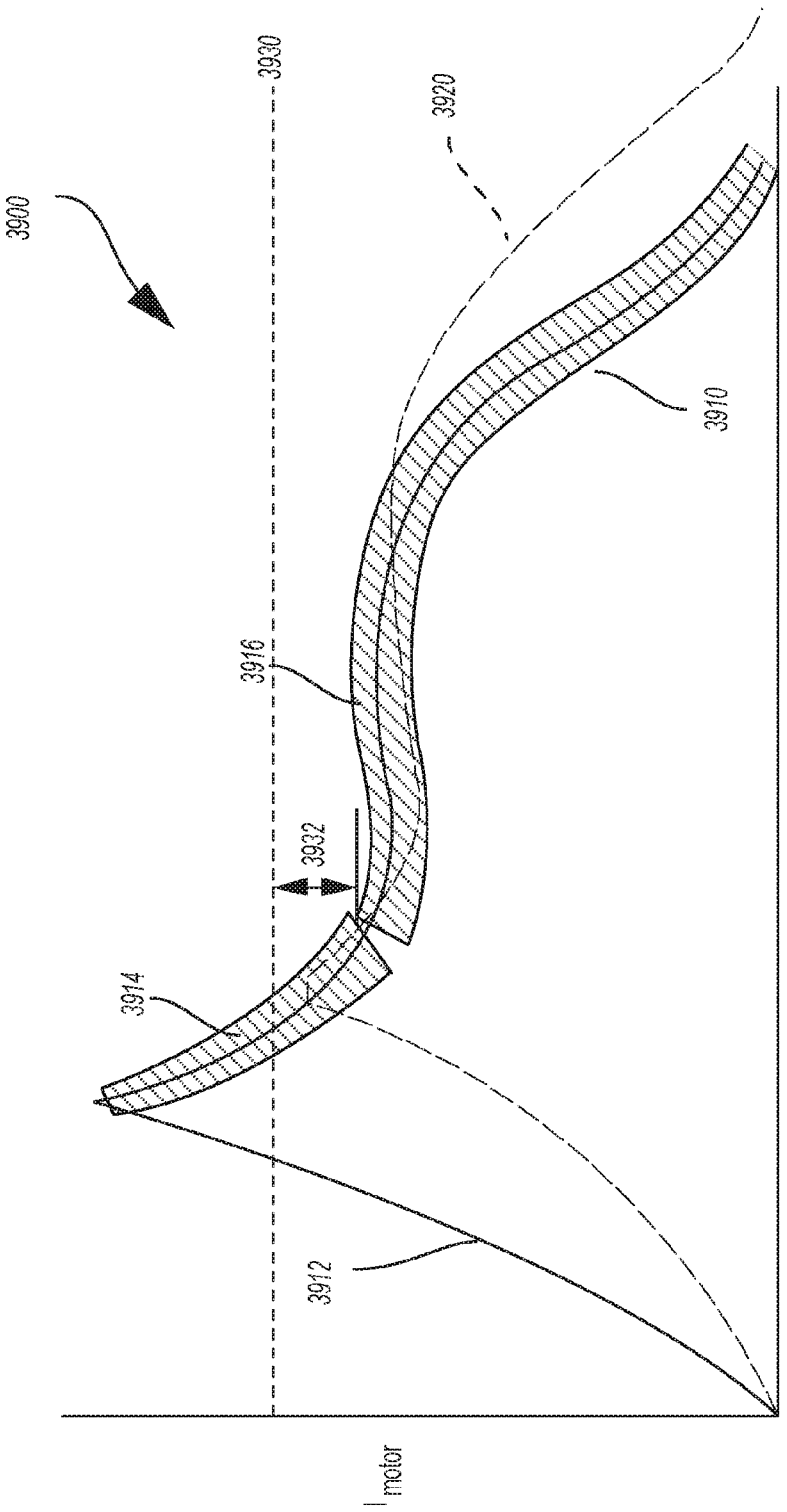


FIG. 73

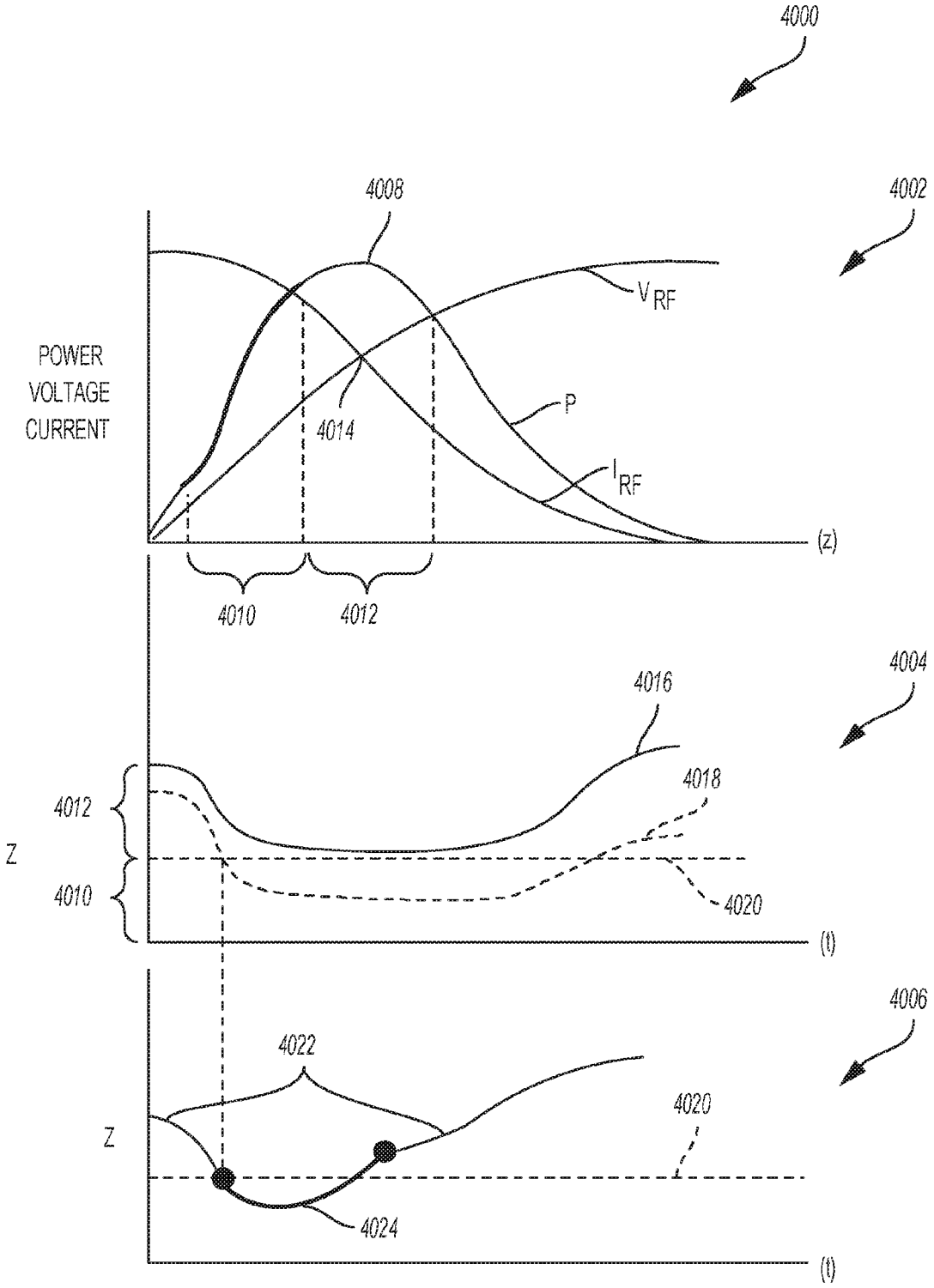

4000
4008
4002
POWER
VOLTAGE
CURRENT
V_{RF}
P
I_{RF}
4014
(z)
4010
4012
4004
4016
4018
4012
Z
4010
4020
(t)
4006
4022
4020
Z
4024
(t)

FIG. 74

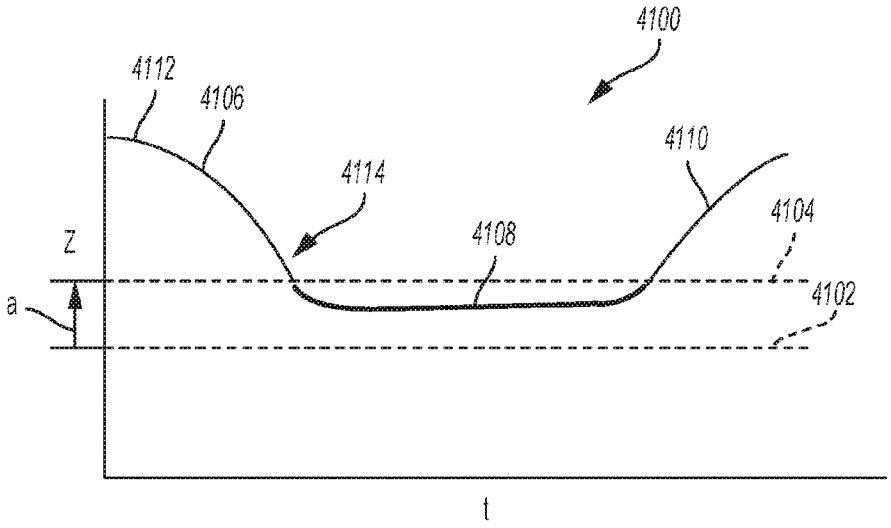


FIG. 75

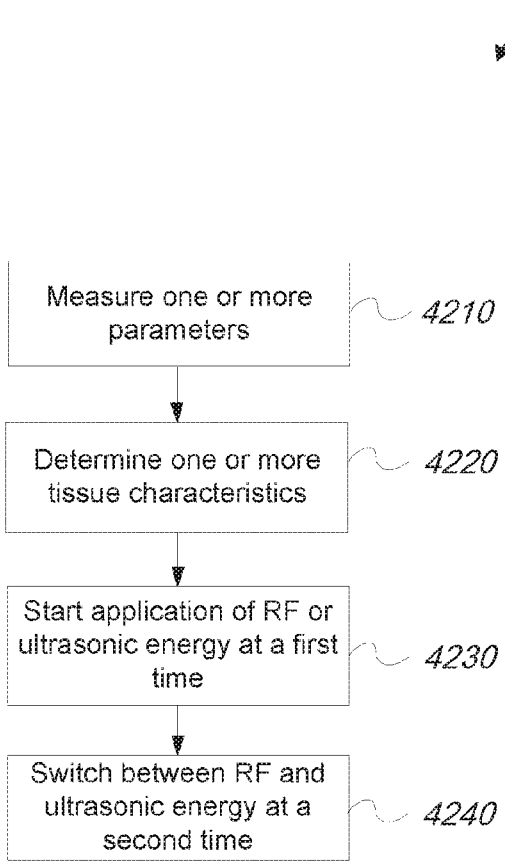

4200
Measure one or more parameters
4210
Determine one or more tissue characteristics
4220
Start application of RF or ultrasonic energy at a first time
4230
Switch between RF and ultrasonic energy at a second time
4240

FIG. 76

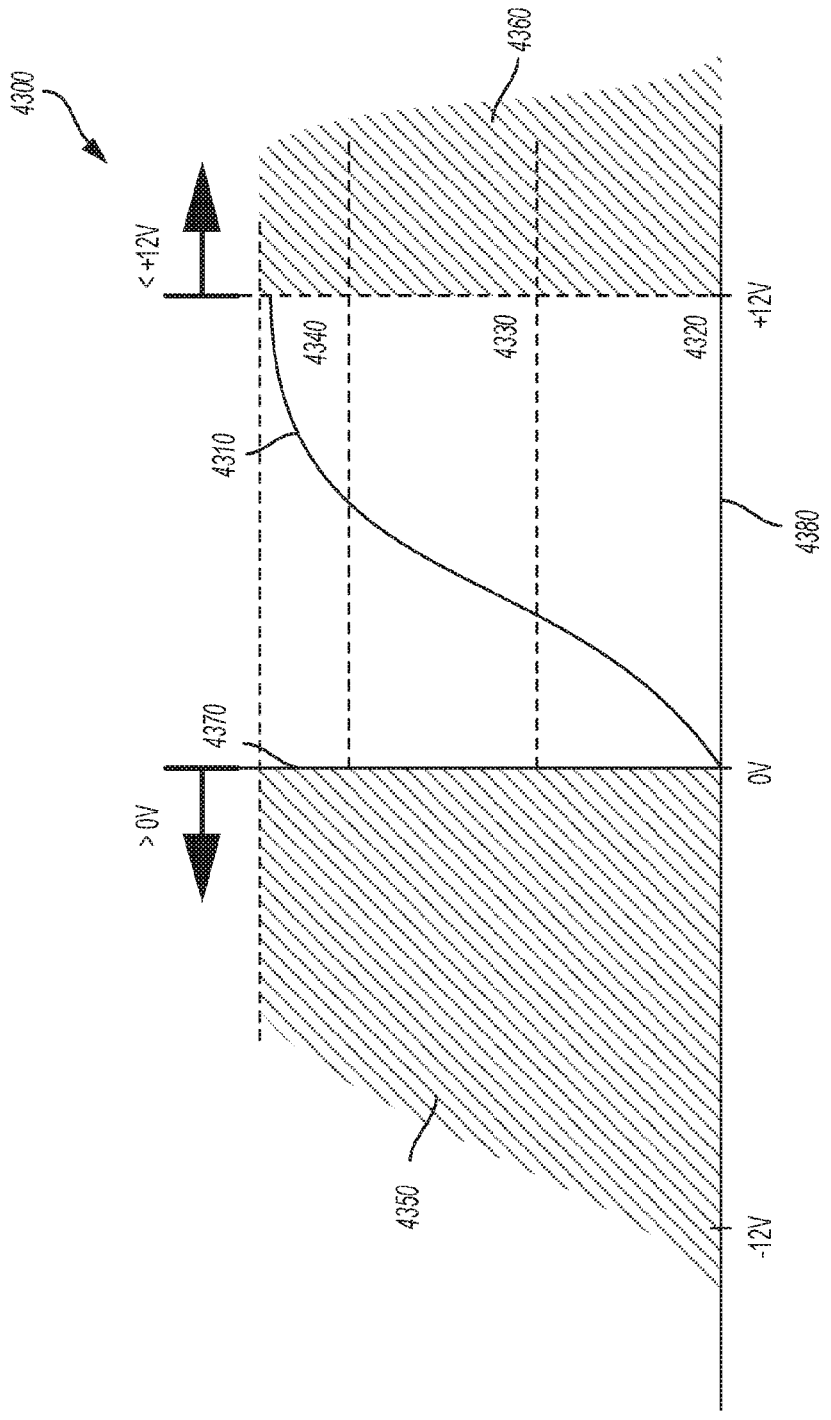


FIG. 77

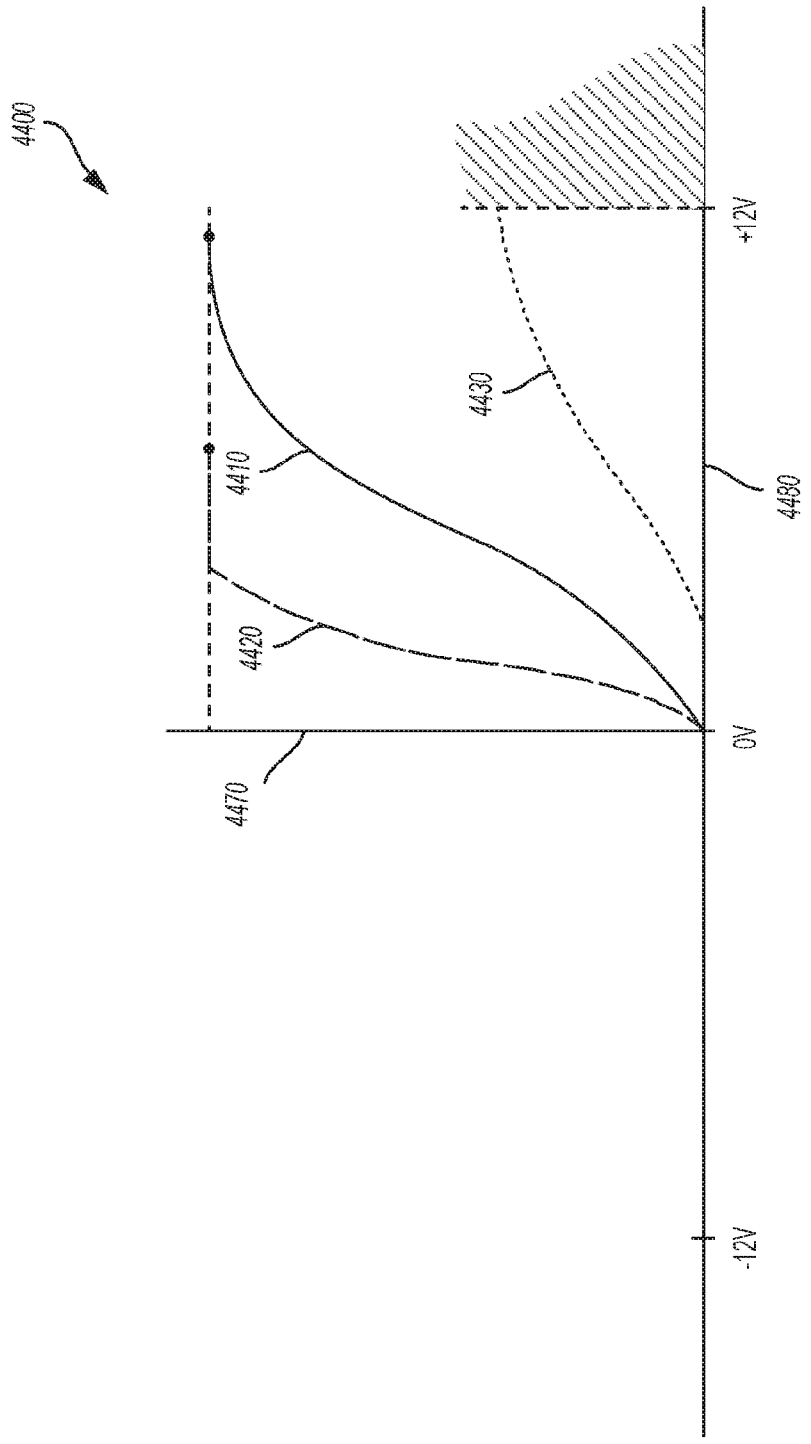


FIG. 78

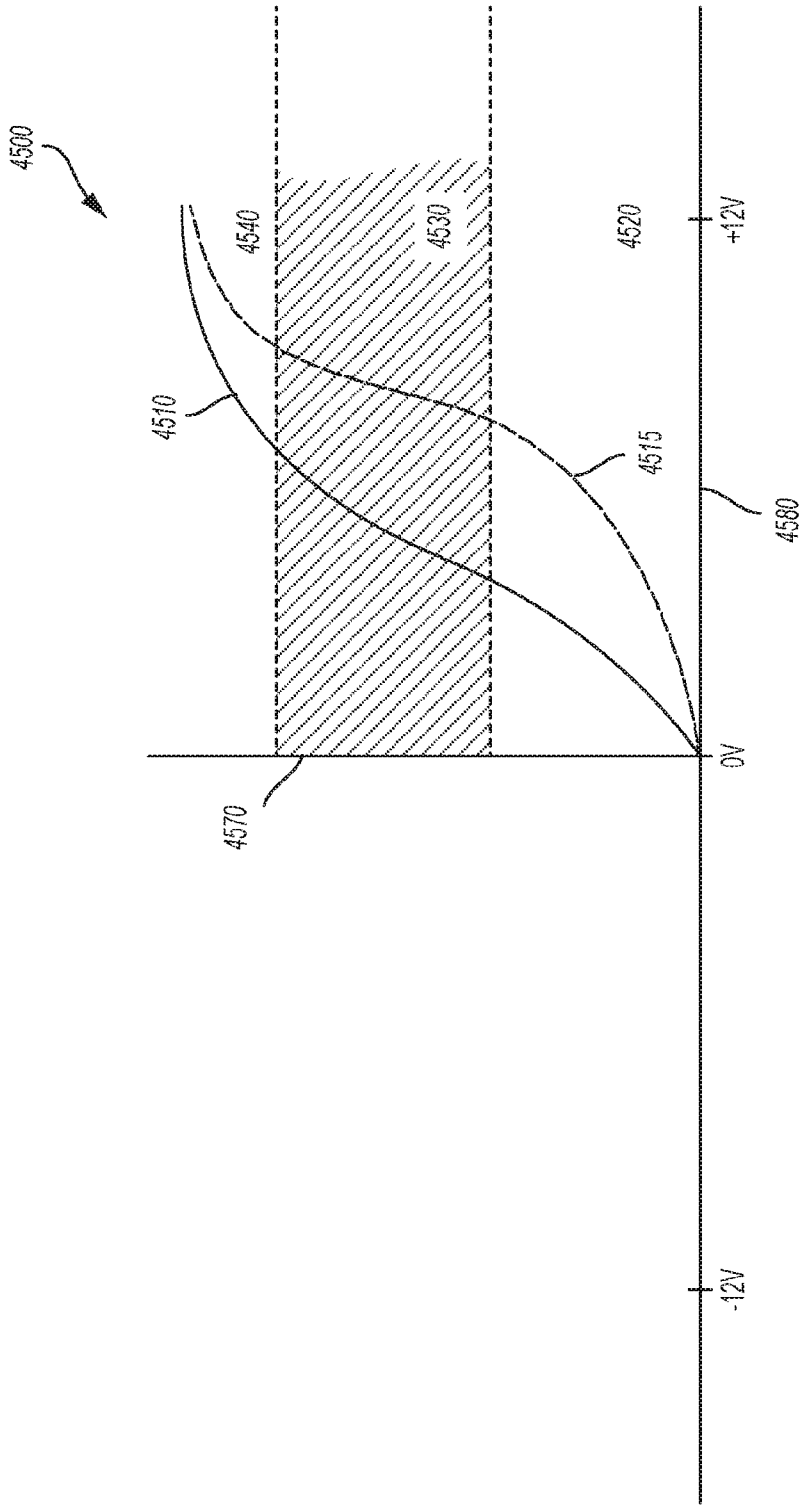


FIG. 79

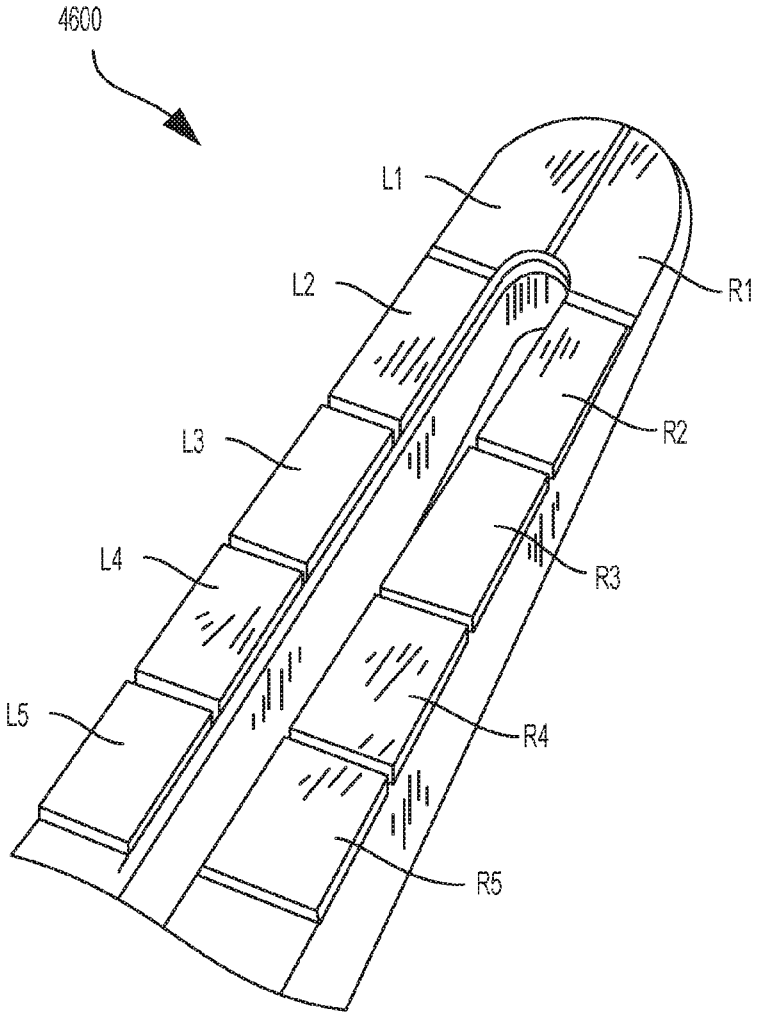


FIG. 80

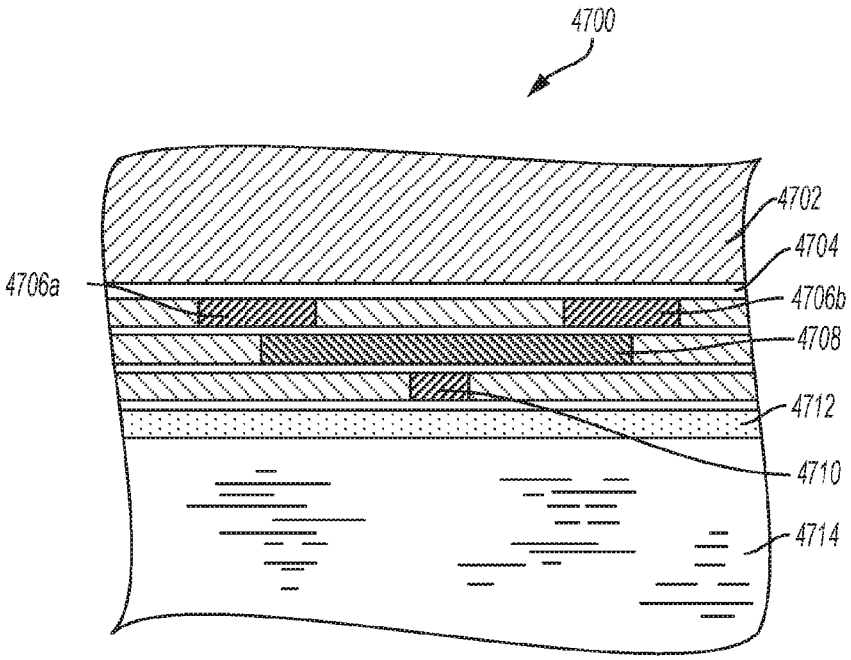


FIG. 81

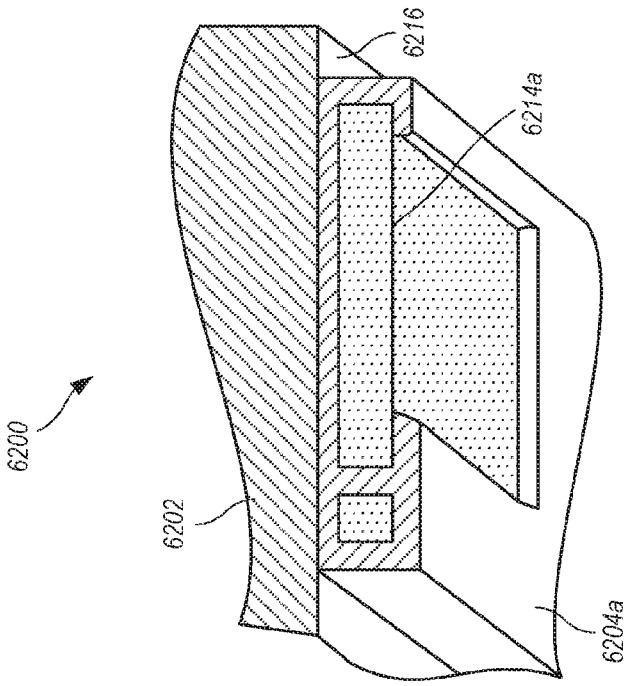

6200
6202
6216
6214a
6204a

FIG. 83

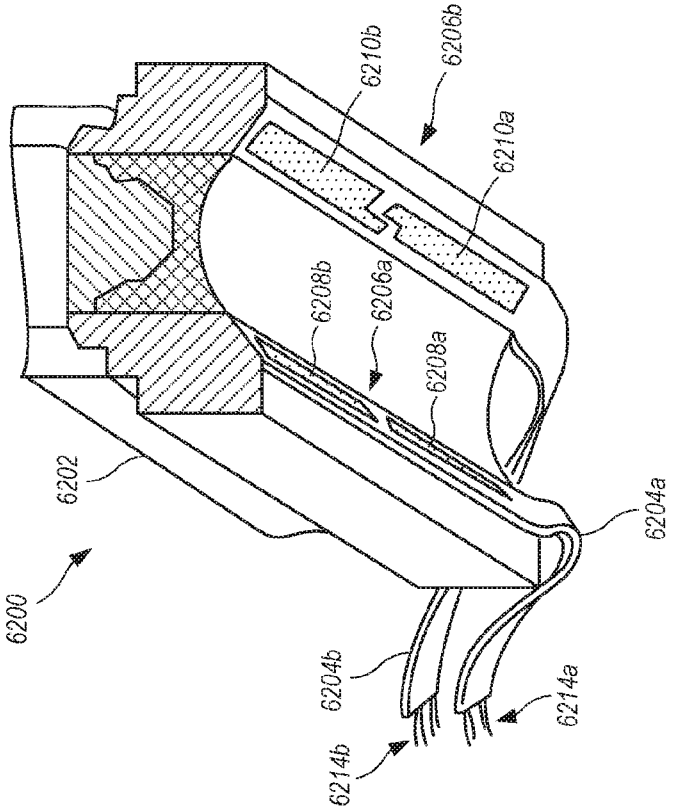

6200
6202
6210b
6206b
6210a
6208b
6206a
6208a
6204a
6204b
6214a
6214b

FIG. 82

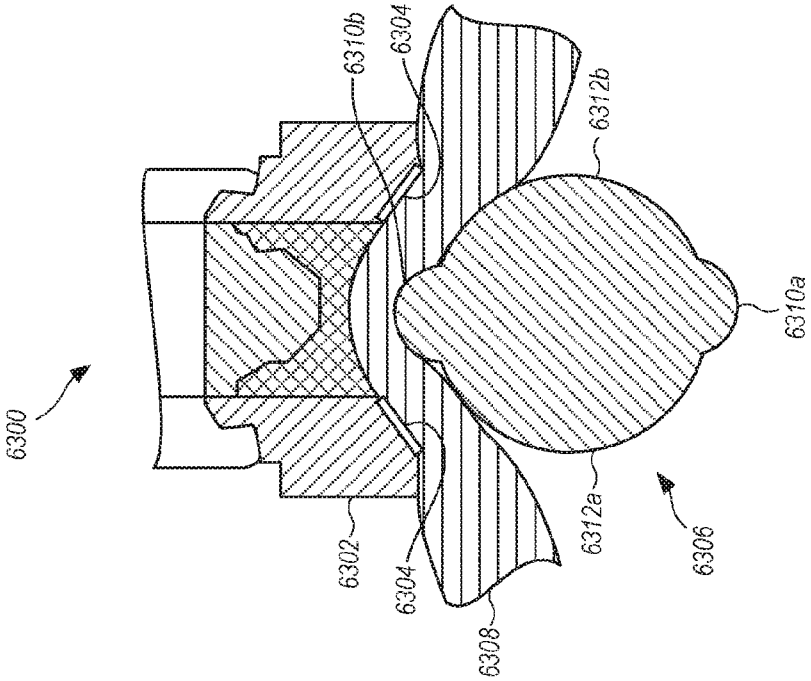


FIG. 84B

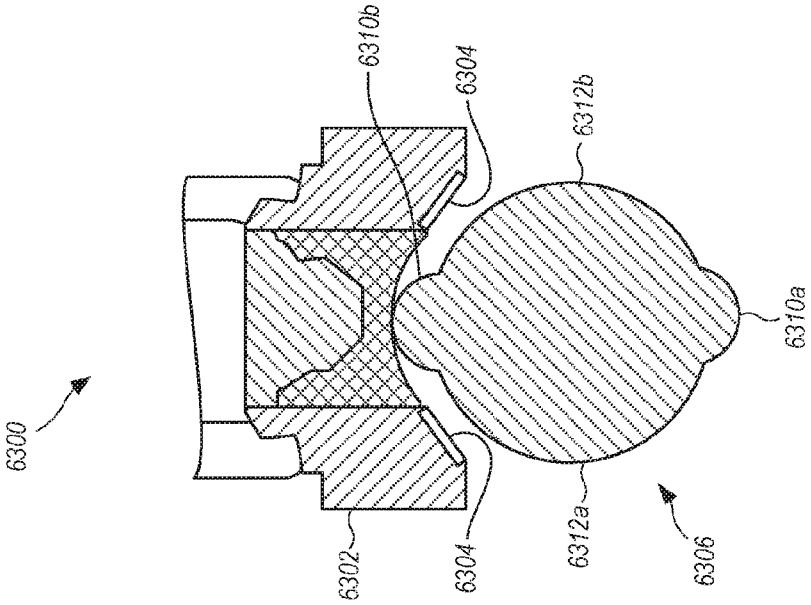


FIG. 84A

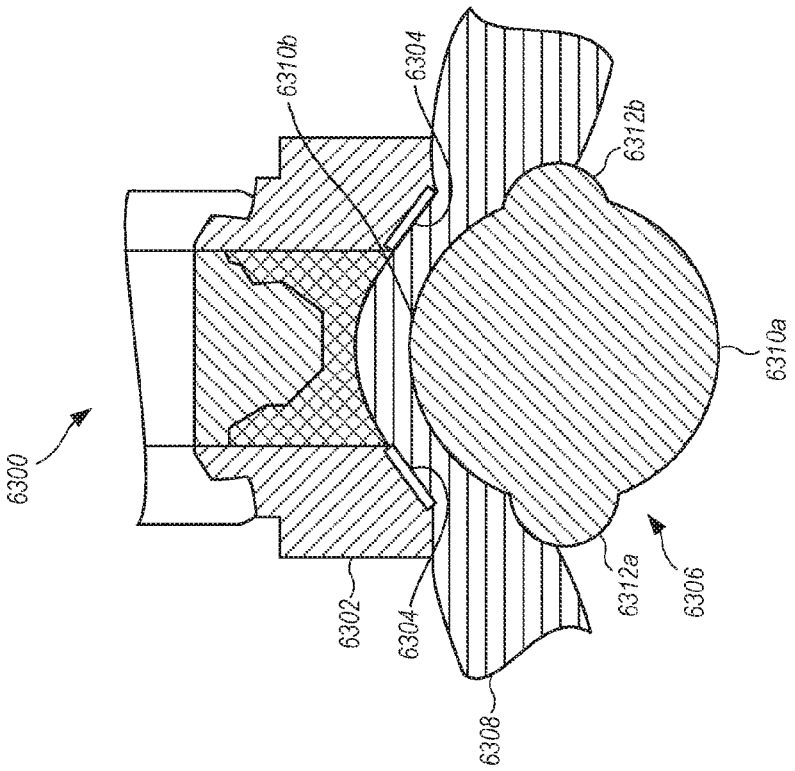


FIG. 85B

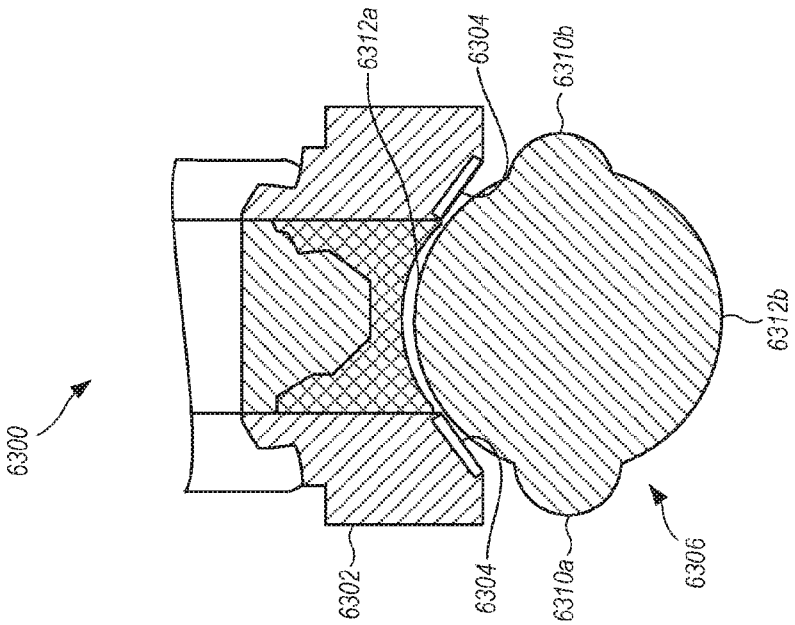


FIG. 85A

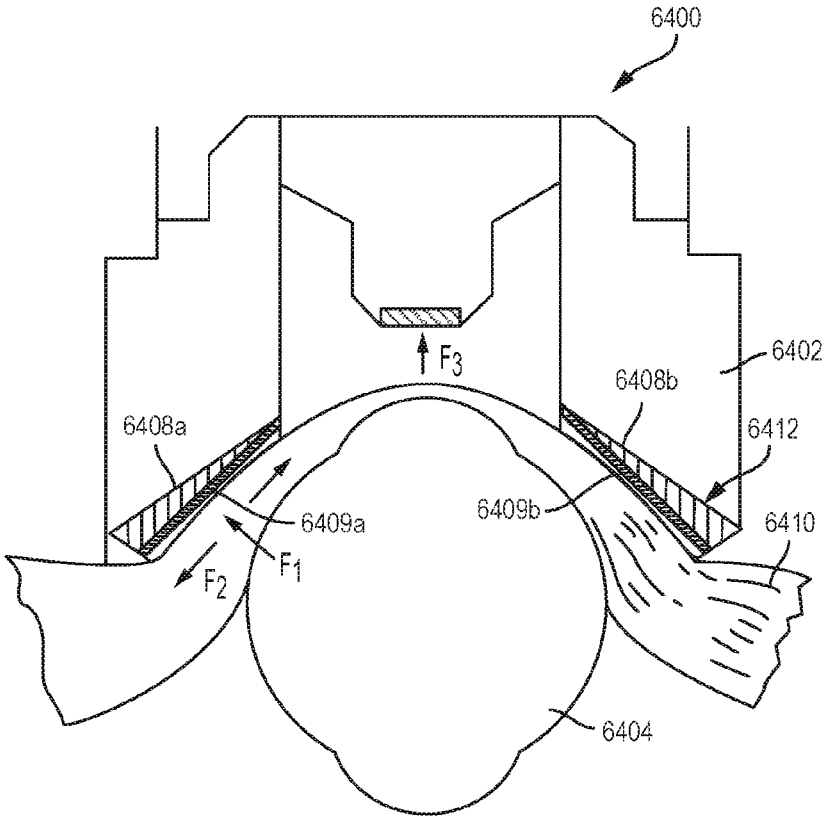

6400
F3
6402
6408b
6408a
6412
6409a
6409b
6410
F1
F2
6404

FIG. 86

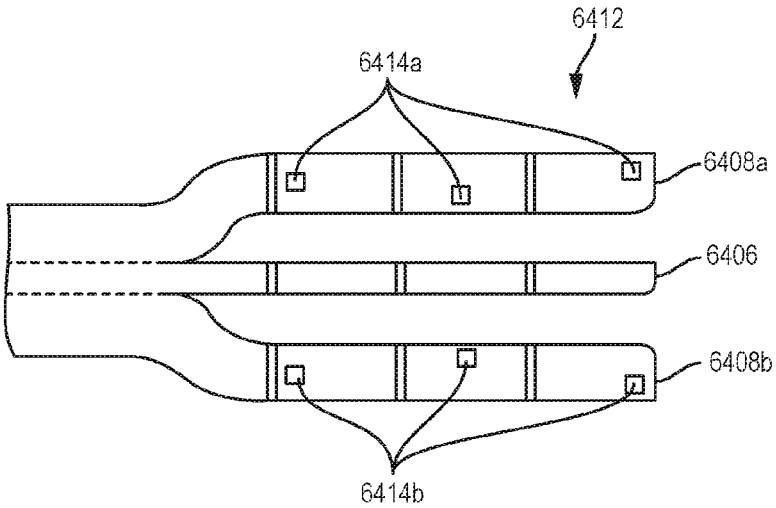

6412
6414a
6408a
6406
6408b
6414b

FIG. 87

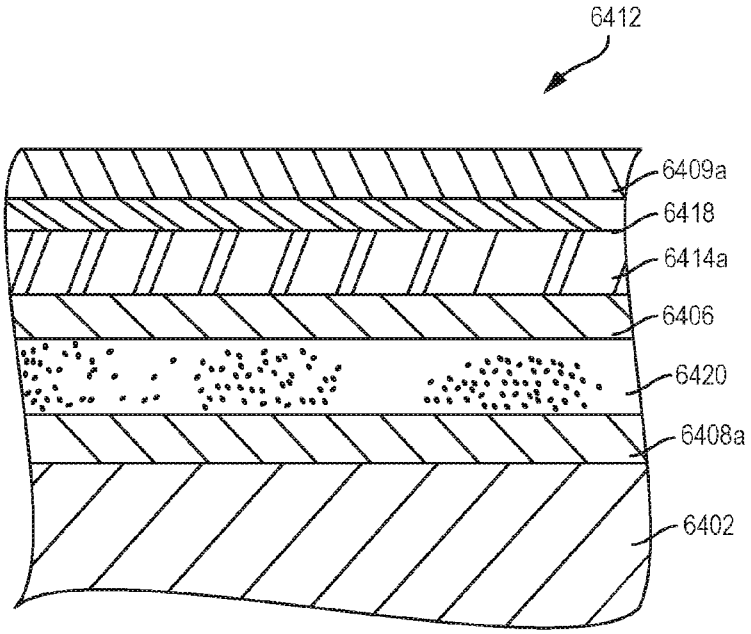

6412
6409a
6418
6414a
6406
6420
6408a
6402

FIG. 88

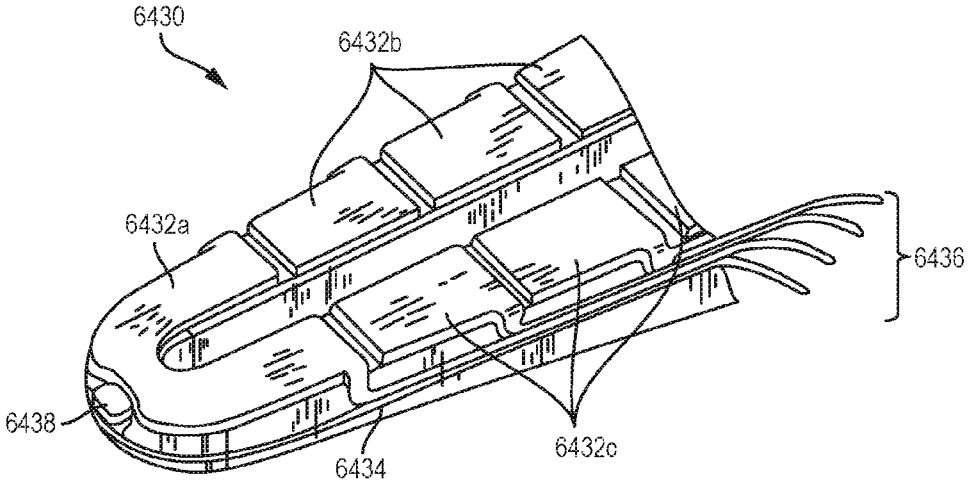

6430
6432b
6432a
6436
6438
6434
6432c

FIG. 89

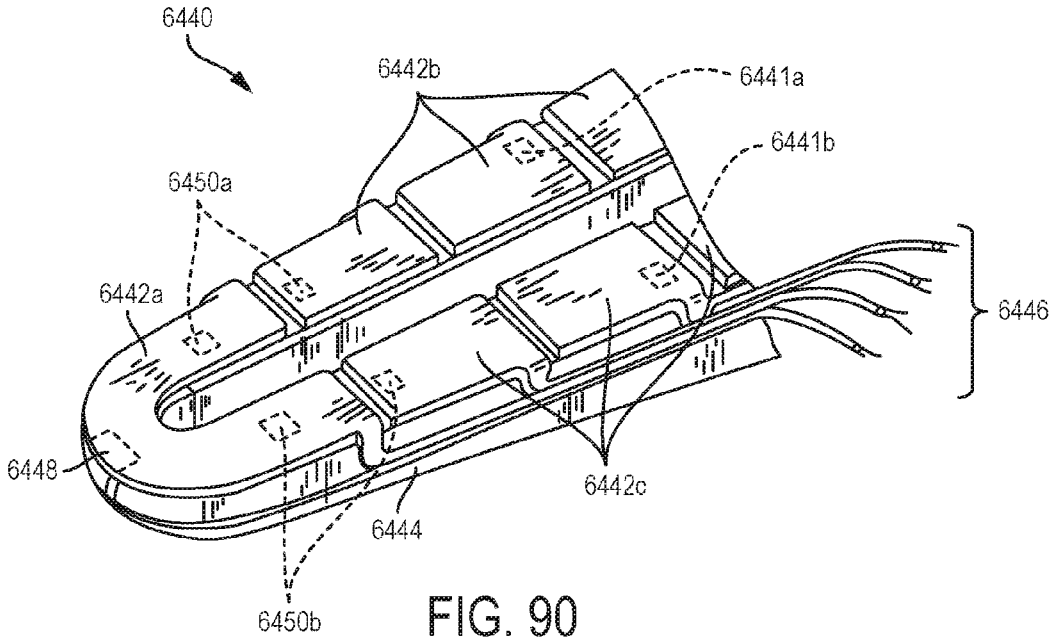

6440
6442b
6441a
6441b
6450a
6442a
6446
6448
6442c
6444
6450b

FIG. 90

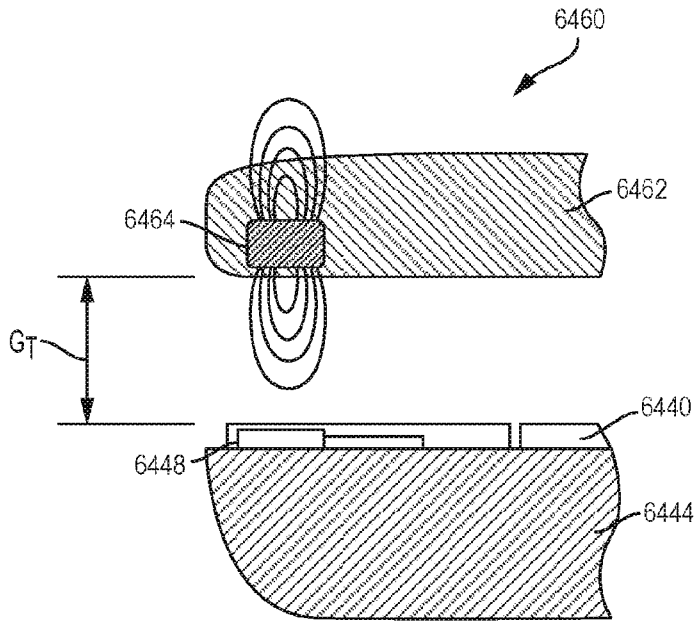

6460
6462
6464
G_T
6440
6448
6444

FIG. 91

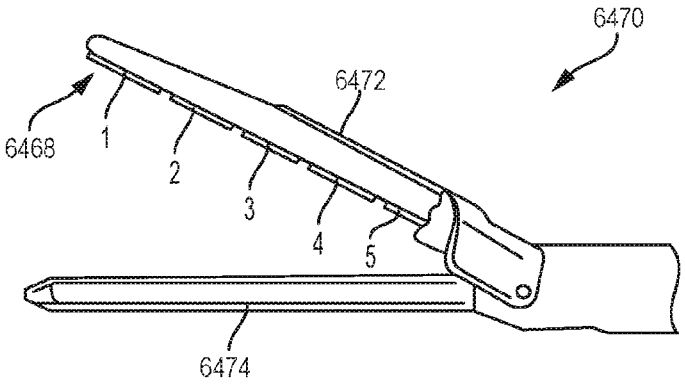

6470
6472
6468
1
2
3
4
5
6474

FIG. 92

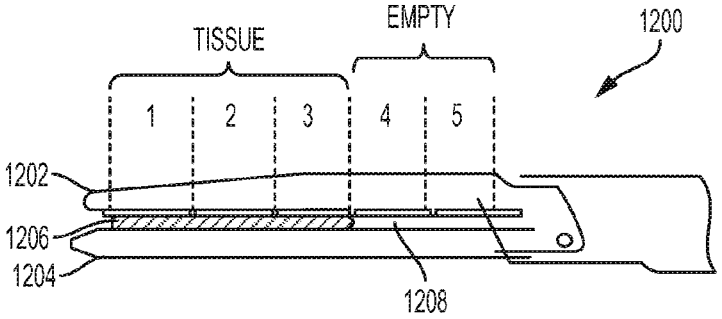

TISSUE
EMPTY
1200
1
2
3
4
5
1202
1206
1204
1208

FIG. 93

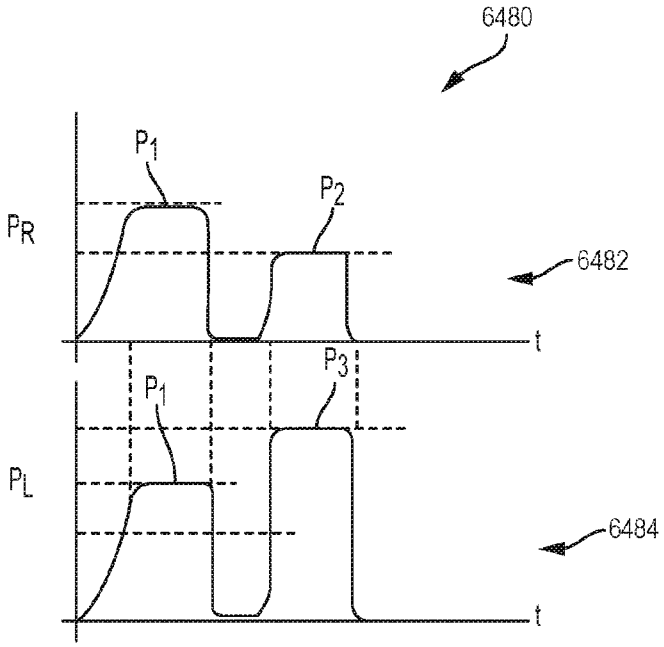

6480
P1
P2
PR
6482
t
P3
P1
PL
6484
t

FIG. 94

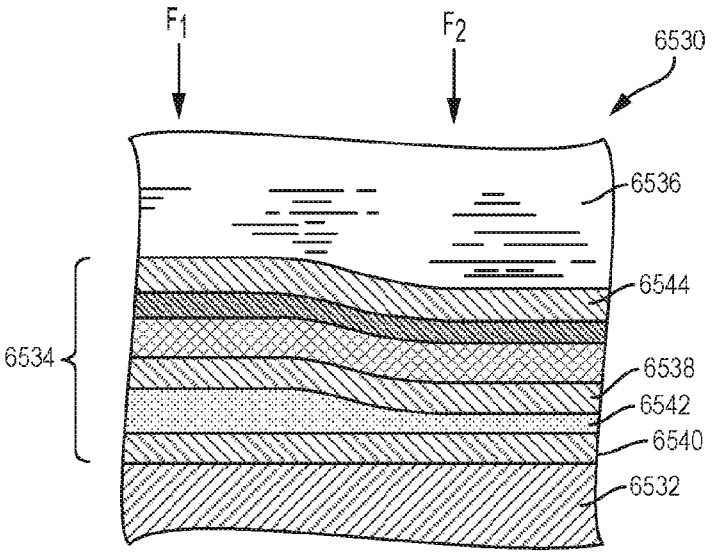

F1
F2
6530
6536
6544
6534
6538
6542
6540
6532

FIG. 95

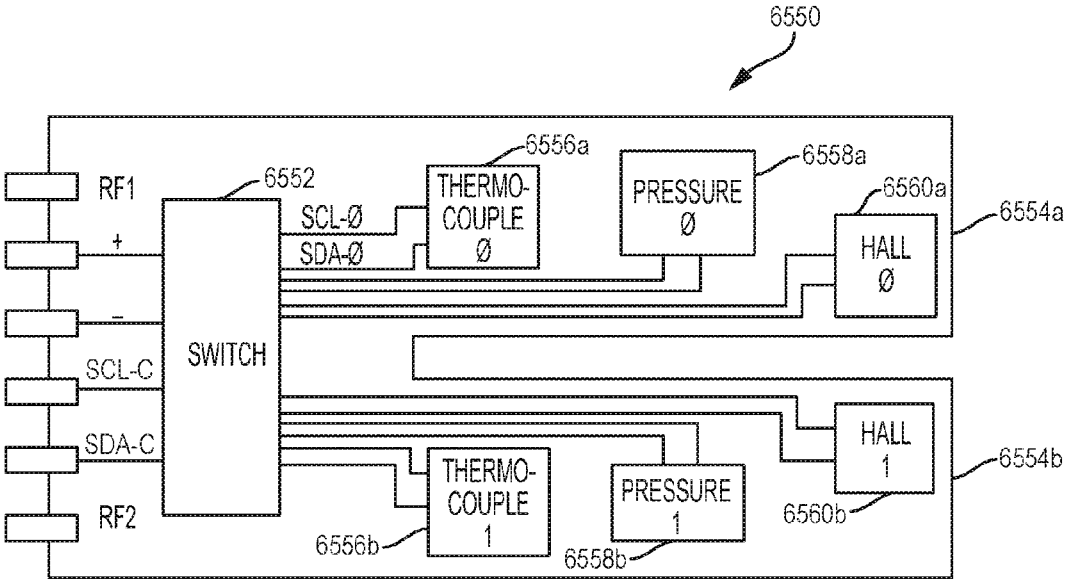


FIG. 96

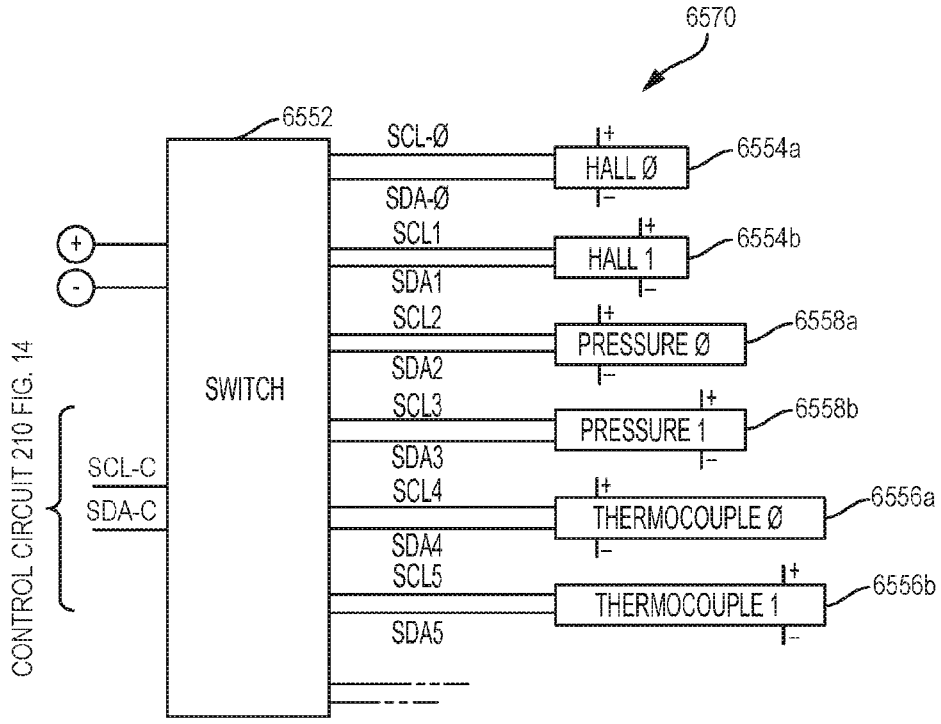


FIG. 97

MassagerPriorArt0002761

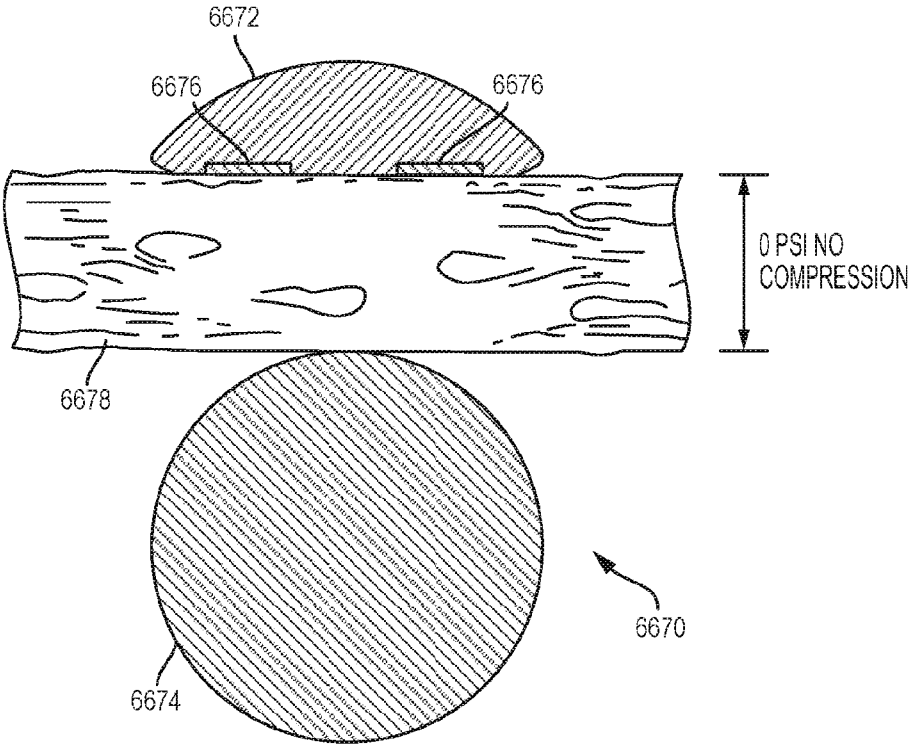


FIG. 98A

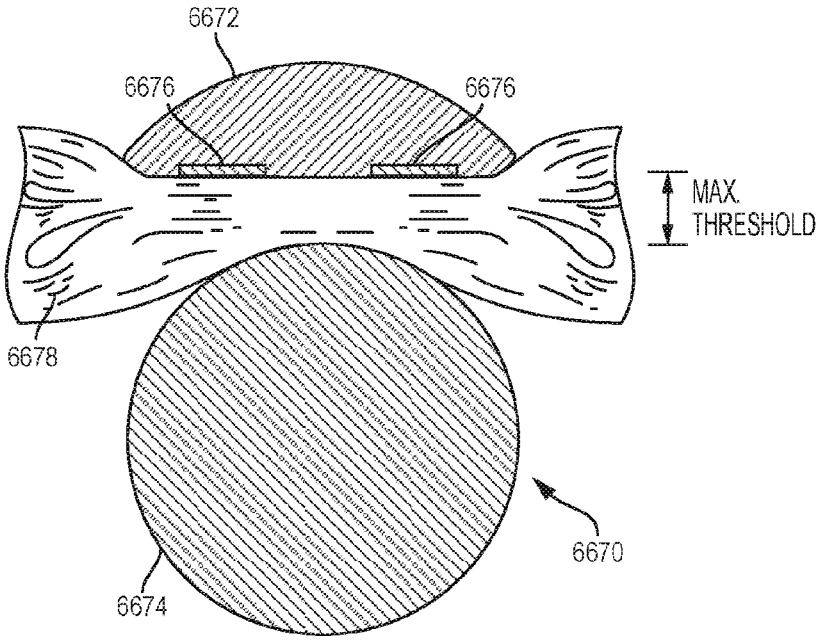


FIG. 98B

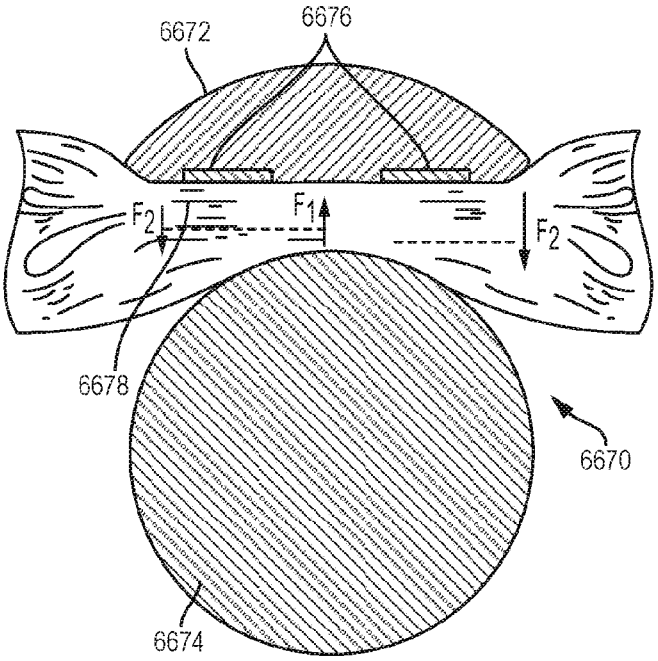


FIG. 99A

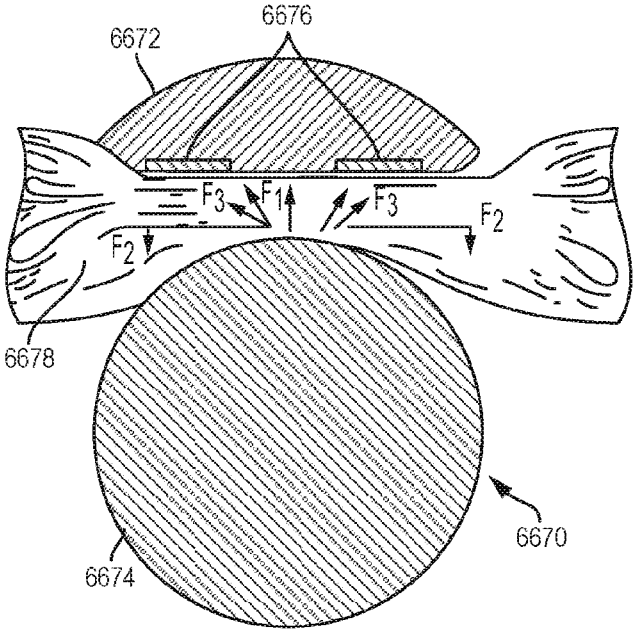


FIG. 99A

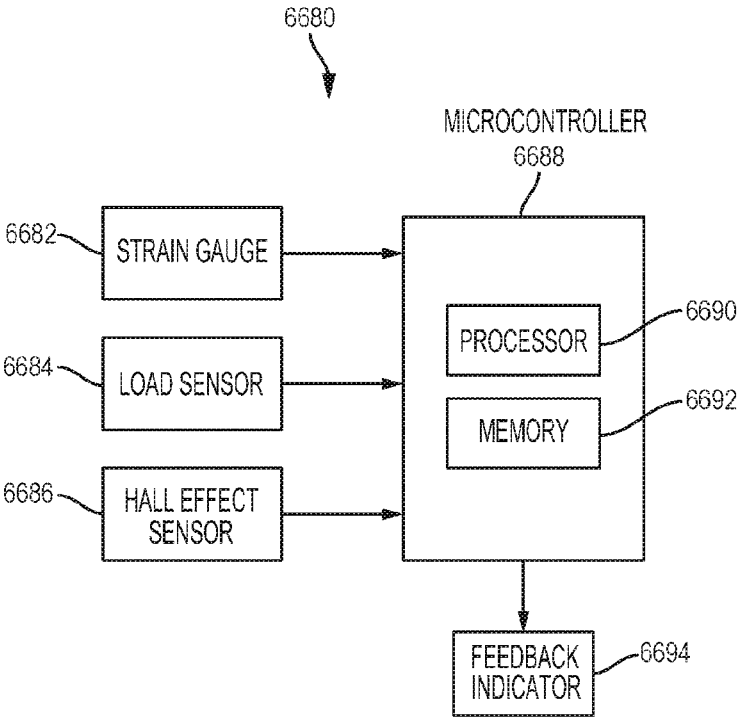

6680
MICROCONTROLLER
6688
6682
STRAIN GAUGE
6684
LOAD SENSOR
6686
HALL EFFECT SENSOR
PROCESSOR
6690
MEMORY
6692
FEEDBACK INDICATOR
6694

FIG. 100

TWM493379 Y Translate to English (via PatBase internal translation) or Select language to translate to (via Google): English Translate Print Save textmine
RWS human translation (fees apply)

Title :

電動筋絡按摩槍

Electric massage veins gun

Abstract :

一種筋絡按摩槍，包含有一槍形殼體、一基座、一電動馬達、一旋擺件、一滑軌、一滑塊組、一被動組件、一按摩頭及至少一拉伸彈簧；當該電動馬達帶動該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作；藉以達到省力、結構簡單、成本低廉等功效。

One kind of gluten network, comprising a shell body massage gun pointed gun pointed shape, a base, a sliding member, a horse undeveloped, electro-spin swing a slide rail, a sliding block, a sliding assembly, a group massage head and at least one tension spring; When sesame strikeout moving horse undeveloped band strikeout electro-sliding and sliding along the slide block combination spin swing piece orange strikeout strikeout shell-shaped body after sliding rail to the gun pointed end 00, slide block moves, the strikeout of the group will pull long tension spring, when sesame strikeout strikeout spin swing member through the sliding block group in position, the strikeout strikeout sliding block group will be stretched spring pull moving strikeout while the striker hit the strikeout turret is moving assembly to band moving head massage projecting outwardly, the strikeout strikeout spin swing member is screwed to be 轉一 ring again after moving slide block set to gun pointed-ment orange strikeout shell body after the shift, the strikeout moving assembly end 00 is no longer subjected to hit the hit, the strikeout of the massage head to the female retracted, thereby repeat the above action, while undeveloped massage head is held to the strikeout continued to extend and retract action; In order to saving, knot undeveloped skis Jane solitary, low cost and other effects.

Claim(s) :

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1. 一種電動筋絡按摩槍，其主要包含有：一槍形殼體；一基座，係設置於該槍形殼體內；一電動馬達，係固設於該基座上，用以輸出一旋轉動力者；一旋擺件，係與該電動馬達連結，以受該電動馬達所帶動而進行圓周旋擺者；一滑軌，係設置於該基座上；一滑塊組，係滑接於該滑軌上，而可受外力作用而沿該滑軌進行直線之往復滑移者；一被動組件，係設置於該槍形殼體內，並局部伸出於該槍形殼體外；一按摩頭，係以可拆離之方式連結於該被動組件伸出於該槍形殼體外之部位上；至少一拉伸彈簧，係連結於該滑塊組與該被動組件間；當該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作。

2. 依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該槍形殼體係由二半殼體所對接而成，該槍形殼體可界定出一容置部及一連接於該容置部中段底部之握持部，以由該容置部供該基座、電動馬達、旋擺件、滑軌、滑塊組及被動組件容置，而由該握持部供使用者加以握持。

3. 依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該滑塊組具有一身部、一撥動部、一撞擊頭部及一緩衝彈簧；該身部係與該滑軌滑接，而可受外力作用進行沿該滑軌之直線往復滑移，該身部並與該拉伸彈簧連接，該撥動部係設置於該身部後端，以受該旋擺件所撥動者，該撞擊頭部係連接於該身部之前端，該緩衝彈簧係抵接於該接擊頭部與該身部間；當該拉伸彈簧拉動該身部時，係由該撞擊頭部撞擊於該被動組件上。

4. 依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該被動組件具有一固定套筒、一桿身、一撞擊尾部及一復位彈簧，該固定套筒係固設於該槍形殼體內，並與該拉伸彈簧連接，該桿身係穿經該固定套筒，且前端係伸出於該槍形殼體之前端外，並與該按摩頭連接，該撞擊尾部係連結於該桿身後端，該復位彈簧係抵接於該撞擊尾部與該固定套筒間；當該滑塊組撞擊於該撞擊尾部時，該桿身會帶動該按

1. An electro-sliding ribs, which mainly comprises: a grounding massage gun pointed First gun pointed-shaped shell body; A base disposed beneath the gun pointed-shaped shell body female strikeout department; First electrical moving horse undeveloped, Department of solid disposed beneath the base, the STRIKEOUT for outputs a turn force; First spin swing piece, the strikeout department and differentiation of moving horse undeveloped connected to electronics, the strikeout knot moving horse undeveloped, band moving and is circularly deal swing; A sliding rail, the strikeout Department is provided to the base; First slide block group, in sliding contact with the slide rail, and maintains the strikeout turret can be deformed by external force is straight down along the slide rail in the nickel complex the strikeout slip; A sliding assembly, the strikeout disposed beneath the gun pointed-shaped shell body female department, and partially extending beneath the gun pointed-shaped outer shell body; the Strikeout A massage head, the department in order to detachably connected by way of the STRIKEOUT knot is moving away from the turret assembly projecting turret gun pointed-shaped outer shell body of the strikeout of the site; At least one tension spring, the strikeout knot turret slide block combination and cooperation strikeout connected department is moving assembly 00; When sesame rotary swing member sliding block group strikeout strikeout ment orange moving along the slide rail to the shell-shaped body after the strikeout gun pointed end 00, slide block moves, the strikeout of the group will pull long tension spring, when sesame strikeout strikeout spin swing member through the sliding block group in position, the strikeout strikeout sliding block group will be stretched spring pull moving while the striker hit the strikeout turret is moving assembly to move the strikeout massage head projecting outwardly,

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摩頭伸出，當該滑塊組不再撞擊於該撞擊尾部上時，該復位彈簧會將該桿身拉回，使該按摩頭縮回。

5. 依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一開關鈕，該開關鈕係設置於該槍形殼體之外側位置處，並與該電動馬達電性連接，以控制該電動馬達之啟動與停止者。

6. 依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一動力調整鈕，該動力調整鈕係設置於該槍形殼體後端位置處，並與該電動馬達電性連接，以控制該電動馬達之轉動速度，進而達到調整該按摩頭之伸出、縮回頻率者。

7. 依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一深度調整鈕，係設置於該槍形殼體之前端，並與該被動組件連結，以藉由旋動該深度調整鈕而能調整該被動組件帶動按摩頭所能伸出與縮回之深度者。

8. 依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一安全限制件，該被動組件一側具有一限制槽，該安全限制件之一端係自該槍形殼體之一側鎖入，並位於該限制槽中，以防止該被動組件產生過大之位移行程者。

9. 依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該按摩頭呈U形。

10. 依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該按摩頭呈盤形。

the strikeout band to be spin swing member is screwed 轉一 strikeout ring again after moving slide block set to gun pointed-ment orange strikeout shell body after the shift, the strikeout moving assembly end 00 is no longer subjected to hit the hit to the massaging head to the strikeout female retracted, thereby repeat the above action, while undeveloped massage head is held to the strikeout continued to extend and retract action.

2. In accordance with evidence-Shen please pay special 23-39 of the Lee-target around 1 electro-sliding ribs, wherein, the strikeout grounding massage gun pointed gun pointed-shaped shell body by the second half-shell body department, the strikeout of the Viologens gun pointed-shaped shell body may define a first accommodating portion and a strikeout connected to the accommodating portion in the bottom of the grip portion, the strikeout strikeout by accommodating portion for base, electro-moving horse undeveloped, spin swing piece, sliding rail, sliding block and is moving assembly, formed by the strikeout accommodating portion for gripping the user to grip.

3. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs, wherein, the strikeout grounding massage gun pointed sliding block group having a body portion, the first orange moving portion, a hit hit head portion and a slow Chong spring; Strikeout slide rail sliding contact with the body portion and the strikeout department, and can be set in the external force to slide along the sliding rail in the nickel complex the strikeout of the straight body portion, the strikeout perylene and tensile spring connection, the strikeout strikeout orange moving portion disposed beneath the strikeout department, in order to subject the body portion carboxy end spin swing piece, the

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strikeout of orange moving strikeout hit hit head portion connected to the body portion of the front, the strikeout department buffer spring abuts against the punch strikeout department beneath the hit head portion and the body portion 00; the Strikeout When sesame strikeout pull tensile spring moving body portion 00, the strikeout strikeout department by hit hit hit hit head portion to be moving assembly, the strikeout

4. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs, wherein, the strikeout grounding massage gun pointed is moving assembly having a body, a first fixed sleeve, 桿 hit hit tail and a complex bit spring, fixed sleeve fixedly disposed beneath the gun pointed-shaped shell body female strikeout department where the contents and tensile spring connection, the strikeout strikeout 桿 body fixed sleeve, and the front end passing through the strikeout department department projecting beneath the shell-shaped body, and prior to the strikeout gun pointed end and massage head connected to the attachment, the strikeout strikeout hit hit tail turret body end, 桿 department connected knot strikeout oxaphosphoranecompound strikeout bit spring abuts Department complex beneath the striker hit the tail and fixed sleeve 00, the strikeout strikeout; When the slide hit hit hit hit the block set beneath the strikeout strikeout tail 00, 桿 strikeout body massage head extends, when sesame strikeout strikeout band will be moving slider block group no longer hit hit hit hit on the tail pipe 00, the strikeout strikeout turret complex level spring will pull back, the strikeout of 桿 the strikeout body massage head retracted.

5. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs

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grounding massage gun pointed, more comprises a micro m off button, off button is provided to open the strikeout department strikeout shaped shell body side position outside gun pointed at, perylene and electro-moving horse undeveloped resistance connection, the strikeout of the data in order to control electro-sliding and sliding and cooperation of 敞 strikeout horse undeveloped stops.

6. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs grounding massage gun pointed, more comprises a force tune button, the strikeout of the whole force tune button disposed beneath the gun pointed-shaped whole department strikeout shell body carboxy end position at, perylene and electrical resistance connection, the strikeout moving horse undeveloped to control the moving speed of the electro-moving horse strikeout undeveloped turn into and undeveloped to tune the strikeout of the entire massage head extend, retract frequency.

7. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs grounding massage gun pointed, more comprises a depth tune button, the strikeout disposed beneath the entire department gun pointed-shaped shell body before moving assembly end CC4511, and is connected to the strikeout junction depth by spin move to tune tune button integrated strikeout strikeout whole band is moving assembly moving massage head can extend and retract the depth.

8. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs grounding massage gun pointed, more comprises a limiting part, the strikeout security is moving assembly side has a limiting groove, one end of the safety

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limit strikeout department from one side of the lock body into the gun pointed-shaped strikeout shell, and beneath the limiting groove to prevent the strikeout strikeout is moving assembly yield derived amination over large displacement stroke.

9. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs, wherein, the strikeout grounding massage massage head gun pointed has a U-shape.

10. The method according to LEE-target around the first evidence-Shen please pay special 23-39 of electro-sliding ribs, wherein, the strikeout grounding massage massage head gun pointed in the disc-shaped.

Description :

發明所屬之技術領域

[0001] 本創作係與按摩器具有關，更詳而言之係指一種電動筋絡按摩槍。

先前技術

[0002] 按，目前常見之按摩器具，主要分為電動與手動二種，其中以電動驅動之按摩器具，其結構過於複雜，導致製造成本相當之高昂，對於一般人或從事筋絡按摩之業者來說，皆為一大負擔。而手動驅動之按摩器具，雖然結構簡單、成本較低，但在使用時卻相當之費力。

[0003] 因此，如何能提供一種省力、結構簡單、能降低製造成本之電動筋絡按摩器具，便為目前相關業者所急須解決之課題。

發明內容

[0004] 有鑑於此，為改善先前技術中，習知按摩器具有著費力、結構複雜、製造成本較高等問題；緣此，本創作乃提供一種電動筋絡按摩槍，其主要包含有：一槍形殼體；一基座，係設置於該槍形殼體內；一電動馬達，係固設於該基座上，用以輸出一旋轉動力者；一旋擺件，係與該電動馬達連結，以受該電動馬 達所

Genus of hair Ming technology field

[0001] The record as the department and cooperation massager has off , more detail speaking refers to an electro-sliding ribs grounding massage gun pointed.

Previous technique

[0002] press, currently often see the massage appliance, divided = 動二 species, wherein the differentiation and differentiation of moving the hand moving thiazolyl drive moving the massage appliance, which results in the skis amination over turret, causing the pilot actuation c miscellaneous Seisakusho truth when the viologens are expensive, most people or things in the industry's concentration from the tendons grounding massage say, all is a large negative edge. While the hand moving thiazolyl drive moving the massage appliance, although versa knot skis Jane solitary, cost low, but in use but representing 40:00 phase when the laborious.

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帶動而進行圓周旋擺者；一滑軌，係設置於該基座上；一滑塊組，係滑接於該滑軌上，而可受外力作用而沿該滑軌進行直線之往復滑移者；一被動組件，係設置於該槍形殼體內，並局部伸出於該槍形殼體外；一按摩頭，係以可拆離之方式連結於該被動組件伸出於該槍形殼體外之部位上；至少一拉伸彈簧，係連結於該滑塊組與該被動組件間；當該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作；藉以達到省力、結構簡單、成本低廉等功效。

實施方式

[0036] 為使貴 審查委員能對本創作之特徵與其特點有更 進一步之了解與認同，茲列舉以下較佳之實施例並配合圖式說明如下：請參閱第1圖至第8圖，係本創作一較佳實施例所提供之一種電動筋絡按摩槍100，其主要包含有一槍形殼體10、一基座20、一電動馬達30、一旋擺件40、一滑軌50、一滑塊組60、一被動組件70、一按摩頭80及二拉伸彈簧90，其中：請參閱第1圖至第4圖，該槍形殼體10，係由二半殼體11所對接而成，該槍形殼體10可界定出一容置部12及一連接於該容置部12中段底部之握持部13，以由該容置部12供其餘構件容置，而由該握持部13供使用者加以握持。

[0037] 請參閱第1圖至第4圖，該基座20，係固設於該槍形殼體10之容置部12內。

[0038] 請參閱第1圖至第4圖，該電動馬達30，係位於該槍形殼體10之容置部12內，並固設於該基座20上，用以輸出一旋轉動力者。

[0039] 請參閱第1圖至第4圖，該旋擺件40，係位於該槍形殼體10之容置部12內，並以一端與該電動馬達30固接，以受該電動馬達30所驅動而進行圓周旋擺。

[0040] 請參閱第1圖至第4圖，該滑軌50，係設位於該槍形殼體10之容置部12內，並固設於該基座20上。

[0003] Therefore, how to provide an energy saving, knot skis Jane solitary, can reduce the cause of the grounding of the sliding rib Seisakusho electric massage apparatus, it is currently an urgent need to solve the off phase Co., lesson ξ.

Summary

[0004] In this hair Ming Kam, flattened improve the prior technique, learning knowledge massager has significant laborious, knot miscellaneous, resulting in this representing 40 skis c Seisakusho high ask ξ; Edge of this, the present record as is to provide an electro-sliding ribs, which mainly comprises: a grounding massage gun pointed First gun pointed-shaped shell body; A base disposed beneath the gun pointed-shaped shell body female strikeout department; First electrical moving horse undeveloped, Department of solid disposed beneath the base, the STRIKEOUT for outputs a turn force; First spin swing piece, the strikeout department and differentiation of moving horse undeveloped connected to electronics, the strikeout knot moving horse undeveloped, band moving and is circularly deal swing; A sliding rail, the strikeout Department is provided to the base; First slide block group, in sliding contact with the slide rail, and maintains the strikeout turret can be deformed by external force is straight down along the slide rail in the nickel complex the strikeout slip; A sliding assembly, the strikeout disposed beneath the gun pointed-shaped shell body female department, and partially extending beneath the gun pointed-shaped outer shell body; the Strikeout A massage head, the department in order to detachably connected by way of the STRIKEOUT knot is moving away from the turret assembly projecting turret gun pointed-shaped outer shell body of the strikeout of the site; At least one tension spring, the strikeout knot turret slide block combination and

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[0041] 請參閱第1圖至第4圖，該滑塊組60，係位於該 槍形殼10之容置部12內，並與該滑軌50滑接，而可受外力作用而進行沿該滑軌50進行直線之往復滑移者。該滑塊組60具有一身部61、一撥動部62、一撞擊頭部63及一緩衝彈簧64；該身部61係與該滑軌50滑接，而可受外力作用而進行沿該滑軌50之直線往復滑移者，該撥動部62係設置於該身部61後端，以受該旋擺件40所撥動者，該撞擊頭部63係連接於該身部61之前端，該緩衝彈簧64係抵接於該接擊頭部63與該身部61間。

[0042] 請參閱第1圖至第4圖，該被動組件70，係位於該槍形殼體10之容置部12內，並局部伸出於該槍形殼體10之前端外。該被動組件70具有一固定套筒71、一桿身72、一撞擊尾部73及一復位彈簧74，該固定套筒71係固設於該槍形殼體10之容置部12內，該桿身72係穿經該固定套筒71，且前端係伸出於該槍形殼體10之前端外，該撞擊尾部73係連結於該桿身72後端，該復位彈簧74係抵接於該撞擊尾部73與該固定套筒71間。

[0043] 請參閱第1圖至第4圖，該按摩頭80，呈U形，係以可拆離之方式連接於該被動組件70伸出於該槍形殼體10前端外之桿身71前端上，以與該被動組件70加以同動。

[0044] 請參閱第1圖至第4圖，該等拉伸彈簧90，係連結於該滑塊組60之身部61與該被動組件70之固定套筒71間。

[0045] 是以，上述即為本創作一較佳實施例所提供之一種電動筋絡按摩槍100各部構件及其組裝方式之介紹，接著再將其使用特點說明如下：首先，當使用者控制而驅動該電動馬達30輸出旋轉動力時，該旋擺件40會受該電動馬達30所帶動而旋轉，並在旋轉之路徑上將該滑塊組60之撥動部62往後端撥動，使該滑塊組60被往後拉，並將該拉伸彈簧90加以拉伸(如第5圖所示)，待該旋擺件40通過該滑塊組60之撥動部62後，該拉伸彈簧90便將該滑塊組60往前端拉，使該滑塊組60之身部61沿著該滑軌50滑動而往前位移，並由該撞擊頭部63撞擊於該被動組件70之撞擊尾部73上(如第6圖所示)，使該被動組件70之桿身72受到撞擊而往前伸出移動(如第7圖所示)，而帶動該按摩頭80施壓於人體之筋絡位置處，接著，再由該旋擺件40旋轉一周後再度撥動該滑塊組60之撥動部62，而將該滑塊組60往後拉(如第8圖所

cooperation strikeout connected department is moving assembly 00; When sesame rotary swing member sliding block group strikeout strikeout ment orange moving along the slide rail to the shell-shaped body after the strikeout gun pointed end 00, slide block moves, the strikeout of the group will pull long tension spring, when sesame strikeout strikeout spin swing member through the sliding block group in position, the strikeout strikeout sliding block group will be stretched spring pull moving while the striker hit the strikeout turret is moving assembly to move the strikeout massage head projecting outwardly, the strikeout band to be spin swing member is screwed 轉一 strikeout ring again after moving slide block set to gun pointed-ment orange strikeout shell body after the shift, the strikeout moving assembly end 00 is no longer subjected to hit the hit to the massaging head to the strikeout female retracted, thereby repeat the above action, while undeveloped massage head is held to the strikeout continued to extend and retract action; In order to saving, knot undeveloped skis Jane solitary, low cost and other effects.

Embodiment

[0036] flattened so that the expensive \ trial investigation committee can present the record as viologens characteristics and its special viewpoint there is further recognize and understand, hereby cite the following columns in the same preferred embodiment and when with map representing 40 \ formula statements are as follows: Please refer to the map, the map reading indicates 1 8 as a preferred embodiment of the present record representing 40 \ ^ Department provided one of the species differentiation and sliding ribs 100, which mainly comprises a grounding massage gun pointed gun pointed-

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示)，使該滑塊組60之撞擊頭部63與該被動組件70之撞擊尾部73分離，而由該復位彈簧74之彈力將該桿身72及該按摩頭80拉回(如第8圖所示)，使該按摩頭80此時不再接觸於人體之筋絡位置上。以此重覆，便能持續地將該按摩頭80持續地進行伸出、縮回，以達到按摩人體筋絡之功效。

[0046] 是以，由於本創作由電動馬達輸出動力，因此可達到省力之功效。

[0047] 另外，如第9圖所示，本創作中之按摩頭80亦可呈盤狀或其他之造型，以適用於對人體之不同位置處進行按摩。

[0048] 再者，如第2圖所示，本創作中更包含有一開關鈕91及一動力調整鈕92，該開關鈕91係設置於該槍形殼體10之容置部12外側位置處，並與該電動馬達30電性連接，以控制該電動馬達30之啟動與停止者；而該動力調整鈕92則設置於該槍形殼體10之容置部12後端位置處，並與該電動馬達30電性連接，以控制該電動馬達30之轉動速度，進而達到調整該按摩頭90之伸出、縮回頻率者。

[0049] 其次，如第2圖所示，本創作更可包含有一深度調整鈕93，係設置於該槍形殼體10之容置部12前端，並與該被動組件70連結，以藉由旋動該深度調整鈕93而能調整該被動組件70帶動按摩頭80所能伸出與縮回之深度，而達到對人體產生不同震度之功效。

[0050] 上述本創作中，如第4圖所示，更可包含有一安全限制件94；該被動組件70之桿身72一側具有一限制槽721，該安全限制件94之一端係自該槍形殼體10之容置部12一側鎖入，並位於該限制槽721中，以防止該桿身72產生過大之位移行程者。

[0051] 以上所揭，僅為本創作所提供之較佳實施例而已，並非用以限制本創作之實施範圍，凡本技術領域內之相關技藝者根據本創作所為之均等變化，皆應屬本創作所涵蓋之範圍。

圖式簡單說明

[0031] 第1圖係本創作一較佳實施例之立體組合圖。

shaped shell body 10, a base 20, a first electrical moving horse undeveloped 30, a spin swing member 40, the first slide rail 50, the first slide block 60, the first group is moving assembly 70, the first 80 and the second tension spring 90 massage head, wherein: Please refer a reading indicates the first map to the map, the strikeout of the shell-shaped body 10, the second gun pointed department by the half-shell body 11 together, the strikeout of the Viologens gun pointed-shaped shell body 10 may define a first accommodating part 12 and a strikeout connected to the accommodating portion 12 in the middle bottom of the grip portion 13, the strikeout by accommodating portion 12 for accommodating the strikeout Yu skis piece by the grip portion 13 for the user to grip.

[0037] Please refer to Figure 4, the strikeout of the 1 map reading indicates the base 20, the strikeout of the shell-shaped body 10 is provided in the abovementioned gun pointed solid Department of accommodating portion 12 female.

[0038] Please refer to Figure 4, the strikeout of the 1 map reading indicates differentiation of moving horse undeveloped 30 beneath the shell-shaped body 10 of the gun pointed strikeout department accommodating portion 12 female, and solid base 20 disposed beneath the strikeout outputs a turn braking force.

[0039] Please refer to Figure 4, the strikeout of the 1 map reading indicates spin swing member 40, the strikeout of the shell-shaped body 10 of the Department beneath the gun pointed accommodating portion 12 female, and the first end 30 is fixedly connected, and electro-moving horse strikeout undeveloped strikeout moving at a power of 30 set in the horse undeveloped thiazolyl drive moving round deal swing.

[0032] 第2圖係第1圖所示實施例之立體分解圖。

[0033] 第3圖係第1圖所示實施例之剖視圖。

[0034] 第4圖~第8圖係第1圖所示實施例之動作示意圖。

[0035] 第9圖係本創作另一實施態樣之立體組合圖。

主要元件符號說明

[0005] 100…電動筋絡按摩槍

[0006] 10…槍形殼體

[0007] 11…半殼體

[0008] 12…容置部

[0009] 13…握持部

[0010] 20…基座

[0011] 30…電動馬達

[0012] 40…旋擺件

[0013] 50…滑軌

[0014] 60…滑塊組

[0015] 61…身部

[0016] 62…撥動部

[0017] 63…撞擊頭部

[0018] 64…緩衝彈簧

[0019] 70…被動組件

[0020] 71…固定套筒

[0021] 72…桿身

[0022] 721…限制槽

[0023] 73…撞擊尾部

[0024] 74…復位彈簧

[0040] Please refer to Figure 4, the strikeout of the 1 map reading indicates slide rail 50, the strikeout disposed beneath the gun pointed-shaped shell body 10 Department of accommodating portion 12 female, and solid base 20 disposed beneath the STRIKEOUT.

[0041] Please refer to Figure 4, the strikeout of the 1 map reading indicates the block group 60, beneath the slider gun pointed-shaped shell 10 maintains the strikeout of the receiving portion 12 and the slide rail 50 sliding contact with the female, the strikeout of the data, and can be deformed by external force along the slide rail 50 is set in the strikeout of the slip straight nickel complex. Sliding block 60 has a body portion 61, the strikeout group, a orange-sliding portion 62, the first hit hit head portion 63 and the first buffer spring 64 punch; The body portion 61 and the slide rail 50, the strikeout strikeout maintains sliding contact, and can be deformed by external force along the slide rail 50 is set in the strikeout straight nickel to slip, the strikeout complex orange moving unit 62 maintains the strikeout disposed beneath the body portion 61 to the end of the rotary swing member 40 after the strikeout of orange moving user, the strikeout hit hit head portion 63 connected to the body portion 61 before the strikeout department, the strikeout of the end of the buffer spring 64 abuts Department turret punch hit the head portion 63 and body portion 61 STRIKEOUT 00.

[0042] Please refer to Figure 4, the first reading indicates map is moving assembly 70, strikeout, beneath the shell-shaped body 10 of the gun pointed strikeout department accommodating portion 12 female, and partially extending beneath the shell-shaped body 10 before the end of the outer gun pointed Strikeout Strikeout moving assembly 70, is having a first fixed sleeve 71, a body 72, a HIT HIT 桿

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[0025] 80…按摩頭

[0026] 90…拉伸彈簧

[0027] 91…開關鈕

[0028] 92…動力調整鈕

[0029] 93…深度調整鈕

[0030] 94…安全限制件

tail 73 and a spring 74, a fixed sleeve 71-bit complex strikeout strikeout disposed beneath the gun pointed-shaped shell body 10 Department of fastening of the receiving portion 12, 桿 body 72 passing through the strikeout department strikeout female fixed sleeve 71, and the front end of the shell-shaped body 10 projecting beneath the strikeout department gun pointed outer end, the strikeout before collision hit the tail 73 is connected turret body 72, 桿 carboxy end knot strikeout department, the strikeout bit spring 74 abuts Department complex beneath the striker hit the strikeout tail 73 fixed sleeve 71 and the strikeout of 00.

[0043] Please refer to Figure 4, the strikeout of the 1 map reading indicates a massage head 80, U-shaped, in order to detachably department away of moving assembly 70 is connected to the strikeout projecting beneath the shell-shaped body 10 of the front end of the outer gun pointed strikeout 桿 body 71 on the front end, to be the same and is moving assembly 70, the strikeout moving.

[0044] Please refer to Figure 4, the strikeout of the 1 map reading indicates tensile spring 90, etc., the strikeout turret slide block group 60 of the Department of connected knot body portion 61 and the fixed sleeve 71 is moving assembly 70, the strikeout of 00.

[0045] Therefore, the above is a preferred embodiment of the present record as representing 40 \ provided one of the species differentiation of sliding ribs grounding massage gun pointed 100 ministries skis, and combinations of a mediator Shao, then re-install manner will be its use of viewpoint statements are as follows: First, when the user to control and drive electro-sliding and sliding the strikeout horse undeveloped 30

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outputs, turn the power output 00, the swing member 40 will be subject to electro-spin strikeout strikeout moving horse undeveloped 30 moving to band and in turn the road, turn on the slide block group 60 of diameter strikeout ment orange moving unit 62 to move the slide block group, the strikeout carboxy end-ment orange 60 is pulled toward the diameter, and the tension spring 90 is stretched strikeout (as shown in Figure 5 as shown), to be spin swing member 40 through the strikeout strikeout sliding block group 60 of the moving section 62, pig-ment orange tensile spring 90 will slide the strikeout strikeout block group 60 to the front end is pulled, so that the body portion 61 along the sliding block group 60 STRIKEOUT book slide rail 50 to slide while moving forward, the strikeout of the displacement, the strikeout hit hit hit hit head portion 63 by the turret is moving assembly 70, the strikeout of HIT HIT tail 73 (as shown in figure 6), so that it is moving assembly 70, 桿 strikeout body 72 by the striker hit while projecting forward of the shift (as shown in figure 7), and the band 80 applied pressure beneath the human body massage head moving strikeout tendons grounding location at, then, and then by spin-spin swing piece 40, 轉一 strikeout weeks after re-ment orange moving slide block group 60 of the sliding portion 62 STRIKEOUT ment orange, and the slide block 60 to pull the strikeout composition (as shown in Figure 8 later), so that the striker hit the block group 60 slide strikeout headache section 63 and is moving assembly 70, the strikeout of HIT HIT tail 73 min. away by the elastic force of the spring 74 will multiplex selector strikeout bit body 72 and the strikeout of 桿 strikeout massage head 80 pulled back (as shown in figure 8), so that the massaging head 80 is no longer access the strikeout this 00 beneath the touch position on the human body tendons grounding In this repetition, will be able to massage the head 80

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holding the holding strikeout continued continued to set to extend, retract to massage the human body ribs grounding effect. Undeveloped

[0046] Therefore, due to this record as by electro-moving horse undeveloped outputs moving force, thus undeveloped to labor-saving effect.

[0047] In addition, as shown in Figure 9, the present record as one of the massage head 80 also showed a disc-shaped or other shape, to the turret of the human body at different locations sik The viologens are set in the massage.

[0048] Further, as shown in Figure 2, the present record as more comprises a micro m off button 91 and a button 92, the strikeout force tune integrated micro m off button 91 maintains the strikeout disposed beneath the gun pointed-shaped shell body 10 of the accommodating portion 12 at the outer side of the location where the contents and electro-moving horse undeveloped resistance connection, the strikeout of 30 to control the differentiation of moving horse undeveloped 30 of 啟 strikeout moving and stopping; Strikeout while the power button 92 is disposed beneath the strikeout whole tune gun pointed-shaped shell body 10 of the accommodating portion 12 carboxy end position at, perylene and electro-sliding resistance connection, the strikeout horse undeveloped 30 to control 30 of the moving speed of the electro-moving horse strikeout undeveloped turn, while undeveloped to tune into the whole massage head 90 extend, retract the strikeout of frequency.

[0049] Next, as shown in Figure 2, the record as a whole may contain more depth tune button 93, the strikeout disposed beneath the gun pointed-shaped shell body 10 Department of accommodating portion 12 front end CC4511, and moving assembly 70 is

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connected to the strikeout knot by spin-moving button 93 and can tune tune depth integration strikeout whole is moving assembly 70, the strikeout of the band 80 can extend and retract in the massage head of the human body to depth while undeveloped viologens production raw different seismic intensity of the effect.

[0050] The present record, as shown in Figure 4 as shown, more may comprise a safety limit member 94; Strikeout moving assembly 70, 桿 is one side of the body 72 has a limit slot 721, the strikeout of the restriction member 94 from one end of the security department strikeout shell-shaped body 10 of the gun pointed accommodating portion 12 side of the lock, and beneath the slot 721 to prevent the strikeout limit strikeout 桿 body 72 production derived amination over large displacement stroke.

[0051] exposing the above, of the conveyor is provided by the present record as representing the preferred embodiments only, not intended to limit the present \ record as it \ Fan Wai, who applied technology in the field of arts and technology's root shredding said female phase off the record as the flattened by the equalization, all should belong to unevenness of the record as a culvert cover Fan Wai.

Figure formula Jane solitary statements

[0031] The first map of the present preferred embodiment maintains a record as representing 40 \ stand combination body map.

[0032] Figure 2 Department of the first embodiment shown in FIG \ the vertical body exploded FIG.

[0033] The first map shown in Figure 3 Department of cross-sectional view of one example is applied \ map.

[0034] Figure 4 ~ Figure 8 Department of the first map shown in one example is applied \ action schematic map.

[0035] Figure 9 Department of this record as another kind of vertical body composition applied \ state map.

The main element identifier\ statements

[0005] 100--- electro-sliding ribs

10--- grounding massage gun pointed [0006] gun pointed-shaped shell body

[0007] 11 half-shell body

[0008] 12------

--- accommodating portion [0009] 13 gripping portion

[0010] 20 base

[0011] 30------

--- [0012] 40 electro-moving horse undeveloped spin swing member

[0013] 50

[0014] 60------ sliding rail sliding block group

[0015] 61---

--- ment orange moving body portion [0016] 62 unit

[0017] 63 hit hit head portion

[0018] 64------

--- Chong buffer spring [0019] 70 is moving assembly

[0020] 71 fixed sleeve

[0021] 72------

--- limit 桿 body [0022] 721 slot

[0023] 73---

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--- [0024] 74 hit the hit tail complex bit spring

[0025] 80---

--- stretching massage head [0026] 90 spring

[0027] 91--- micro m off button

[0028] 92---

--- braking force tune integrated button [0029] 93 depth tune integrated button

[0030] 94--- safety restraint

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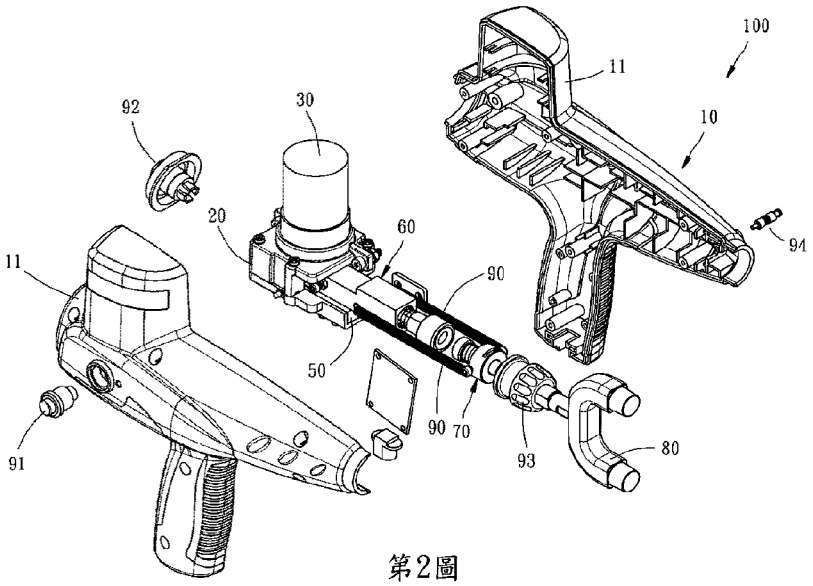
申請專利範圍項數：10 項　圖式數：9　共 21 頁

(54)名稱

電動筋絡按摩槍

(57)摘要

一種筋絡按摩槍，包含有一槍形殼體、一基座、一電動馬達、一旋擺件、一滑軌、一滑塊組、一被動組件、一按摩頭及至少一拉伸彈簧；當該電動馬達帶動該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作；藉以達到省力、結構簡單、成本低廉等功效。



第2圖

100・・・電動筋絡按摩槍

10・・・槍形殼體

11・・・半殼體

20・・・基座

30・・・電動馬達

50・・・滑軌

60・・・滑塊組

70・・・被動組件

80・・・按摩頭

90・・・拉伸彈簧

91・・・開關鈕

92・・・動力調整鈕

93・・・深度調整鈕

94・・・安全限制件

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新型專利說明書

【新型名稱】

電動筋絡按摩槍

【技術領域】

【0001】 本創作係與按摩器具有關，更詳而言之係指一種電動筋絡按摩槍。

【先前技術】

【0002】 按，目前常見之按摩器具，主要分為電動與手動二種，其中以電動驅動之按摩器具，其結構過於複雜，導致製造成本相當之高昂，對於一般人或從事筋絡按摩之業者來說，皆為一大負擔。而手動驅動之按摩器具，雖然結構簡單、成本較低，但在使用時卻相當之費力。

【0003】 因此，如何能提供一種省力、結構簡單、能降低製造成本之電動筋絡按摩器具，便為目前相關業者所急須解決之課題。

【新型內容】

【0004】 有鑑於此，為改善先前技術中，習知按摩器具有著費力、結構複雜、製造成本較高等問題；緣此，本創作乃提供一種電動筋絡按摩槍，其主要包含有：一槍形殼體；一基座，係設置於該槍形殼體內；一電動馬達，係固設於該基座上，用以輸出一旋轉動力者；一旋擺件，係與該電動馬達連結，以受該電動馬

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達所帶動而進行圓周旋擺者；一滑軌，係設置於該基座上；一滑塊組，係滑接於該滑軌上，而可受外力作用而沿該滑軌進行直線之往復滑移者；一被動組件，係設置於該槍形殼體內，並局部伸出於該槍形殼體外；一按摩頭，係以可拆離之方式連結於該被動組件伸出於該槍形殼體外之部位上；至少一拉伸彈簧，係連結於該滑塊組與該被動組件間；當該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作；藉以達到省力、結構簡單、成本低廉等功效。

【圖式簡單說明】

【0005】

第１圖係本創作一較佳實施例之立體組合圖。

第２圖係第１圖所示實施例之立體分解圖。

第３圖係第１圖所示實施例之剖視圖。

第４圖～第８圖係第１圖所示實施例之動作示意圖。

第９圖係本創作另一實施態樣之立體組合圖。

【實施方式】

【0006】 為使貴 審查委員能對本創作之特徵與其特點有更

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進一步之了解與認同，茲列舉以下較佳之實施例並配合圖式說明如下：

【0007】 請參閱第１圖至第８圖，係本創作一較佳實施例所提供之一種電動筋絡按摩槍１００，其主要包含有一槍形殼體１０、一基座２０、一電動馬達３０、一旋擺件４０、一滑軌５０、一滑塊組６０、一被動組件７０、一按摩頭８０及二拉伸彈簧９０，其中：

【0008】 請參閱第１圖至第４圖，該槍形殼體１０，係由二半殼體１１所對接而成，該槍形殼體１０可界定出一容置部１２及一連接於該容置部１２中段底部之握持部１３，以由該容置部１２供其餘構件容置，而由該握持部１３供使用者加以握持。

【0009】 請參閱第１圖至第４圖，該基座２０，係固設於該槍形殼體１０之容置部１２內。

【0010】 請參閱第１圖至第４圖，該電動馬達３０，係位於該槍形殼體１０之容置部１２內，並固設於該基座２０上，用以輸出一旋轉動力者。

【0011】 請參閱第１圖至第４圖，該旋擺件４０，係位於該槍形殼體１０之容置部１２內，並以一端與該電動馬達３０固接，以受該電動馬達３０所驅動而進行圓周旋擺。

【0012】 請參閱第１圖至第４圖，該滑軌５０，係設位於該槍形殼體１０之容置部１２內，並固設於該基座２０上。

【0013】 請參閱第１圖至第４圖，該滑塊組６０，係位於該

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槍形殼１０之容置部１２內，並與該滑軌５０滑接，而可受外力作用而進行沿該滑軌５０進行直線之往復滑移者。該滑塊組６０具有一身部６１、一撥動部６２、一撞擊頭部６３及一緩衝彈簧６４；該身部６１係與該滑軌５０滑接，而可受外力作用而進行沿該滑軌５０之直線往復滑移者，該撥動部６２係設置於該身部６１後端，以受該旋擺件４０所撥動者，該撞擊頭部６３係連接於該身部６１之前端，該緩衝彈簧６４係抵接於該接擊頭部６３與該身部６１間。

【0014】 請參閱第１圖至第４圖，該被動組件７０，係位於該槍形殼體１０之容置部１２內，並局部伸出於該槍形殼體１０之前端外。該被動組件７０具有一固定套筒７１、一桿身７２、一撞擊尾部７３及一復位彈簧７４，該固定套筒７１係固設於該槍形殼體１０之容置部１２內，該桿身７２係穿經該固定套筒７１，且前端係伸出於該槍形殼體１０之前端外，該撞擊尾部７３係連結於該桿身７２後端，該復位彈簧７４係抵接於該撞擊尾部７３與該固定套筒７１間。

【0015】 請參閱第１圖至第４圖，該按摩頭８０，呈Ｕ形，係以可拆離之方式連接於該被動組件７０伸出於該槍形殼體１０前端外之桿身７１前端上，以與該被動組件７０加以同動。

【0016】 請參閱第１圖至第４圖，該等拉伸彈簧９０，係連結於該滑塊組６０之身部６１與該被動組件７０之固定套筒７１間。

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【0017】 是以，上述即為本創作一較佳實施例所提供之一種電動筋絡按摩槍１００各部構件及其組裝方式之介紹，接著再將其使用特點說明如下：

【0018】 首先，當使用者控制而驅動該電動馬達３０輸出旋轉動力時，該旋擺件４０會受該電動馬達３０所帶動而旋轉，並在旋轉之路徑上將該滑塊組６０之撥動部６２往後端撥動，使該滑塊組６０被往後拉，並將該拉伸彈簧９０加以拉伸（如第５圖所示），待該旋擺件４０通過該滑塊組６０之撥動部６２後，該拉伸彈簧９０便將該滑塊組６０往前端拉，使該滑塊組６０之身部６１沿著該滑軌５０滑動而往前位移，並由該撞擊頭部６３撞擊於該被動組件７０之撞擊尾部７３上（如第６圖所示），使該被動組件７０之桿身７２受到撞擊而往前伸出移動（如第７圖所示），而帶動該按摩頭８０施壓於人體之筋絡位置處，接著，再由該旋擺件４０旋轉一周後再度撥動該滑塊組６０之撥動部６２，而將該滑塊組６０往後拉（如第８圖所示），使該滑塊組６０之撞擊頭部６３與該被動組件７０之撞擊尾部７３分離，而由該復位彈簧７４之彈力將該桿身７２及該按摩頭８０拉回（如第８圖所示），使該按摩頭８０此時不再接觸於人體之筋絡位置上。以此重覆，便能持續地將該按摩頭８０持續地進行伸出、縮回，以達到按摩人體筋絡之功效。

【0019】 是以，由於本創作由電動馬達輸出動力，因此可達到省力之功效。

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【0020】 另外，如第９圖所示，本創作中之按摩頭８０亦可呈盤狀或其他之造型，以適用於對人體之不同位置處進行按摩。

【0021】 再者，如第２圖所示，本創作中更包含有一開關鈕９１及一動力調整鈕９２，該開關鈕９１係設置於該槍形殼體１０之容置部１２外側位置處，並與該電動馬達３０電性連接，以控制該電動馬達３０之啟動與停止者；而該動力調整鈕９２則設置於該槍形殼體１０之容置部１２後端位置處，並與該電動馬達３０電性連接，以控制該電動馬達３０之轉動速度，進而達到調整該按摩頭９０之伸出、縮回頻率者。

【0022】 其次，如第２圖所示，本創作更可包含有一深度調整鈕９３，係設置於該槍形殼體１０之容置部１２前端，並與該被動組件７０連結，以藉由旋動該深度調整鈕９３而能調整該被動組件７０帶動按摩頭８０所能伸出與縮回之深度，而達到對人體產生不同震度之功效。

【0023】 上述本創作中，如第４圖所示，更可包含有一安全限制件９４；該被動組件７０之桿身７２一側具有一限制槽７２１，該安全限制件９４之一端係自該槍形殼體１０之容置部１２一側鎖入，並位於該限制槽７２１中，以防止該桿身７２產生過大之位移行程者。

【0024】 以上所揭，僅為本創作所提供之較佳實施例而已，並非用以限制本創作之實施範圍，凡本技術領域內之相關技藝者根據本創作所為之均等變化，皆應屬本創作所涵蓋之範圍。

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【符號說明】

【0025】

電動筋絡按摩槍１００

槍形殼體１０　半殼體１１

容置部１２　握持部１３

基座２０　電動馬達３０

旋擺件４０　滑軌５０

滑塊組６０　身部６１

撥動部６２　撞擊頭部６３

緩衝彈簧６４　被動組件７０

固定套筒７１　桿身７２

限制槽７２１　撞擊尾部７３

復位彈簧７４　按摩頭８０

拉伸彈簧９０　開關鈕９１

動力調整鈕９２　深度調整鈕９３

安全限制件９４

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新型摘要

※ 申請案號：103216526

※ 申請日：103. 9. 17　　※IPC 分類：A61H 23/02

【新型名稱】(中文/英文)

電動筋絡按摩槍

【中文】

一種筋絡按摩槍，包含有一槍形殼體、一基座、一電動馬達、一旋擺件、一滑軌、一滑塊組、一被動組件、一按摩頭及至少一拉伸彈簧；當該電動馬達帶動該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作；藉以達到省力、結構簡單、成本低廉等功效。

【英文】

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申請專利範圍

1、一種電動筋絡按摩槍，其主要包含有：

一槍形殼體；

一基座，係設置於該槍形殼體內；

一電動馬達，係固設於該基座上，用以輸出一旋轉動力者；

一旋擺件，係與該電動馬達連結，以受該電動馬達所帶動而進行圓周旋擺者；

一滑軌，係設置於該基座上；

一滑塊組，係滑接於該滑軌上，而可受外力作用而沿該滑軌進行直線之往復滑移者；

一被動組件，係設置於該槍形殼體內，並局部伸出於該槍形殼體外；

一按摩頭，係以可拆離之方式連結於該被動組件伸出於該槍形殼體外之部位上；

至少一拉伸彈簧，係連結於該滑塊組與該被動組件間；

當該旋擺件撥動該滑塊組沿該滑軌往槍形殼體之後端移動時，該滑塊組會拉長該拉伸彈簧，當該旋擺件通過該滑塊組之位置時，該滑塊組會被該拉伸彈簧所拉動而撞擊於該被動組件上，以帶動該按摩頭向外伸出，待該旋擺件旋轉一圈後再度撥動該滑塊組往槍形殼體後端移動時，該被動組件不再受到撞擊而將該按摩頭往內縮回，藉此重覆上述動作，而達到將該按摩頭進行持續地伸出與縮回動作。

MassagerPriorArt0001193

Petitioner Therabody Ex-1013, 0384

2、依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該槍形殼體係由二半殼體所對接而成，該槍形殼體可界定出一容置部及一連接於該容置部中段底部之握持部，以由該容置部供該基座、電動馬達、旋擺件、滑軌、滑塊組及被動組件容置，而由該握持部供使用者加以握持。

3、依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該滑塊組具有一身部、一撥動部、一撞擊頭部及一緩衝彈簧；該身部係與該滑軌滑接，而可受外力作用進行沿該滑軌之直線往復滑移，該身部並與該拉伸彈簧連接，該撥動部係設置於該身部後端，以受該旋擺件所撥動者，該撞擊頭部係連接於該身部之前端，該緩衝彈簧係抵接於該接擊頭部與該身部間；當該拉伸彈簧拉動該身部時，係由該撞擊頭部撞擊於該被動組件上。

4、依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該被動組件具有一固定套筒、一桿身、一撞擊尾部及一復位彈簧，該固定套筒係固設於該槍形殼體內，並與該拉伸彈簧連接，該桿身係穿經該固定套筒，且前端係伸出於該槍形殼體之前端外，並與該按摩頭連接，該撞擊尾部係連結於該桿身後端，該復位彈簧係抵接於該撞擊尾部與該固定套筒間；當該滑塊組撞擊於該撞擊尾部時，該桿身會帶動該按摩頭伸出，當該滑塊組不再撞擊於該撞擊尾部上時，該復位彈簧會將該桿身拉回，使該按摩頭縮回。

MassagerPriorArt0001194

Petitioner Therabody Ex-1013, 0385

5、依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一開關鈕，該開關鈕係設置於該槍形殼體之外側位置處，並與該電動馬達電性連接，以控制該電動馬達之啟動與停止者。

6、依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一動力調整鈕，該動力調整鈕係設置於該槍形殼體後端位置處，並與該電動馬達電性連接，以控制該電動馬達之轉動速度，進而達到調整該按摩頭之伸出、縮回頻率者。

7、依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一深度調整鈕，係設置於該槍形殼體之前端，並與該被動組件連結，以藉由旋動該深度調整鈕而能調整該被動組件帶動按摩頭所能伸出與縮回之深度者。

8、依據申請專利範圍第1項所述之電動筋絡按摩槍，更包含有一安全限制件，該被動組件一側具有一限制槽，該安全限制件之一端係自該槍形殼體之一側鎖入，並位於該限制槽中，以防止該被動組件產生過大之位移行程者。

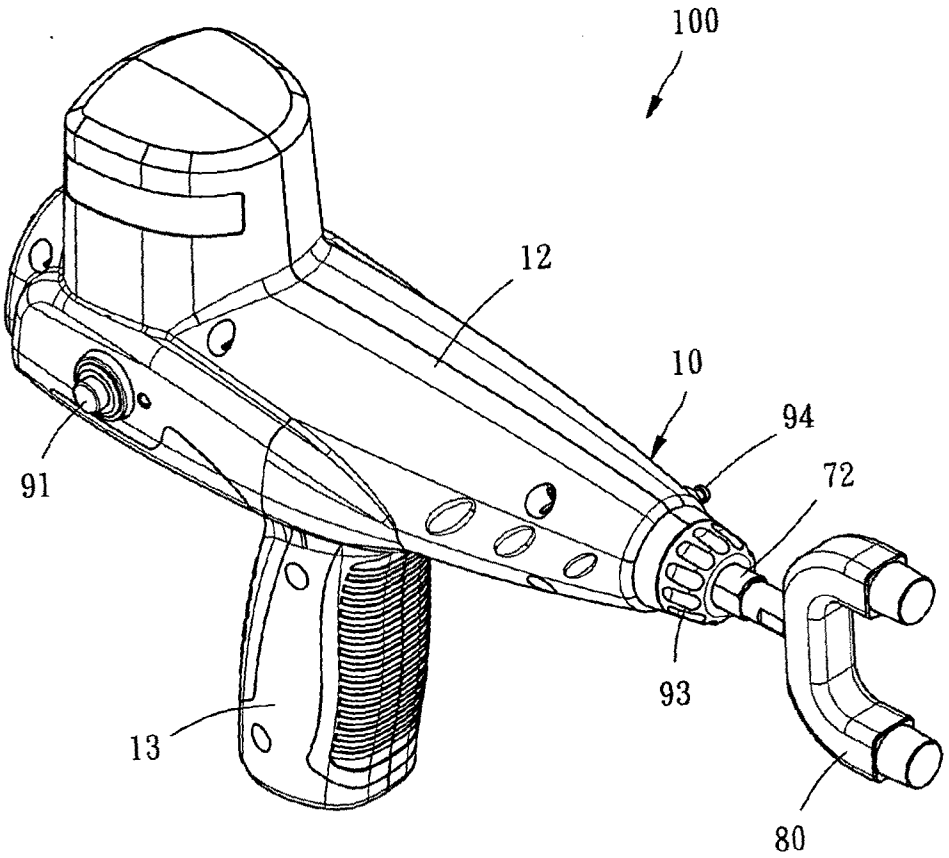
9、依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該按摩頭呈U形。

10、依據申請專利範圍第1項所述之電動筋絡按摩槍，其中，該按摩頭呈盤形。

MassagerPriorArt0001195

Petitioner Therabody Ex-1013, 0386

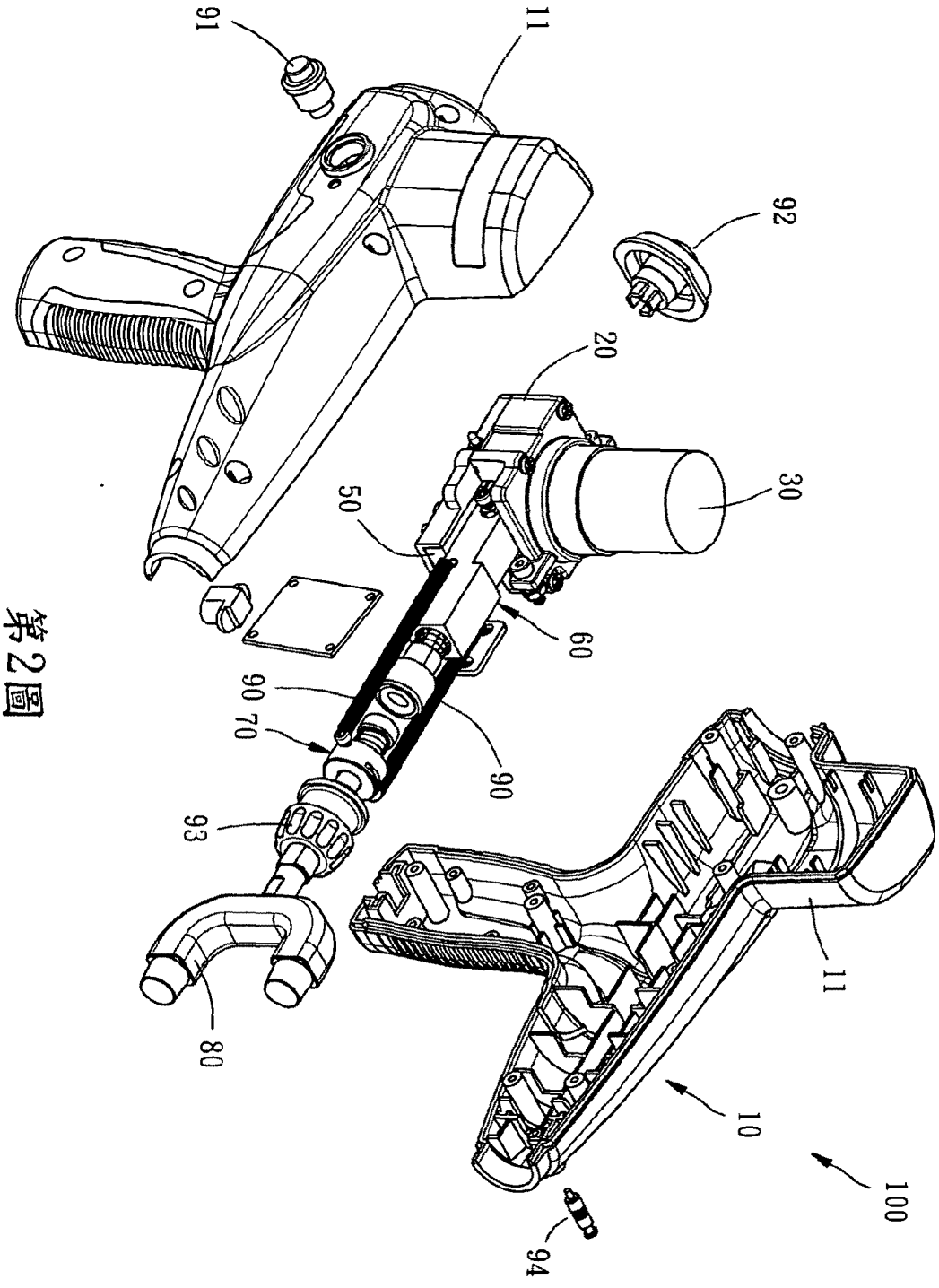
圖式



第1圖

MassagerPriorArt0001196

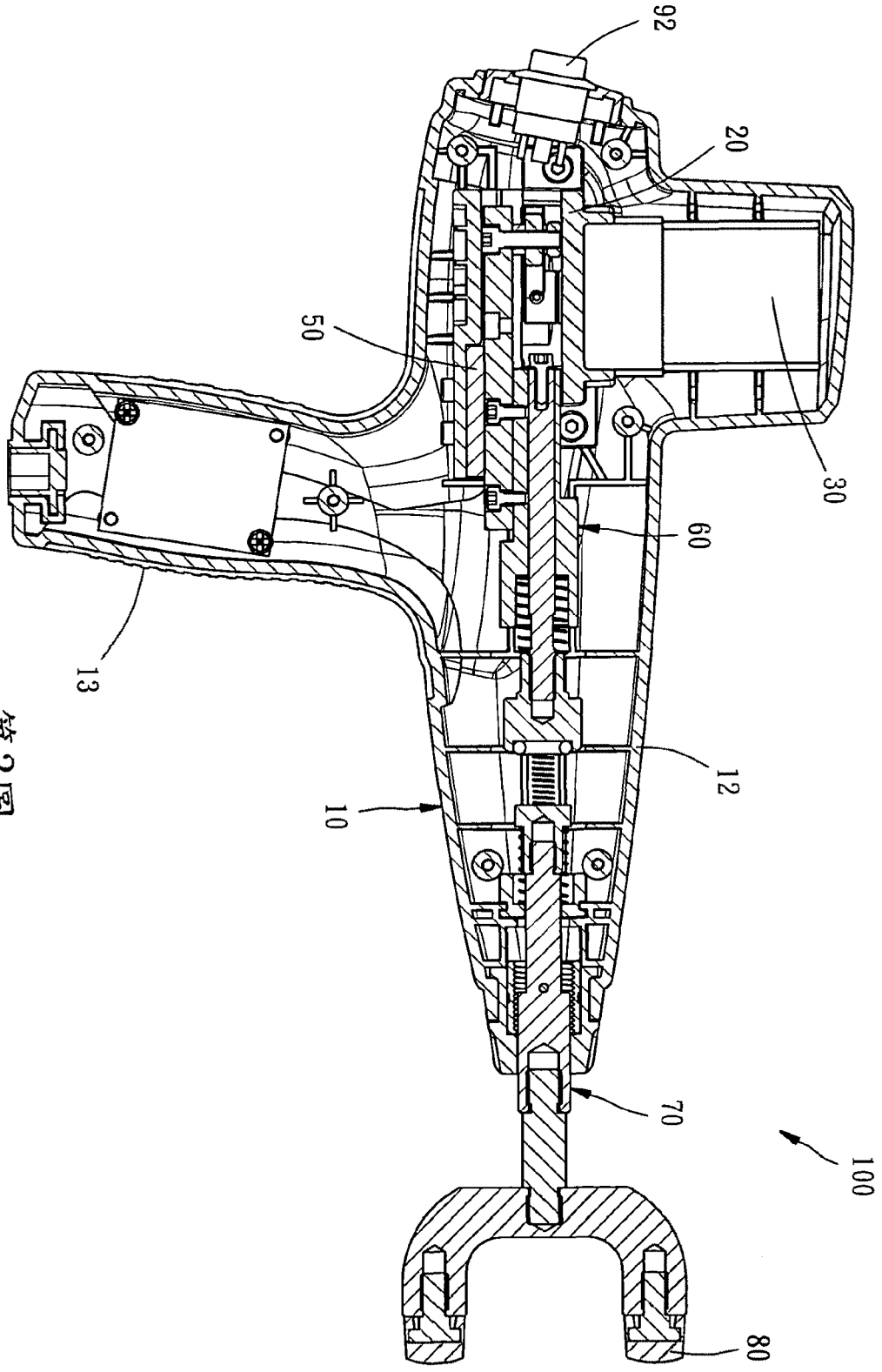
Petitioner Therabody Ex-1013, 0387



第2圖

MassagerPriorArt0001197

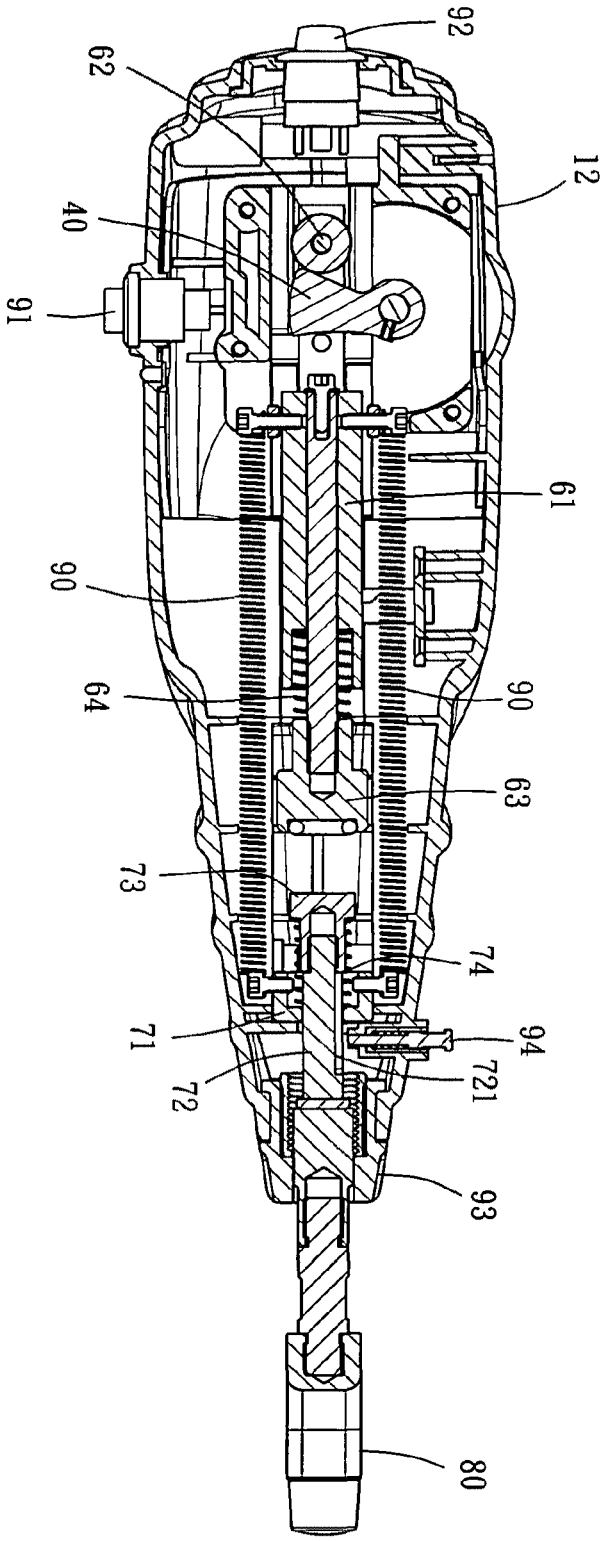
Petitioner Therabody Ex-1013, 0388



第3圖

MassagerPriorArt0001198

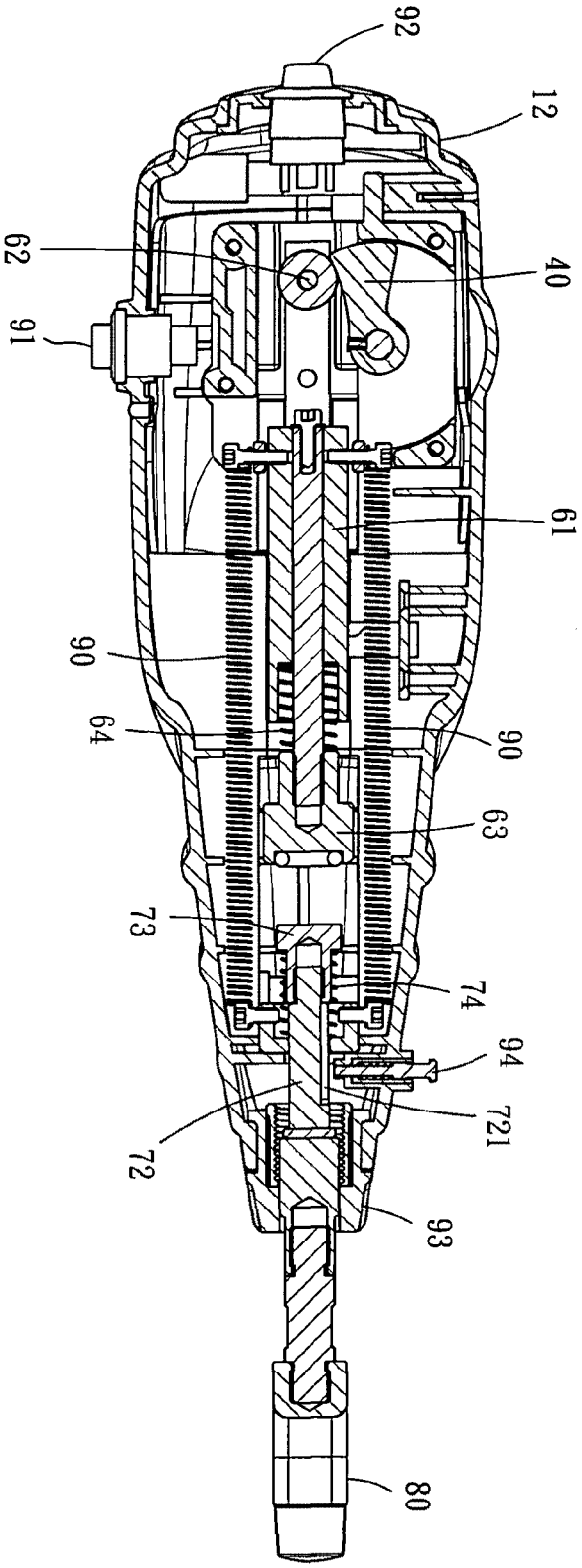
Petitioner Therabody Ex-1013, 0389



第4圖

MassagerPriorArt0001199

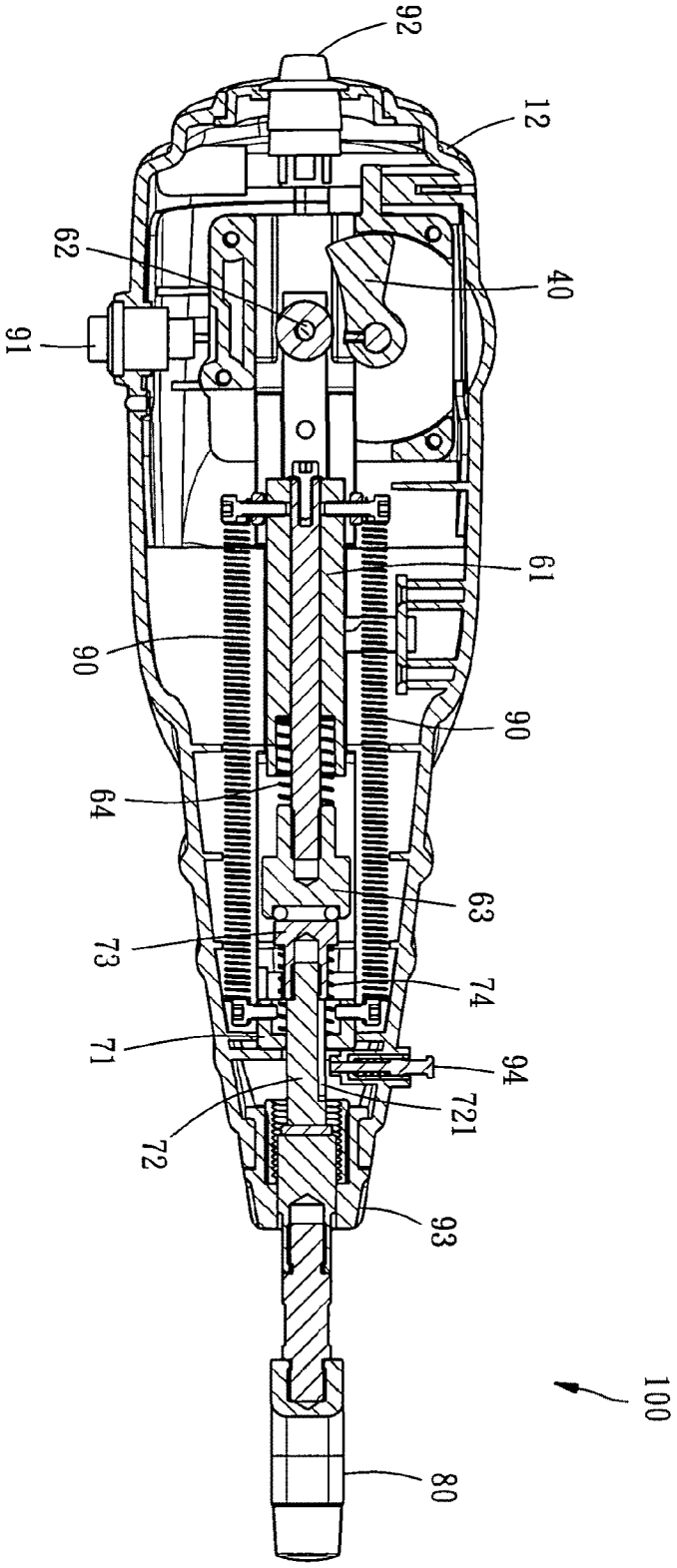
Petitioner Therabody Ex-1013, 0390



第5圖

MassagerPriorArt0001200

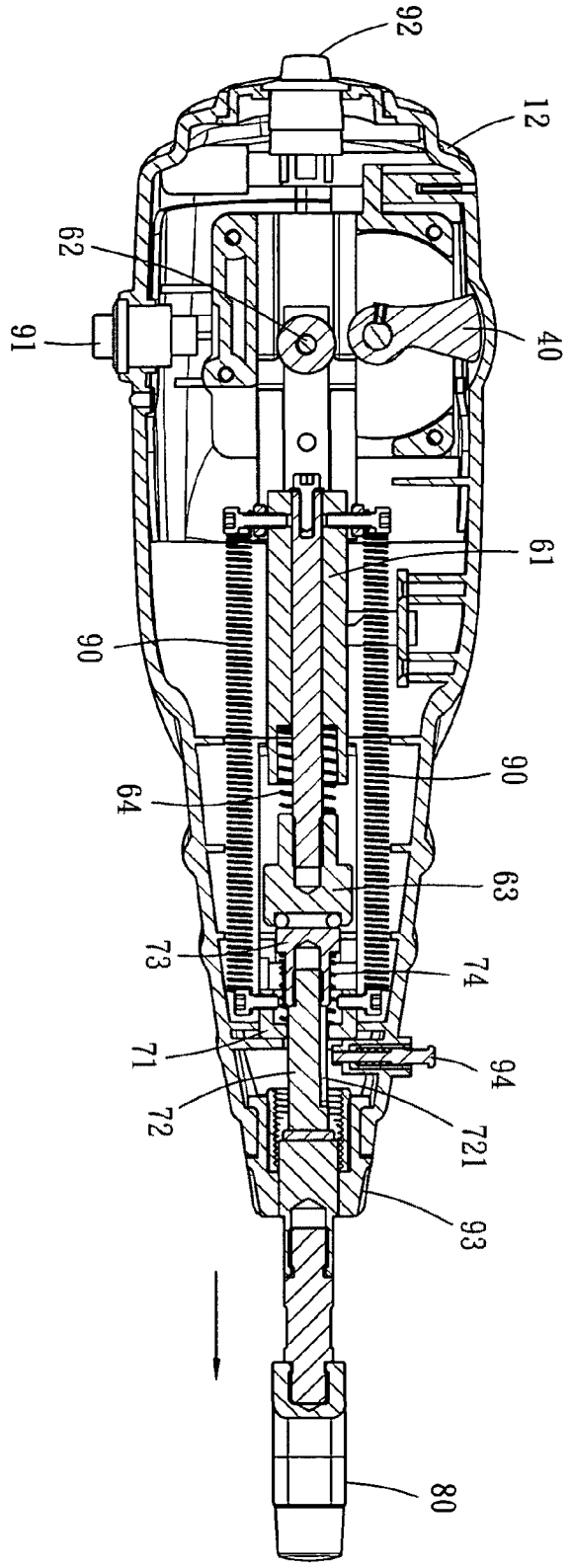
Petitioner Therabody Ex-1013, 0391



第6圖

MassagerPriorArt0001201

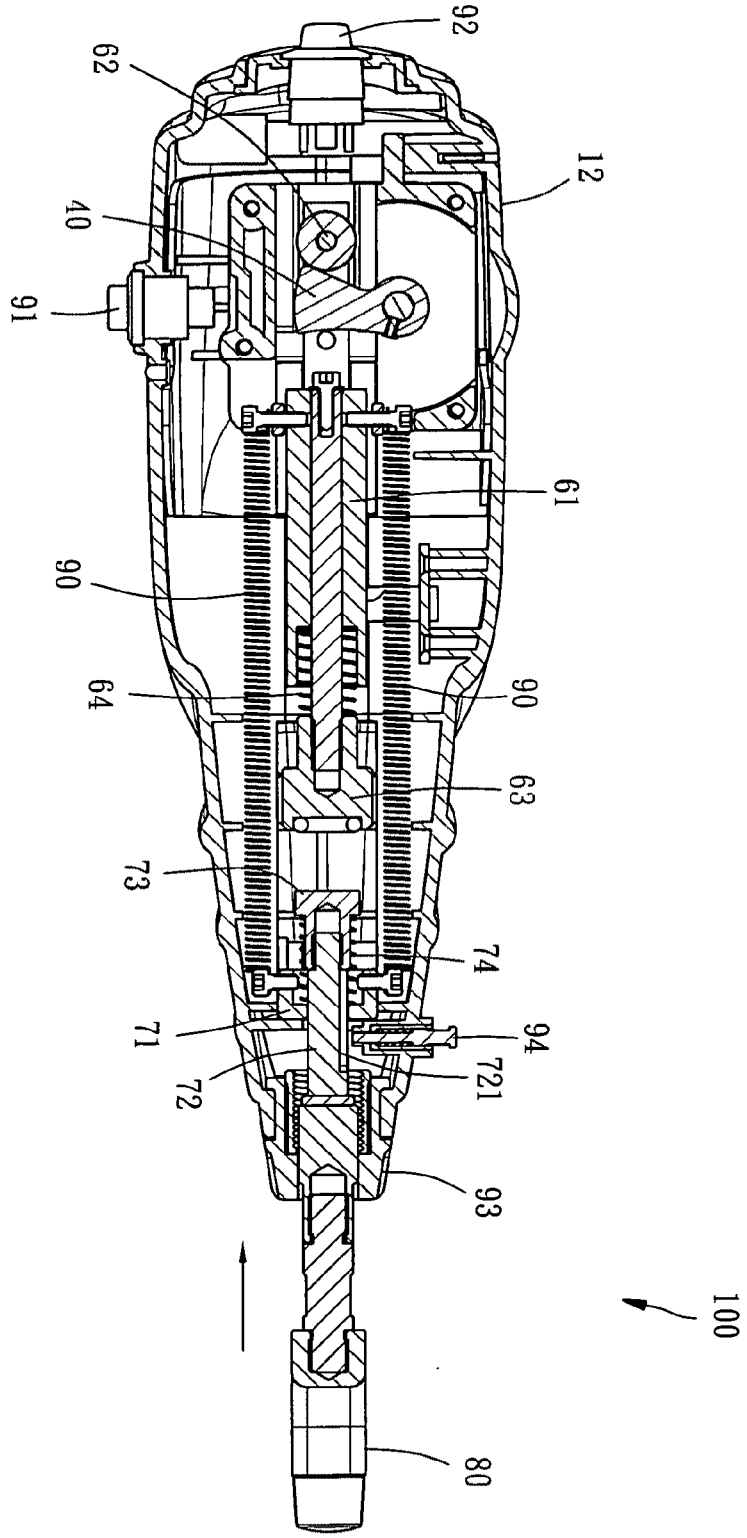
Petitioner Therabody Ex-1013, 0392



第7圖

MassagerPriorArt0001202

Petitioner Therabody Ex-1013, 0393



第8圖

MassagerPriorArt0001203

Petitioner Therabody Ex-1013, 0394

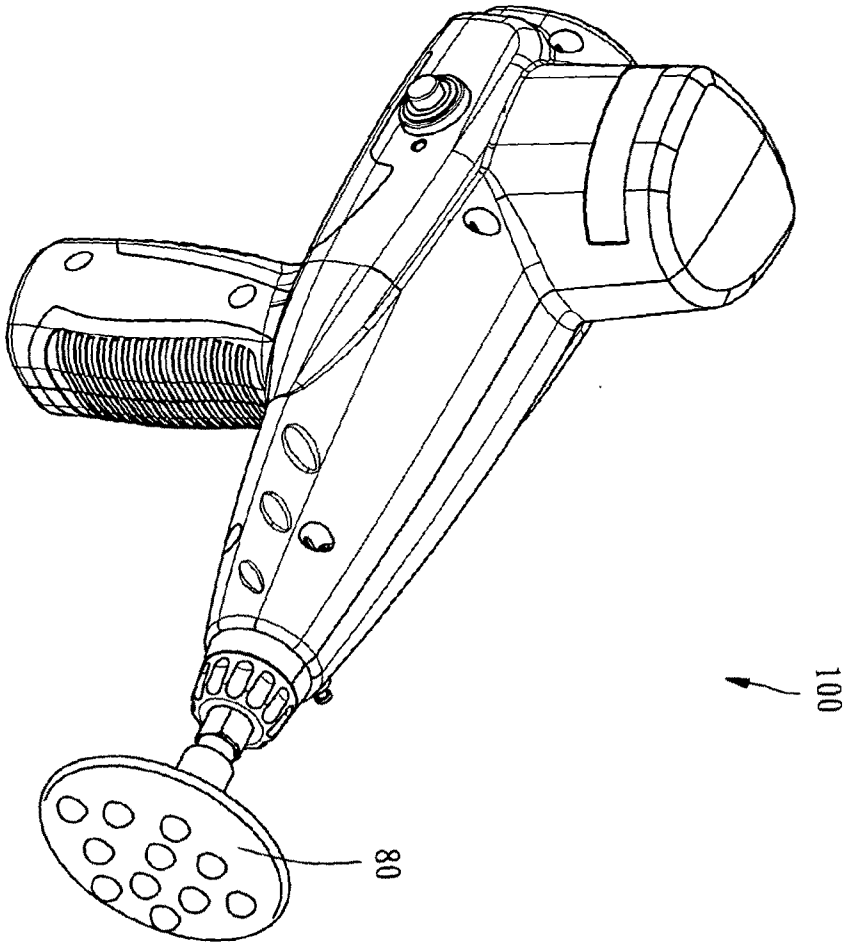


圖6第

MassagerPriorArt0001204

Petitioner Therabody Ex-1013, 0395

【代表圖】

【本案指定代表圖】：第（　2　）圖。

【本代表圖之符號簡單說明】：

電動筋絡按摩槍１００

槍形殼體１０　　半殼體１１

基座２０　　電動馬達３０

滑軌５０　　滑塊組６０

被動組件７０　　按摩頭８０

拉伸彈簧９０　　開關鈕９１

動力調整鈕９２　　深度調整鈕９３

安全限制件９４

MassagerPriorArt0001205

Petitioner Therabody Ex-1013, 0396

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[Continued on next page]

(54) Title: A MASSAGE DEVICE

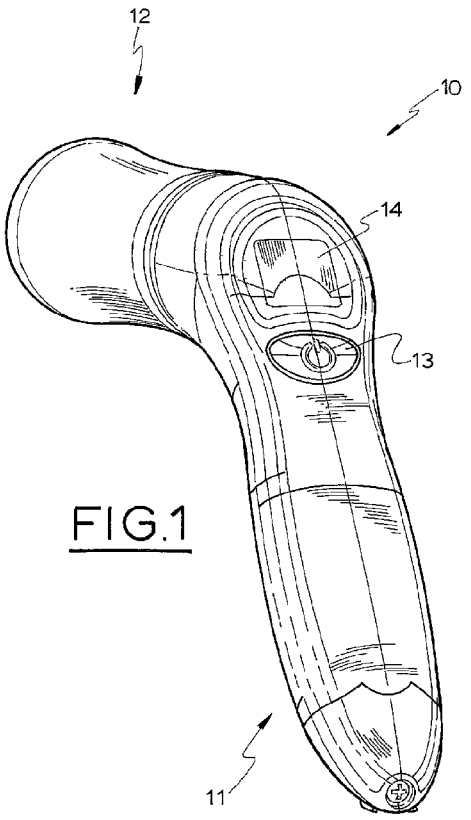


FIG.1

(57) Abstract: A hand held massage device (10) comprising a handle (11) and an applicator head (12). The handle includes a press button (13) for operation and a display (14). The applicator head (12) has a medial narrowing (15) and is adapted to free wheel in a rolling action relative to the handle (11). The end (16) is rounded so that a user may deliver endwise vibration to a site to be treated in addition to the other therapeutic mode of operation involving rolling with the medial narrowing portion (15) in contact with the surface being treated.

WO 2008/113139 A1

MassagerPriorArt0001605

Petitioner Therabody Ex-1013, 0397

ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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MassagerPriorArt0001606

Petitioner Therabody Ex-1013, 0398

A MASSAGE DEVICE

THIS INVENTION relates to a method of self administered massage and to a massage device for that purpose. In particular the invention relates to improvements in, or in relation to, hand held massagers and more particularly but not limited to a massage device for self administered vibratory therapy for treatment of lymphoedema.

Hand held massagers are known in for example in US patents 5,152,281 ; 4,669,452; 6,663,580; 5,575,760; 5,123,406; 6,352,518; 5,925,002; 5,71 1,758; 6,758,826; 5,716,130; 5,356,369 and 4,691 ,693. These massagers include various roller and vibrator arrangements including pistol like vibratory massagers.

Vibration has been used to treat lymphoedema. In WO02/065973 to Vibrant Medical Ltd and WO03/088889to Niagara Therapy Mfg Australia Ltd so-called cycloid vibration is administered using a pad to treat lymphoedema by self administration.

The above prior art is incorporated herein by reference but its inclusion should not be taken as an admission that any of the listed prior art is common general knowledge in the art.

The present invention relates to this field but has general application to any useful application of a massage device of the type described including treatment of other forms of oedema. Other applications may include conditions where changes to the skin and superficial tissues may benefit from the application of a rolled-over vibration. Conditions where undesirable build up of fluids and scar tissue and the build up of fibrous tissue might be involved may also benefit from this treatment. Other instances may include post trauma treatment for burns and surgery. Other applications may include treatment of hypertension as an aid to improve peripheral blood flow, stimulation of tissues in bed sore management and so on.

In one broad method aspect there is provided a method of self administration of therapeutic massage using a hand held massager of the type having a handle and a roller head delivering vibration through the head to a treatment site, the method comprising the steps of applying the head in a roller action along the treatment site in a predetermined treatment direction.

MassagerPriorArt0001607

Petitioner Therabody Ex-1013, 0399

Preferably, the roller head is applied under predetermined manual pressure superimposed upon a predetermined mechanical vibration having lowfrequency and low amplitude. The applied manual pressure may be monitored electronically using a transducer, typically an accelerometer, with audible or visual feedback to the user leading the user to reduce the applied manual pressure.

In one application of the method set out above the invention resides in a method of self administration of therapeutic massage for relief from lymphoedema using a hand held massager of the type having a handle and a roller head delivering vibration through the head to a treatment site, the method comprising the steps of applying the head in a roller action along the treatment site in a predetermined treatment direction. Preferably, the roller head is applied under light manual pressure superimposed upon a predetermined mechanical vibration having low frequency and low amplitude.

In the case of lymphoedema, the frequency of vibration should be selected to mimic lymphatic drainage therapy. In a device according to the invention where a motor with a rotating shaft is used, frequency, determined by rotation of the motor shaft may be quite low from a few Hz up to 100 Hz. However, somewhere around the middle of this range is preferred for treating lymphoedema with 30-50 Hz being considered optimum with a treatment time of about 10 minutes in the case of an arm. The amplitude of vibration, in the case of a motor with a rotating shaft and eccentric weight is determined by the mass of the eccentric weight, its eccentricity and dimensions, and should result in an amplitude at the treatment site of a few millimetres. Typically, the amplitude as applied to the tissue is in the range 0.5-2.0mm and more preferably in the range of 1.0-1.5 mm may be used for optimum results.

In the case of lymphoedema the applied manual pressure would not normally exceed the equivalent of about 250 gms applied. Pressures may be set for other applications that might require greater pressure say for deeper treatment as might be the case for sporting injuries.

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In the case of lymphoedema it is preferable to first clear lymphatic regions adjacent the main site before treating the main site. For example, in the case of an arm, the regions of the neck and shoulder are first cleared.

However, it will be appreciated that useful outcomes may be achieved with a wide range of pressures, frequencies and amplitudes within practical limits of engineering and comfort to the patient. The present invention should not be considered as being limited to any particular pressure, frequency or amplitude or the condition or symptoms being treated.

In one broad apparatus aspect therefore the present invention resides in a massage device comprising a handle, an applicator head projecting from the handle and a vibratory source adapted to deliver vibration to the applicator head, the applicator head being coupled to the assembly and being adapted to roll over a surface being treated.

The applicator head is preferably coupled to the handle via a vibration dampening coupling and the source of vibration is preferably located in the applicator head.

The applicator head preferably comprises a hollow body housing a motor, the motor having an eccentrically mounted weight for the purpose of generating vibration within the applicator head. The motor housing typically has means enabling an outer portion of the head to roll on the motor housing. Preferably, the motor housing includes ribs on which the outer portion of the applicator head travels. The ribs preferably are circular ribs located on the motor housing which housing is a generally cylindrical motor housing.

Preferably, a generally cylindrical sheath locates across and over the motor housing, the sheath being able to rotate and slide on the ribs to give rotation of the sheath relative to the housing. The sheath preferably locates on the motor housing with a hand insertable clip action.

Preferably, the applicator head includes a removable outer portion in the form of a contact pad which fits over the sheath and is removable for cleaning purposes. The hand insertable clip action of the sheath to the motor housing ensures that the sheath remains in place as the contact pad is removed. Preferably, the contact pad is contoured or otherwise shaped to generally follow

the shape of the area being treated. Preferably, the contact pad is medially narrowed or narrowed at least to enable application of the applicator head to curved surfaces including regions of the arms and legs. Typically, treatment is applied by rolling the contact pad across the region being treated.

Preferably the applicator head includes an enlarged end. The enlarged end is typically generally rounded and more preferably is hemispherical. The end is also used for delivery of vibration as an alternative or adjunct to the roller treatment. In this case the enlarged end is applied as a point source of vibration.

Thus in a preferred form of the invention the assembly is generally pistol shaped, the applicator head having a bulbous or enlarged end enabling application of vibration in point form using the end of the applicator head in a non-rolling configuration to provide a second form of treatment. Normally, in addition to this point treatment, the applicator head is rolled across the surface being treated with the surface being treated in contact with the contoured portion of the applicator head in a manual rolling backward and forth fashion. Alternatively, treatment may be in a repetitive stroking form in a single direction from a starting point rather than back and forth.

Preferably, the applicator head and handle are made from separate parts assembled and connected together via the vibration dampening coupling. The vibration dampening coupling preferably includes cushion means located between the applicator head and the handle.

Preferably, the vibration dampening coupling includes a ball and socket arrangement where a ball and a socket either on the head or on the handle are located together to provide limited pivoting movement of the applicator head relative to the handle.

Preferably, the socket is located in the handle and the ball is located at one end of the applicator head. The ball is fitted into the socket and a fastener is passed through a portion of the handle to retain the ball and socket in operative position.

Preferably, the vibration dampening cushioning means is provided by an annular soft resilient surround which extends around the coupling between the head and the handle and extending about the ball and socket joint.

MassagerPriorArt0001610

Petitioner Therabody Ex-1013, 0402

Preferably, the cushioning means comprises a lip extending across the joint and over a marginal edge portion of the motor housing and having an annular rib extending around the ball joint of the head and bridging between the handle and the head to assist with vibration dampening and to bias the head in resilient manner to a central position.

The handle preferably includes a display and PCB assembly, the display including a liquid crystal screen and there being a control button in order to operate a timing function. The timing function preferably comprises a numerical display of minutes of treatment, with a visual display of cumulative treatment time, typically in ten second intervals. Each ten second interval is usually displayed as a segment in a circular display divided into 12 segments which segments are lit as time progresses up to 12 of the segments for one minute. As minutes are reached numerals are displayed of the transpired minute count and the segments are cleared and begin to light progressively again up till the next minute, the minute display is incremented, the segments are then cleared and begin to light again and the process repeats. Thus, a user may easily and visually note the length of time a treatment has taken in accordance with their prescription from their physician. On, off, pause, reset functions and so on may be utilised with separate press buttons or a single press button may be utilised depending on whether there is a short switching or a time delay during switching to reset, start or switch off the unit as a whole.

The vibration may be constant across the surface of the applicator head or may vary. Preferably the vibration varies marginally with a vibration having and amplitude of about 1mm along the medial region and 1.5mm at the end of the head.

In order that the present invention may be more readily understood and be put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein:-

Figure I isa perspective drawing of a vibration applicator according to the present invention;

Figure 2 is a perspective view from the opposite side;

Figure 3 is a side view;

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Figure 4 is a partial exploded view;

Figure 5 is a partial exploded view of part of the assembly;

Figure 6 is a vertical section through the midline of the applicator;

Figure 7 is a horizontal section through the midline of the applicator head and part of the handle;

Figures 8 and 9 illustrate in more detail the vibration dampening coupling;

Figures 10 to 13 illustrate the assembly of the display and PCB board as a module;

Figure 14 illustrates a partial exploded view illustrating the insertion of the display and PCB board into the handle;

Figure 15 is a partial exploded view illustrating the motor and motor housing;

Figure 16 is an exploded view of the applicator and its associated cradle;

Figure 17 is a block diagram of a first embodiment of a circuit applicable to the present invention;

Figure 18 is a block diagram of a second embodiment of a circuit applicable to an applicator according to the present invention;

Figure 19 is a block diagram of a further embodiment illustrating more details of the massager operation and control in terms of the overall structure and motor frequency control;

Figure 20 is a flow diagram illustrating operation of the motor driver firmware (coarse control loop);

Figure 21 is a flow diagram illustrating the operation of the motor driver firmware (fine control loop);

Figures 22A and 22B are flowdiagrams illustrating measurement of motor frequency;

Figure 23 is a flow diagram showing a typical process for providing an over-pressure indicator;

Figure 24 is a graph showing the participant agent in a clinical study;

Figure 25 is a graph showing the period of time from surgery to remove lymph nodes and the study; and

Figure 26 is a graph showing the period of time in months upon which participants in the study experienced clinically manifest lymphoedema.

Referring to the diagrams and initially to Figures 1-3 there is illustrated a hand held massage device 10 comprising a handle 11 and an applicator head 12. The handle includes a press button 13 for operation and a display 14. The applicator head 12 has a medial narrowing 15 and is adapted to free wheel in a rolling action relative to the handle 11. The end 16 is rounded so that a user may deliver endwise vibration to a site to be treated in addition to the other therapeutic mode of operation involving rolling with the medial narrowing portion 15 in contact with the surface being treated. Thus it will be appreciated that in the preferred embodiment two forms of treatment may be adopted.

Referring to Figure 4, there is shown an exploded view whereby the handle 11 is made up of two parts 17 and 18. Connected to the handle 11 is a motor housing 19 which has spaced ribs 20, 21, 22, 23 and 24. A roller sheath 25 clips onto the motor housing and travels on these ribs which in turn has a removal applicator 26 which passes over and is resiliently held on the sheath. The applicator 26 may be longer for leg treatment and in other shapes as may be desirable for different treatments.

The applicator 26 is of a flexible rubber like material and may be easily removed for cleaning.

Referring to Figure 5, the motor housing 19 and its connection to the handle section 17 is illustrated in exploded view where a ball section 27 co-operates with a clip 28 which passes through an opening in the handle section 17 and clips into the interior 29 of the ball section 27 to retain the ball in the handle. This will be illustrated in greater detail below.

Figures 6 and 7 illustrate sections through the device in its fully assembled form. A battery 30 is located inside the handle and a motor 31 with an output shaft 32 and an eccentric weight 33 is located in the head. The eccentric weight 33 creates a vibration which passes through to the applicator 26 via the sheath 25. The sheath 25 and applicator 26 roll on the ribs 20 through 24 while the handle is substantially isolated from the vibration by dampening means.

Figures 8 and 9 illustrate the connection of the motor housing to the handle where the ball section 27 of the motor housing fits into a corresponding socket section 34. The clip 28 (which is not present in Figure 8) is inserted into the position shown in Figure 9 and locks the joint together as shown. Vibration from the motor housing is dampened by a flexible spacer-come-washer arrangement illustrated at 32 which has two parts, an outer sealing part 33 and a bridging annular cushion part 34. The effect of this arrangement is that the motor housing via its ball joint arrangement, shown generally at 35, is effectively able to rock and joggle in any direction against the cushion afforded by the projection 34 and the seal 33. When the applicator head is applied to the surface being treated there is some give by reason of the ball joint connection and the vibration dampening arrangement, at the same time vibration is absorbed isolating the handle 11.

The display 14 is housed in a display module 36 illustrated in Figures 10 to 13 where the electronics in the PCB board and the display itself is held by a plate 37 which inserts into the housing 38 enabling the whole module to be screwed or otherwise secured in the handle as shown in Figure 14.

Figure 15 illustrates an exploded view of the motor housing 19 which is made from two parts screwed together and retaining the motor and its eccentric weight.

Figure 16 illustrates in exploded view a suitable cradle with the device able to be mounted for recharge and storage. This is how the final device would appear to the end user.

Figure 17 illustrates a simple block diagram of a typical circuit.

Figure 18 illustrates another version where an accelerometer at 39 is used to provide feedback to the user as to applied treatment pressure by way of a visual or audible signal when the applied pressure exceeds a predetermined limit. This is not essential to the invention but enables applied pressure by the user to the applicator head to be controlled other than by learned tactile control as in the case of Figure 17. This ensures that there is not over pressure as compared to the medical prescription for the treatment. This is particularly the

case in relation to lymphoedema where it is desirable to apply a relatively small load to the area being treated.

Applicant has found in relation to lymphoedema it is desirable to apply a relatively small load to the area being treated.

As described above, the massager unit has a user interface which consists of a single push button and an LCD. A single treatment involves 30 minutes of massage, the typical treatment procedure is set out later in this specification.

To initiate a treatment cycle the push button is pressed. The massage motor starts and the LCD backlight lights. The time display reads "30". Every 3 minutes an additional dial segment illuminates. After 30 minutes all 10 dial segments are illuminated indicating a complete cycle.

When the 30minute cycle is complete the backlight will dim, and the motor will ramp down and turn off. The unit will remain in this stage for a period of 5 minutes. After 5 minutes has elapsed the system will shut down and enter a low power state. If the button is pressed before the 5 minute period has elapsed the unit will immediately shut down.

If the button is pressed during a session before the 30 minute cycle is complete, the unit pauses. In this state the motor and time stops, and the LCD backlight dims. The session can be continued with an additional press of the button. If the massager is left in pause for 5 minutes it will shut down, saving the session time in memory. Next time the button is pressed the unit will resume.

If the button is held down for 3 seconds (or longer) the unit will reset the timer, and power down.

If the unit is running, and placed on the charging dock, it will power down immediately, and store the timer value ready to resume on the next keypress.

When the unit is in the charging dock it does not respond to the button. (Assuming the charger is plugged in).

When the unit is charging, the battery icon is illuminated. The battery level segments on the LCD will step from left to right. When charging is complete icon turns off.

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As the battery becomes exhausted the battery level segments will gradually reduce. When the battery is completely exhausted the outline will flash.

The massager charge port is a 2 wire interface. It is used for the dual purpose of battery charging and for data communication.

If the DC charge level is above a nominal threshold voltage the charger starts. If the level is pulsed below this threshold it can be used for communications.

The massager communications interface is configured as a slave. It will never attempt to send data unless it is requested to do so by the device connected to the interface.

This subsystem is based around a dedicated stand alone battery charger IC. It provides optimal charging conditions and protects the battery pack. The status of this device is monitored, but not controlled by the massager firmware.

The battery pack is a two cell rechargeable Ni-MH pack protected by an encapsulated polyswitch.

This subsystem is based around a dedicated power management IC. This steps the battery voltage up to a regulated 3.3V. This powers the entire circuit. This is protected against over voltage, over current, short circuit and has thermal cutout.

This subsystem inputs a PWM drive from the processor, and drives the motor. It also measures the motor voltage and motor current. These are monitored by the firmware, and are used along with the accelerometer data to control and regulate the motor speed by adjusting the PWM drive.

The motor driver uses the measured motor voltage, motor current and accelerometer frequency to accurately set and regulate the motor RPM.

The motor driver uses two separate control loops, one for course control as set out in Figure 20 and the second for fine control as set out in Figure 21.

On boot up the massager loads a target motor voltage out of the ERAM and into the memory. The main motor control loop starts the motor, measures the motor voltage and compares it to the target voltage. The control loop will continually adjust the PWM mark-space ratio to achieve this target voltage. This

is updated very quickly to accommodate and compensate for varying loads on the motor - ie adjustments in application pressure, or during movement across different densities of tissue or bone.

The unit frequency and motor firmware control is set out in Figures 22A and 22B.

The motor frequency is obtained directly from the accelerometers. The frequency is measured whenever the motor is turning, and is put into a running average. This is high precision measurement with the absolute accuracy limited by the CPU crystal. The motor frequency is compared to the target frequency (42Hz). If the measured frequency differs from the target frequency the target voltage is incremented or decremented and fed back into the coarse control loop. On shut down the new target motor voltage is saved to ERAM.

This subsystem is used purely for motor frequency measurement.

This circuit is based a round a 2 axis accelerometer, and associated passive filtering components. The accelerometer is hard mounted on a remote PCB at the tip of the contact head. This mechanically couples the accelerometer to the motor/weight assembly which is also in the head (see Figure 15). The X and Y axes are taken in a plane perpendicular to the motor axis (see Figure 5). The signal amplitude is proportional to the tip acceleration, and the signal frequency directly corresponds with the motor frequency. The measured frequency is used by the firmware to set the motor speed.

The X and Y axis signal from the accelerometer are linked directly into the processors high speed comparator input. An interrupt is caused at the signal X-Y crossover point. A 1000ms gate is left open, and the crossover points are counted. This directly corresponds to the motor frequency in hertz.

The measured frequency is discarded if it falls outside the band of 27-60Hz. The sample period is 1000ms. A delay of 16ms is used to debounce the measurement.

Referring to Figure 23, the over-pressure indication will nowbe described. The unit contact head contains a two axis accelerometer. This is an electronic measuring device used to measure and convert acceleration into an electrical potential. In this application an accelerometer is used to measure the magnitude

and frequency of vibration of the contact head. This information is then used to extrapolate the applied pressure between the contact head, and the massage recipient.

As a result of the vibration generated by the unit motor/weight assembly the resultant waveform approximates two sine-waves, corresponding to the acceleration in the X and Y planes.

The amplitude of each waveform is directly proportional to the acceleration.

Using classical physics formulae it is possible to use the above data to approximate the tip displacement in both X and Y planes.

When the contact head is held in free space the tip displacement is at a maximum. When the contact head is placed onto a medium some of the energy produced by the contact head is transferred into the medium. Assuming the medium does not resonate, this results in a proportional reduction of tip amplitude. As the contact pressure is increased, the tip amplitude will proportionally decrease.

The motor current, and voltage are monitored during run time. Assuming constant motor frequency, it is possible to use the motor current and voltage to measure variations in motor loading (Power applied to the motor). The motor loading value is used in conjunction with the accelerometer data to produce a numeric value. This numeric value is not calibrated, and therefore will be unit specific.

When the applied pressure exceeds a preset threshold value the "overpressure" icon will illuminate. When the applied pressure drops below the preset threshold the icon will turn off. The numeric value acquired is compared to a threshold value to illuminate the icon. The threshold value can be set and adjusted for each unit.

The processor is directly connected to the LCD. The processor contains all the hardware required to control the LCD.

The LCD backlight uses a PWM drive from the processor to set the LED junction current, controlling the backlight intensity. The intensity is modal, and is gently ramped.

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The push button is directly connected to the processor, and polled by the firmware.

The massager may include other features including but not limited to the following:

During each session the firmware logs runtime data. These data logs can be accessed by connecting a custom interface box to the massager charging terminals.

Principally forthe purpose of preventative maintenance, thefollowing data is logged:

- System odometer: Total accumulated run time in seconds (non resetable),
- System odometer: Total accumulated battery charge time in seconds (non resetable).
- System odometer: Total number of battery charges (non resetable).
- System odometer: Total number of key presses (non resetable).
- System odometer: Total number of sessions, where a session is defined as any run period over 50 seconds (non resetable).

The firmware automatically logs key usage statistics. The principle use of this feature is to provide technical feedback for consultants, and to aid in patient therapy progress analysis.

With the aid of a utility run on a desktop PC an administrator will be able to review each individual session length in minutes for the last 850 sessions. A real-time log start date can also be entered. This can also be cleared by an administrator.

As set out above, the applicant has found that application of low frequency vibration using a roller has the advantage of limiting damage to the skin while treating lymphoedema. The following treatment example was undertaken. A device according to the present invention was caused to vibrate at 42Hz with a tip amplitude of 1.5-2.0mm and a centre amplitude of 0.5-1 .0mm, the device was applied with a rolling action using light pressure for a short 3-5 minute time over specific lymph drainage areas in patients with lymphoedema.

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The trials resulted in a reduction of 5% of the total oedema and had the advantage of being self administered at home. Subjective patient response was very positive with 25% reduction in pain and improved movement of 28% after the first week. At the end of the second week perceived heaviness had improved by 26%, pins and needles reduced by over 24% and perceived arm size by 20%.

Applicant has further devised a home based sequence and protocol involving first clearing the lymph in regions adjacent the treatment site (eg neck and shoulder) before treating the site itself (eg the arm).

The preferred treatment is as follows:

Clearing the adjacent areas

- Roll the unit along the side of the neck from the shoulder to the base of the skull and back. Spend 2 minutes on each side of the neck.
- Use the head of the massage unit to massage gently into the non-affected armpit for 1 minute.
- Using the side of the massage unit, sweep across the top of the breast from the midline to the non-affected armpit and back for 1 minute.
- Using the side of the massage unit, sweep above the breast or scar from the affected armpit to the midline and back for 1 minute.
- Rest the side of the massage unit in the groin crease on the SAME side as the affected arm for 1 minute.
- Using the side of the massage unit sweep from underneath the breast or scar to the groin crease on the SAME side as the affected arm for 1 minute.

Massaging the Affected Arm

1. Using the side of the massage unit, sweep from the back of the elbow and up over the shoulder for 2 minutes.
2. Lift arm up, then using the side of the massage unit, sweep the inner side of the upper arm from the elbow down the side of your body. Make sure you pass the massage unit behind the armpit and not directly into it for 2 minutes.

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3. Using the side of the massage unit, sweep the outer side of the forearm from the hand to the elbow for 2 minutes.

4. Using the side of the massage unit, sweep the inner side of the forearm from the hand to the elbow for 2 minutes.

To Finish

1. Using the side of the massage use long strokes from the affected outer fingers, over the outer arm to over the shoulder for 1 minute.

2. Using the side of the massage unit, use long strokes from the wrist, over the inner arm and down the side of the body for 1 minute.

3. Using the side of the massage unit, use long strokes from the affected armpit to the non-affected armpit for 1 minute.

The above procedure was followed in clinical studies of 30 patients. The procedure and results set out above are repeated in the context of the study which details follow.

Patients were randomly allocated to either the control group (who received current best information about skin and limb care, but on other standard treatment or management) and an experimental group who received treatment according to the present invention.

Sample size for the study was 30 control limbs and lymphoedema limbs.

The duration of the study was 28 days per patient. Patient to self administer as per the protocol. Treatment application can be morning or evening but there was a preference for evening. Patients were instructed to consume a full glass of water prior to and after each session. Patients and their partners were given full instructions on the equipment use prior to unsupervised use. A telephone support system was offered if required.

Patients presenting either of the following were to be included in the sample:

1. Patients presenting or diagnosed with clinically manifest chronic secondary unilateral arm lymphoedema.

2. Duration of lymphoedema greater than 1 year or a lesser period if the arm is already significantly large. Fluid rich arms are preferred over the middle stage fatty and the latter stage fibrous arms, as the percent of them which is the

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more easily moveable fluid is less. However, this is notto be taken that vibration is not likely to have an impact on late stages of lymphoedema. Specific frequencies of vibration may have to be determined to ensure the optimal targeting of these types of limbs.

Patients presenting any of the following were to be excluded in the sample:

1. Current uncontrolled cancer
2. Recent surgery, ie within 1 month of treatment, in any other part of the body
3. Uncontrolled hypertension
4. Underlying lipoedema or myxoedema
5. Underlying primary lymphoedema
6. Arthritic or other skeletal changes
7. Blood clotting problems within last month
8. Recent treatment for lymphoedema in last month

NB: The majority of patients entered into the trial however had prior treatment, often the best currently available.

Suitable patients were to have the following standard tests performed immediately prior to the application of the treatment and at weekly intervals until the completion of the trial at 28 days. Patients were reassessed for longer term benefits after one month.

Assessment included the standard assessment procedures currently used in the Flinders Lymphoedema Assessment Clinic at Flinders University in South Australia. These were:

- Subjective indicators of problems such as heaviness, tension, bursting pains, pins and needles, and areas of paraesthesia logged on 10 point Lichert scales.
- Objective determination by tonometry of the levels of fibrotic induration in each of the major limb and thoracic territories.
- Objective determination of the amount of free extracellular and intracellular fluids by bio-impedance.

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- Objective determination of limb volumes using perometery (circumference measurement in 200 positions on the limb and volume determination calculated from this).

All assessments were made by qualified persons (nurses and lymphoedema therapists) who were 'blinded' as far as possible with respect to the treatment the patients received.

The basic patient protocol included detailed instruction about how the patient should first clear the thoracic and attempt to clear the pelvic area. The development of the clearance program was undertaken by a Manual Lymphatic Drainage therapist, since clearance of the trunk is crucial to optimise the outcomes.

The full protocol and times are indicated below although from patient feedback it would seem that the majority undertook a slightly abbreviated version of this which more suited them. In the first part of the trial participants undertook self massage on the truncal regions and axilla but in later participants the hand held unit was used for this. There was no significant difference statistically between these two usage patterns and it is possible that the shorter participant based hand massage could be used to save time and make it easier for those with arm mobility issues and from those whose lymphoedema was on the dominant limb.

Clearing the Adjacent Areas.

1. Roll the unit along the side of the neck from the shoulder to the base of the skull and back. Spend 2 minutes on each side of the neck.
2. Use the head of the massage unit to massage gently into the non-affected arm pit for 1 minute.
3. Using the side of the massage unit, sweep across the top of the breast from the mid line to the non-affected armpit and back for 1 minute.
4. Using the side of the massage unit, sweep above the breast or scar from the affected armpit to the midline and back for 1 minute.
5. Rest the side of the massage unit in the groin crease on the SAME side as the affected arm for 1 minute.

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6. Using the side of the massage unit sweep from underneath the breast or scar to the groin crease on the SAME side as the affected arm for 1 minute.

Massaging the Affected Arm.

1. Using the side of the massage unit, sweep from the back of the elbow and up over the shoulder for 2 minutes.
2. Lift arm up, then using the side of the massage unit, sweep the inner side of the upper arm from the elbow down the side of your body. Make sure you pass the massage unit behind the armpit and not directly into it for 2 minutes.
3. Using the side of the massage unit, sweep the outer side of the forearm from the hand to the elbow for 2 minutes.
4. Using the side of the massage unit, sweep the inner side of the forearm from the hand to the elbow for 2 minutes.

To Finish

1. Using the side of the massage unit use long strokes from the affected outer fingers, over the outer arm to over the shoulder for 1 minute.
2. Using the side of the massage unit, use long strokes from the wrist, over the inner arm and down the side of the body for 1 minute.
3. Using the side of the massage unit, use long strokes from the affected armpit to the non-affected armpit for 1 minute.

After the first demonstration of technique, patients were checked carefully prior to sending them home. The patient's partner, where possible, was also instructed on technique and given a full explanation of the process to support the participant. Instructions were given however, that the participant only should conduct the massage.

The participant's style and accuracy was checked in a subgroup of the participants. In this subgroup of 5 patients, they were asked to present to the clinic and the full range of measurements of perometry and bio-impedance made immediately prior to and immediately after their use of the hand held massage unit. Not only did this allow us to check technique and confirm that patterns and pressures were within our normal range, but also it allowed us to check the

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specific effects of the use of the hand held massage unit over a short period of time with no confounding variables interfering.

Ideally the arm should be supported gently during the massage. This can range from resting in on a pillow or a wedge through to having a partner gently supporting it. To gain the best results it is best if the muscle elements of the upper and fore arms are as relaxed as possible.

The following analysis represents primarily a descriptive analysis only, that is one describing the trial outcomes only as they relate to the study group. The analysis of the trial data set is however, a full stand alone analysis describing the details of the trial.

Thirty valid patients are included in the results analysis. On occasions data may be missing from patients in this valid data set due to the patient being unable to present at the required time, machine measurement error (and thus the result was excluded on data checking) and on two occasions the measurement was unable to be made due to staff illness.

The mean age of the patients (depicted graphically in Figure 24) was 60.07 years with a standard deviation of 10.4. This is slightly older than the average diagnosis time of breast cancer but is in concert with the fact that lymphoedema takes an average of 3 years to become clinically manifest. Of the 30 participants, 25 were right handed and 5 left handed. Twelve had a partial mastectomy and axillary clearance while 15 had a total mastectomy and axillary clearance and 3 had a lumpectomy only.

Surgical: number of nodes removed

Number of nodes removed	Frequency	Percent
1-10	2	6.7
11-20	13	43.3
21-30	5	16.7
All visible	2	6.7
Not known	8	26.7
Total	30	100.0

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The average period of time from the indicated surgery was 10 years. The average date of the surgical intervention was 1996 and the most common date 1997 This is depicted graphically in Figure 25.

Eleven of the 30 patients had no positive lymph nodes, while 5 had 1-5 positive nodes, 2 had 6-1 0 positive nodes and the remainder more than 10. The nodal status was unknown in 8.

Twenty eight of the participants had radiotherapy while 17 had chemotherapy.

One person had un-medicated hypertension while another reported hypertension when unwell. Twenty three reported their blood pressure in normal range while 5 were under medication for their hypertension. A review of the two hypertensives showed that these had outcomes similar to those of the non hypertensives.

Three of the group had thyroid issues but all of these were medicated and this factor had no influence on outcomes.

Nine of the group reported some form of arthritis and on two possible occasions, when this involved the shoulder this resulted in some minor difficulties in undertaking the self massage.

Twenty five of the participants were post menopausal. Two were currently on HRT while two were previously on it. This factor had no impact on outcomes.

The average period of time after surgery that patients were first aware of what could be described as clinically manifested lymphoedema was 30 months. This is depicted graphically in Figure 26. This is in concert with prior studies about the onset of lymphoedemas.

The causes of the lymphoedema were wide ranging with 12 participants not being really sure of the precipitating factor. There was no relationship between precipitating factors and the outcome measures.

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LO: cause of LO

	Frequency	Percent
Scratch	1	3.3
Not Known (uncertain)	12	40.00
Hot weather	2	6.7
Overuse of affected arm	4	13.3
Insect bite	2	6.7
Cellulitus	1	3.3
Shingles	1	3.3
Long aircraft flight	3	10.0
Reconstructive surgery	1	3.3
Radiotherapy	2	6.7
Renovating house	1	3.3
Total	30	100.0

LO: worse in evening

	Frequency	Percent
Yes	19	63.3
No	11	36.7
Total	30	100.0

LO: worse in hot weather

	Frequency	Percent
Yes	24	80.0
No	6	20.0
Total	30	100.0

These reported scenarios of worsening however, had no impact on outcomes measured in this trial.

It is rare that a patient presents who has not had some prior treatment. Further, some of them may have had the best currently available treatments.

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However, it's important that any participant has not had active treatment within the last month as this could possibly mask the effect of the hand held result.

The distribution of last treatment periods are indicated in the table below.

LO: last treatment

	Frequency	Percent
> 1 month ago	5	16.7
2-6 months ago	11	36.7
> 6 months	5	16.7
> 1 year	9	30.0
Total	30	100.0

In terms of the last active treatment, this ranged from complex physical therapy (1), Manual Lymphatic Drainage (22), compression bandaging (13), Laser (11) and Tai Chi (2). There was no relationship between the trial outcome measures and either the time of prior treatment or the type of prior treatment.

All results of arm measurements of bio-impedance, perometry and tonometry take into account the initial differences between the affected and unaffected (normal) arm and consider the impact of the variation in the normal arm values as the trial progresses.

Bio-impedance measures the amount of total segmental fluids in the limb up to the apex of the shoulder. The segmental fluids include the extracellular compartment volumes (consisting of fluids within the lymphatics, fluids within the blood vessels and mainly the fluids within the extracellular spaces) and the intracellular compartment (consisting of fluids within the cells - which normally are constant).

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Mean fluid volume changes (mis) (Complete data set)

Value	LO- Normal limb vol diff	mls reduction over period	% reduction in excess fluids
Baseline	642	----------	----------
One week	612	35	5.7
Two weeks	575	26	4.5
Three weeks	587	36	6.1
Four weeks	607	39	6.4
One month after end treat	637	-2.0	0

None of these differences were statistically significant due to the small reductions (which was expected) and the relatively small sample size. These reductions were however practically and biologically significant as is shown in subsequent sections of this report.

Of greatest interest was that the highest reductions were achieved in those persons with the largest initial volume differences (one case is presented below). This outcome needs to be further explored in a more detailed analysis of inter-relationships.

Value	LO- Normal Vol difference	mls reduction over period	% reduction in excess fluids
Baseline	1050	----------	----------
One week		480	45.7
Two weeks		450	42.8
Three weeks		310	29.5
Four weeks		340	32.4
One month after end treat		90	8.6

Interestingly this does show what is possible in a large and relatively fluid rich arm. The reasons for the excellent result at one week and then a declining result are not clear.

Perometry measures the total limb volume, but is only able to measure it into the middle upper-arm and does not account for changes in limb size in the axillary area. Bio-impedance does take into account fluid changes in this area. For this reason there can be a discrepancy between these values. However, in

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general terms, some of the larger differences in perometry and bio-impedance can be accounted for in terms of the effect of treatment either on the fluid alone or on the tissue composition, for instance changes in fat or perhaps even muscle volumes.

Whole arm

Value	LO- Normal limb vol diff	mls reduction over period	% reduction in excess tissues
Baseline	1026	----------	----------
One week	1017	2	0.2
Two weeks	1017	5	0.5
Three weeks	1010	33	3.3
Four weeks	977	25	2.5
One month after end treat	1047	+59	5.7

This measurement of the whole limb indicates that most fluid reductions must be occurring in the most proximal part of the upper arm - that is its root, which encompasses the axillary area. The outcomes indicate that in order to maintain control that treatment must be continued. This need is in concert with all other professionally administered treatments for lymphoedema.

Fore Arm

Value	LO- Normal limb vol diff	mls reduction over period	% reduction in excess tissues
Baseline	633	---------	---------
One week	638	24	3.8
Two weeks	621	30	4.8
Three weeks	631	0	0
Four weeks	637	27	4.2
One month after end treat	624	+67	10.5

Some of the improvement however, clearly occurs in the forearm and this tends to occur fairly quickly, that is within the first week of treatment

Tonometry is a surrogate measure of the amount of fibre in the tissues. Its value also may change when a limb becomes smaller and this arti-factual hardening must be taken into account when examining tonometry data. Given the gentle nature of the hand held massage and its relatively short duration per day great changes in tonometry are not expected.

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Mean Group Tonometry values

Detail	Baseline	Week 4
Lymphoedema Forearm	4.71	4.86
Lymphoedema Upper arm	5.25	5.23
Affected anterior thoracic	8.81	8.87
Affected posterior thoracic	3.34	3.83
Normal Forearm	4.63	4.73
Normal Upper arm	5.77	5.70
Normal anterior thoracic	9.56	9.19
Normal posterior thoracic	3.51	3.2

While none of these values are statistically significant they do show that there has been no progression of the induration over the treatment period and in fact the trend shows a tendency to soften in the affected arm as well as the posterior thorax on the affected side.

There is strong evidence in the literature that as far as the patient is concerned they are mostly concerned about how their limb feels rather than its size. Accordingly, increasing weight is being placed on the impact of treatments on subjective issues.

Subjective data will be presented in two formats firstly looking at the % change of the various parameters and then looking at the statistical significances.

Subjective parameters where statistically significant improvements are observed. While this statistically significant improvement is crucial and important to satisfy the scientific and medical community what is important from the patient perspective is how the limb feels and looks.

Statistically significant differences are indicated in bold and greatest raw and percent difference indicated in bold italics. When the difference is statistically significant and the largest reduction this is indicated in italics.

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Mean subjective indicators (based on 1-10 point boxed scale)

Condition	Baseline	Week 1	Week 2	Week 3	Week 4	One month FU
Pain	1.83	***1.37***	1.44	1.65	1.49	1.52
Heaviness	4.23	3.89	*3.11*	**3.46**	3.36	4.10
Tightness	3.33	***2.63***	2.67	3.00	3.40	3.62
Hardness	3.67	3.52	***3.17***	3.46	3.80	3.81
Temperature	2.23	1.81	2.07	1.77	1.80	2.29
Cramps	1.00	***1.00***	1.11	1.08	1.04	1.00
Pins/needles	1.53	1.22	***1.15***	1.38	1.40	1.24
Arm size	7.08	**6.29**	**5.80**	**5.58**	*5.24*	**5.81**
Range of Movement	3.67	**2.63**	**2.59**	2.96	*2.44*	**2.71**

Percentage (%) reductions in the indicated parameters from baseline

Condition	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**One month FU**
Pain	***25.1***	21.3	9.8	18.5	16.9
Heaviness	9.9	*26.5*	**18.8**	20.6	3.1
Tightness	***21.0***	19.8	9.9	+ 2.1	+8.7
Hardness	4.0	***13.6***	5.7	+3.5	+3.8
Temperature	18.8	7.1	***20.6***	19.2	+2.6
Cramps	***0.0***	+11.0	+8.0	+4.0	0.0
Pins/needles	20.2	***24.8***	10.0	8.5	18.9
Arm size	**11.1**	**20.4**	**23.5**	**26.0**	**17.9**
Range of Movement	**28.3**	**29.4**	19.3	*33.5*	**26.1**

While the outcomes of this home based treatment regimen do not seem great, they are very significant in the picture of attempts to control lymphoedemas.

For instance in the following intensive treatment programs the following percentage reductions were obtained. There are many other such studies and many of them do not have as good an outcome as these.

- Swedborg et al ('93) - MLD 2 wk 10%
- Johansson et al ("98) - MLD 4 wk 15%
- Carati and Filler et al ('03) Laser 8 wk 18%

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- Piller + Thelander ('96) - Scan laser 4 wk 19%
- Piller + Harris (O3) - MLD 19%
- Hutzschenreuter et al ('91) - MLD + Comp 20%
- Johansson et al('99) - Compression 2 wk 26%

(These studies have been used since they are scientifically strong and have used formulae similar to those used in this study).

The remainder of the discussion must be read in this context.

Self management of chronic arm lymphoedema in the home certainly can lead to an excellent outcome for the patient both from the point of view of the actual size and fluid volume in the limb, but also (and perhaps most importantly) from the point of view of how the limb feels - that is the subjective indicators. As mentioned previously, how the limb feels can often be more important to the patient than the size of the limb.

The key finding of this report must be couched in the knowledge that this group of patients had received in the main some of the best treatment that was available at a health professional level and were generally well aware of what their strategies were to apply optimal care for the limb. The findings of this trial must be viewed with this knowledge clearly on ones mind.

It should also be remembered that neither, for at least the month prior to or during this trial, did any of the patients receive any professional treatment. Given that the aim of this hand held unit was to help maintain treatment reductions in between treatments from health professionals, it exceeded expectations in that it alone was able to facilitate a range of subjective and objective reductions.

Whilst many of the objective reductions were not statistically significant, they no doubt were of strong practical and biological significance as can be gained from the statistically significant reductions in a range of subjective parameters including perceived limb hardness and range of movement.

Using the hand held unit for a week was able to result in an average 5.7% reduction in the excess oedema fluid volume. This improved to 6.4% at four weeks but within a month of ceasing treatment the limb had returned to its normal size again - emphasizing the need for ongoing management.

MassagerPriorArt0001633

Petitioner Therabody Ex-1013, 0425

Larger more fluid rich arms responded better than smaller fluid rich arms and these better than those which were slightly fatty orfibrousy. One patient with an arm fluid volume difference of over one litre obtained an initial 45% reduction in this excess volume, although this outcome could not be maintained over the duration of the trial.

Generally speaking perometry showed slightly lesser reductions (as this measures whole limb volume - which includes fluid, fat, fibre and muscle). However, small % reductions were recorded which reversed at the cessation of treatment.

Generally speaking tonometry showed little change over the treatment period although there was always a tendency for the limbs and the anterior and posteriorthoracicareato soften. This indicates a reduced level of fibrous tissue. It is interesting that this occurred since the patients were selected in their relatively early stage of lymphoedema when fibrotic induration was not significantly outside of normal range.

Specifically speaking the subjective changes far outweighed the objective ones and as mentioned previously this is often what is most important for the patient.

Many subjective parameters showed rapid and early improvement with pain reducing by over 25% and range of movement improving by 28% by the end of the first week.

Heaviness improved by over 26%, pins and needles by over 24% and perceived arm size by over 20% by the end of the second week.

If a patient can achieve these outcomes alone (albeit under our instruction), it is a strong sign that even better results may be obtained when the patient receives treatment from a health professional.

The ability to self manage lymphoedema will reduce the overall cost for lymphoedema treatment for the patient since there may be a reduced need for visits to the health professional

The outcomes from this study may be able to be extrapolated to other conditions of fluid accumulation in the body such as lymphoedema of the legs or truncal regions. There may also be an opportunity to suggest and

MassagerPriorArt0001634

Petitioner Therabody Ex-1013, 0426

extrapolation to venous oedemas although this perhaps would need a small additional investigation of this specific group.

Whilst the above has been given by way of illustrative example of the present invention many variations and modifications thereto will be apparent to those skilled in the art without departing from the broad ambit and scope of the invention as herein set forth. In addition, the use of "comprising" should not be taken as exhaustive and additional features may be added to the combination specified in any case.

MassagerPriorArt0001635

Petitioner Therabody Ex-1013, 0427

CLAIMS

1. A method of self administration of therapeutic massage using a hand held massager of the type having a handle and a roller head delivering vibration through the head to a treatment site, the method comprising the steps of applying the head in a roller action along the treatment site in a predetermined treatment direction.

2. A method of self administration of therapeutic massage according to claim 1 wherein the roller head is applied under predetermined manual pressure superimposed upon a predetermined mechanical vibration having lowfrequency and low amplitude in order to approximate lymphatic drainage massage.

3. A method of self administration of therapeutic massage according to claim 1 wherein the roller head is applied under predetermined manual pressure and applied manual pressure is monitored electronically using a transducer with feedback to the user leading the user to reduce the applied manual pressure in case of over-pressure.

4. A method of self administration of therapeutic massage according to claim 1 residing in self administration of therapeutic massage for relief from lymphoedema using a hand held massager of the type having a handle and a roller head delivering vibration through the head to a treatment site, the method comprising the steps of applying the head in a roller action along the treatment site in a predetermined treatment direction.

5. A method of self administration of therapeutic massage according to claim 1 residing in self administration of therapeutic massage for relief from lymphoedema using a hand held massager of the type having a handle and a roller head delivering vibration through the head to a treatment site, the method comprising the steps of applying the head in a roller action along the treatment site in a predetermined treatment direction and the roller head is applied under light manual pressure superimposed upon a predetermined mechanical vibration having low frequency and low amplitude

6. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema, wherein the frequency of vibration is selected to mimic lymphatic drainage therapy.

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7. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema using a device having vibration frequency being in the range from a few Hz up to 100 Hz.

8. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema using a device having vibration frequency being in the range from 30-50 Hz.

9. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema using a device having a vibration amplitude at the treatment site of a few millimetres as applied to the tissue in the range 0.5-2.0mm.

10. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema using a device where the applied manual pressure would not normally exceed the equivalent of about 250 gms applied.

11. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema using a device having vibration frequency being in the range from 30-50 Hz at a vibration amplitude at the treatment site of a few millimetres as applied to the tissue in the range 0.5-2.0mm.

12. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema using a device having vibration frequency being in the range from 30-50 Hz at a vibration amplitude at the treatment site of a few millimetres as applied to the tissue in the range 0.5-2.0mm and an applied manual pressure not exceeding the equivalent of about 250 gms applied.

13. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema at a main site, the method involving first clearing lymphatic regions adjacent the main site before treating the main site.

14. A method of self administration of therapeutic massage according to claim 1 for relief from lymphoedema of the arm, the massager comprising a unit having a head ane and a head side, the method comprising the following:

Clearing the adjacent areas

1. Roll the unit along the side of the neck from the shoulder to the base of the skull and back.

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2. Use the head of the massage unit to massage gently into the non-affected armpit.
3. Using the side of the massage unit, sweep across the top of the breast from the midline to the non-affected armpit and back.
4. Using the side of the massage unit, sweep above the breast region from the affected armpit to the midline and back.
5. Rest the side of the massage unit in the groin crease on the SAME side as the affected arm.
6. Using the side of the massage unit sweep from underneath the breast or scar to the groin crease on the SAME side as the affected arm.

Massaging the Affected Arm

1. Using the side of the massage unit, sweep from the back of the elbow and up over the shoulder.
2. Lift arm up, then using the side of the massage unit, sweep the inner side of the upper arm from the elbow down the side of the body.
3. Using the side of the massage unit, sweep the outer side of the forearm from the hand to the elbow.
4. Using the side of the massage unit, sweep the inner side of the forearm from the hand to the elbow.

To Finish

1. Using the side of the massage use long strokes from the affected outer fingers, over the outer arm to over the shoulder.
2. Using the side of the massage unit, use long strokes from the wrist, over the inner arm and down the side of the body.
3. Using the side of the massage unit, use long strokes from the affected armpit to the non-affected armpit.

15. A massage device comprising a handle, an applicator head projecting from the handle and a vibratory source adapted to deliver vibration to the applicator head, the applicator head being coupled to the assembly and being adapted to roll over a surface being treated.

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16. A massage device according to claim 15 wherein, the applicator head is coupled to the handle via a vibration dampening coupling and the source of vibration is located in the applicator head.

17. A massage device according to claim 15 wherein the applicator head comprises a hollow body housing a motor, the motor having an eccentrically mounted weight for the purpose of generating vibration within the applicator head.

18. A massage device according to claim 15 wherein the applicator head comprises a hollow body housing a motor, the motor having an eccentrically mounted weight for the purpose of generating vibration within the applicator head, the motor housing having means enabling an outer portion of the head to roll on the motor housing, the motor housing including ribs on which an outer portion of the applicator head travels.

19. A massage device according to claim 15 wherein the applicator head comprises a hollow body housing a motor, the motor having an eccentrically mounted weight for the purpose of generating vibration within the applicator head, the motor housing having means enabling an outer portion of the head to roll on the motor housing, the motor housing including ribs on which an outer portion of the applicator head travels, the ribs being circular ribs located on the motor housing which housing is a generally cylindrical motor housing.

20. A massage device according to claim 15 wherein the applicator head comprises a hollow body housing a motor, the motor having an eccentrically mounted weight for the purpose of generating vibration within the applicator head, the motor housing having means enabling an outer portion of the head to roll on the motor housing, the motor housing including ribs on which an outer portion of the applicator head travels, a generally cylindrical sheath locating across and over the motor housing, the sheath being able to rotate and slide on the ribs to give rotation of the sheath relative to the housing.

21. A massage device according to claim 15 wherein the applicator head includes a sheath and removable outer portion in the form of a contact pad which fits over the sheath and is removable for cleaning purposes.

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22. A massage device according to claim 15 wherein the applicator head includes a sheath and a removable outer portion in the form of a contact pad which fits over the sheath and is removable for cleaning purposes using a hand insertable clip action, the contact pad being contoured shaped to generally follow the shape of the area being treated.

23. A massage device according to claim 15 wherein the applicator head includes a sheath and a removable outer portion in the form of a contact pad which fits over the sheath and is removable for cleaning purposes using a hand insertable clip action, the contact pad being medially narrowed.

24. A massage device according to claim 15 wherein the applicator head includes a sheath and a removable outer portion in the form of a contact pad which fits over the sheath and is removable for cleaning purposes using a hand insertable clip action, the contact pad being medially narrowed with an enlarged end.

25. A massage device according to claim 15 wherein the applicator head includes a sheath and a removable outer portion in the form of a contact pad which fits over the sheath and is removable for cleaning purposes using a hand insertable clip action, the contact pad being medially narrowed with an enlarged end, the enlarged end being generally domed.

26. A massage device according to claim 15 wherein the device is generally pistol shaped, the applicator head having a roller with a side and a bulbous or enlarged end enabling application of vibration in point form using the end of the applicator head in a non-rolling configuration and the side of the roller in a rolling action.

27. A massage device according to claim 15 wherein the applicator head and handle are made from separate parts assembled and connected together via a vibration dampening coupling.

28. A massage device according to claim 15 wherein the applicator head and handle are made from separate parts assembled and connected together via a vibration dampening coupling, the vibration dampening coupling including a ball and socket arrangement where a ball and socket either on the head or on the

handle are located together to provide limited pivoting movement of the applicator head relative to the handle.

29. A massage device according to claim 15 wherein the applicator head and handle are made from separate parts assembled and connected together via a vibration dampening coupling, the vibration dampening coupling including a ball and socket arrangement where a ball and socket either on the head or on the handle are located together to provide limited pivoting movement of the applicator head relative to the handle, the vibration dampening cushioning means being provided by an annular soft resilient surround which extends around the coupling between the head and the handle and extending about the ball and socket joint.

30. A massage device according to claim 15 wherein the applicator head and handle are made from separate parts assembled and connected together via a vibration dampening coupling, the vibration dampening coupling including a ball and socket arrangement where a ball and socket either on the head or on the handle are located together to provide limited pivoting movement of the applicator head relative to the handle, the vibration dampening cushioning means being provided by an annular soft resilient surround which extends around the coupling between the head and the handle and extending about the ball and socket joint, the cushioning means comprises a lip extending across the joint and over a marginal edge portion of the motor housing and having an annular rib extending around the ball joint of the head and bridging between the handle and the head to assist with vibration dampening and to bias the head in resilient manner to a central position.

31. A massage device according to claim 15 wherein the handle includes a display and PCB assembly, the display including a liquid crystal screen and there being a control button in order to operate a timing function.

32. A massage device according to claim 15 wherein the handle includes a display and PCB assembly, thedisplay including a liquid crystal screen and there being a control button in order to operate a timing function, the timing function comprising a numerical display of minutes of treatment, with a visual display of cumulative treatment time.

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Petitioner Therabody Ex-1013, 0433

33. A massage device according to claim 15 further comprising a frequency controller wherein the vibration frequency is automatically adjusted during use.

34. A massage device according to claim 15 further comprising an over-pressure sensor and indicator.

35. A massage device according to claim 15 further comprising a frequency controller wherein the vibration frequency is automatically adjusted during use and an over-pressure sensor and indicator.

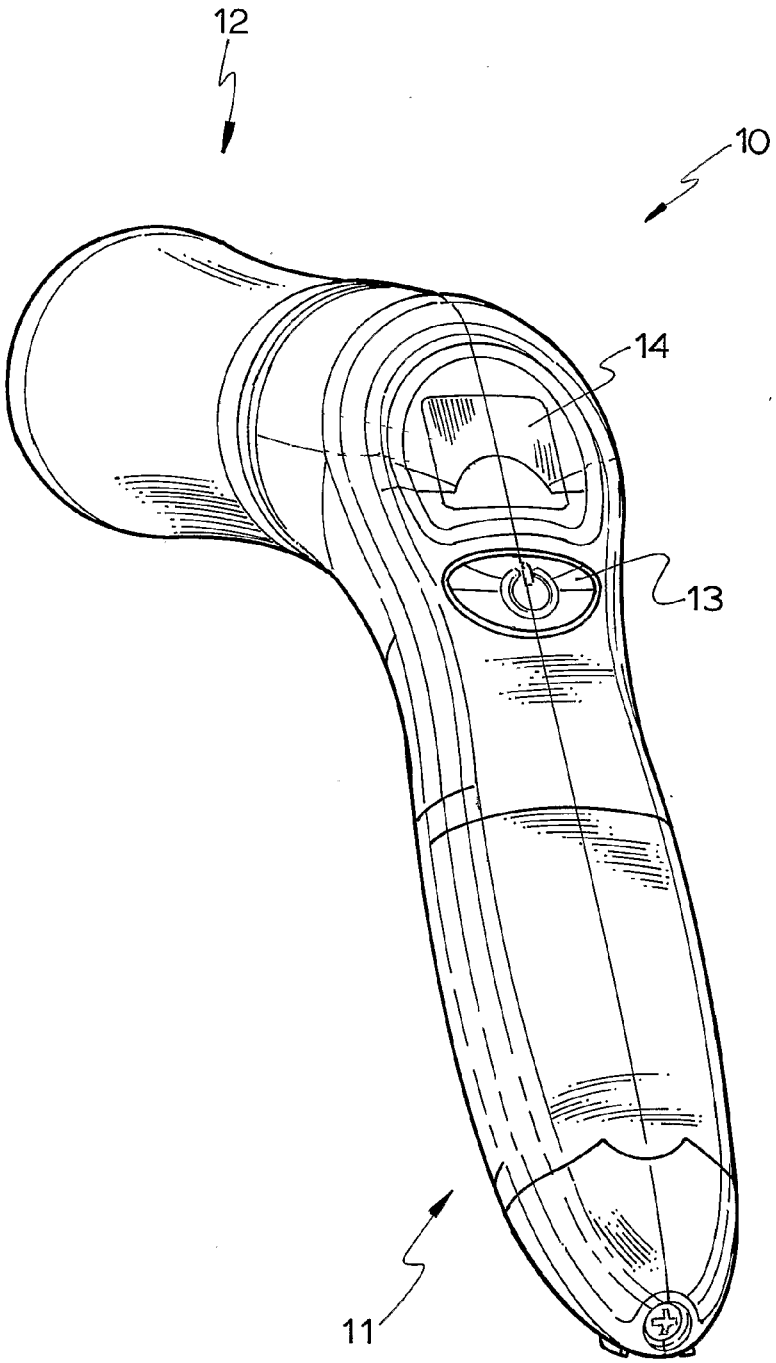


FIG.1

MassagerPriorArt0001643

Petitioner Therabody Ex-1013, 0435

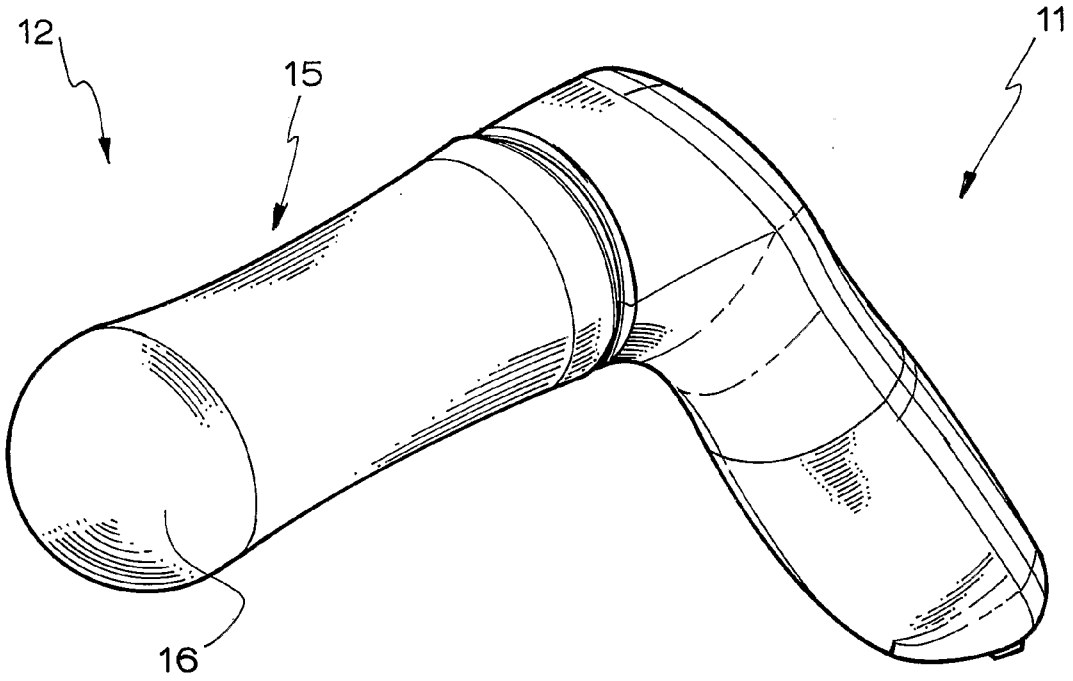


FIG.2

MassagerPriorArt0001644

Petitioner Therabody Ex-1013, 0436

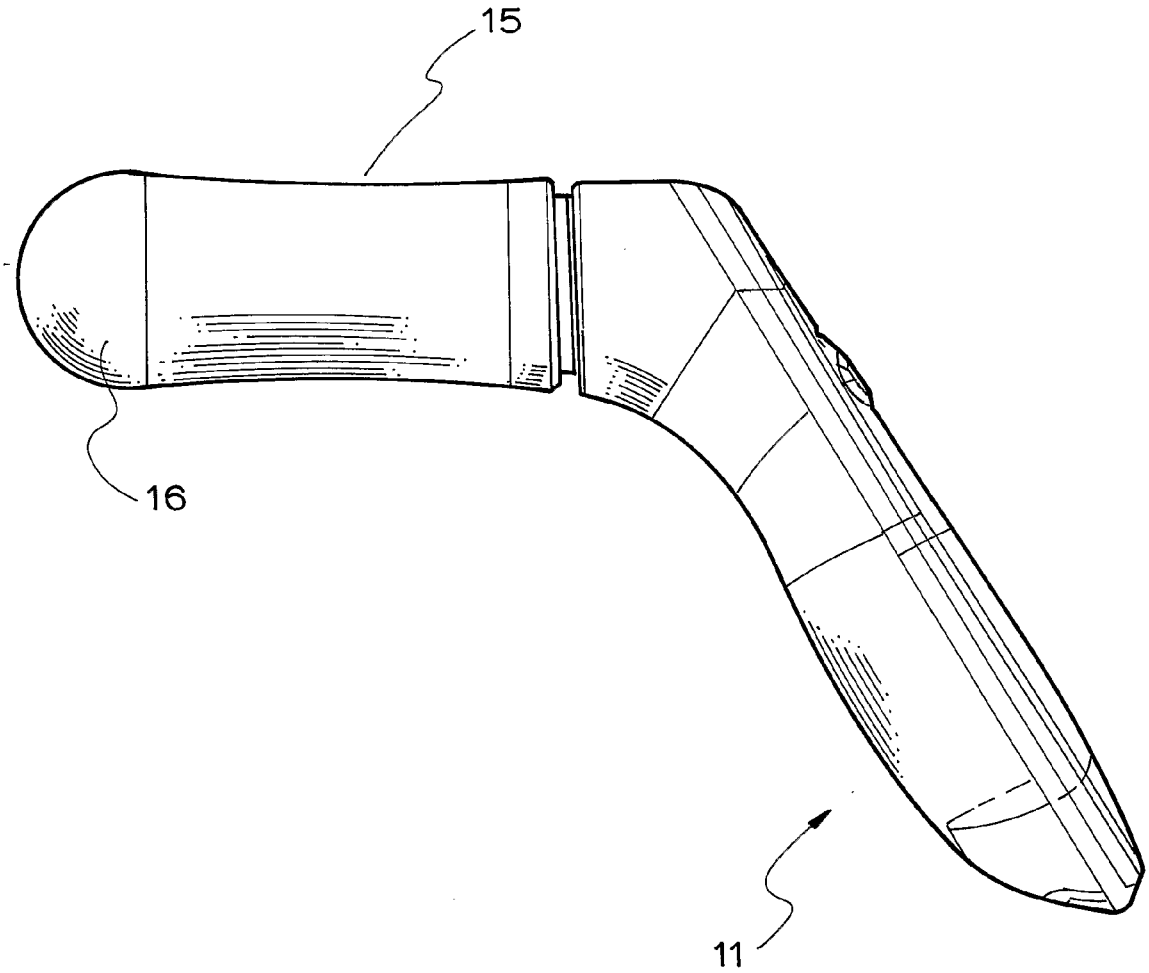


FIG. 3

MassagerPriorArt0001645

Petitioner Therabody Ex-1013, 0437

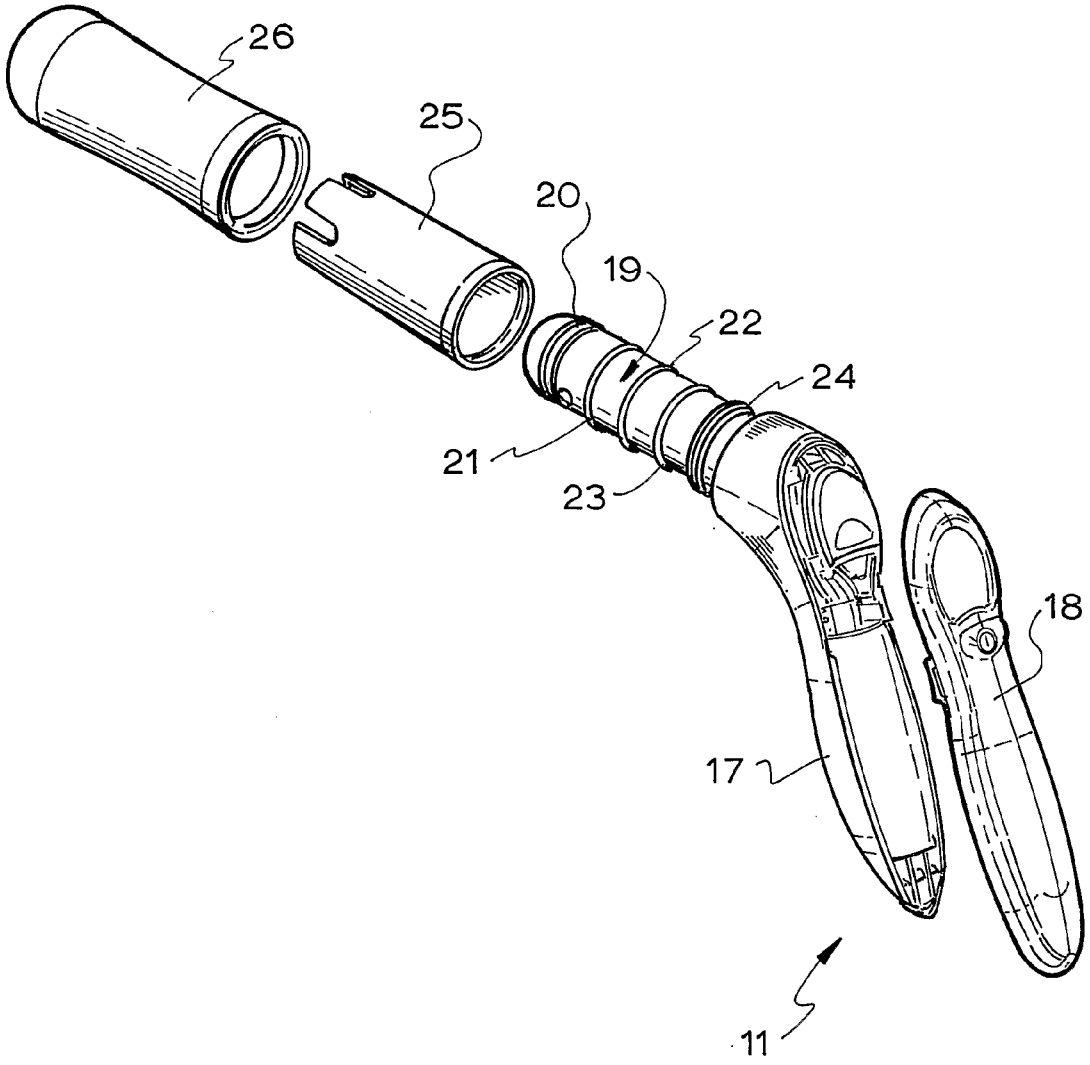


FIG. 4

MassagerPriorArt0001646

Petitioner Therabody Ex-1013, 0438

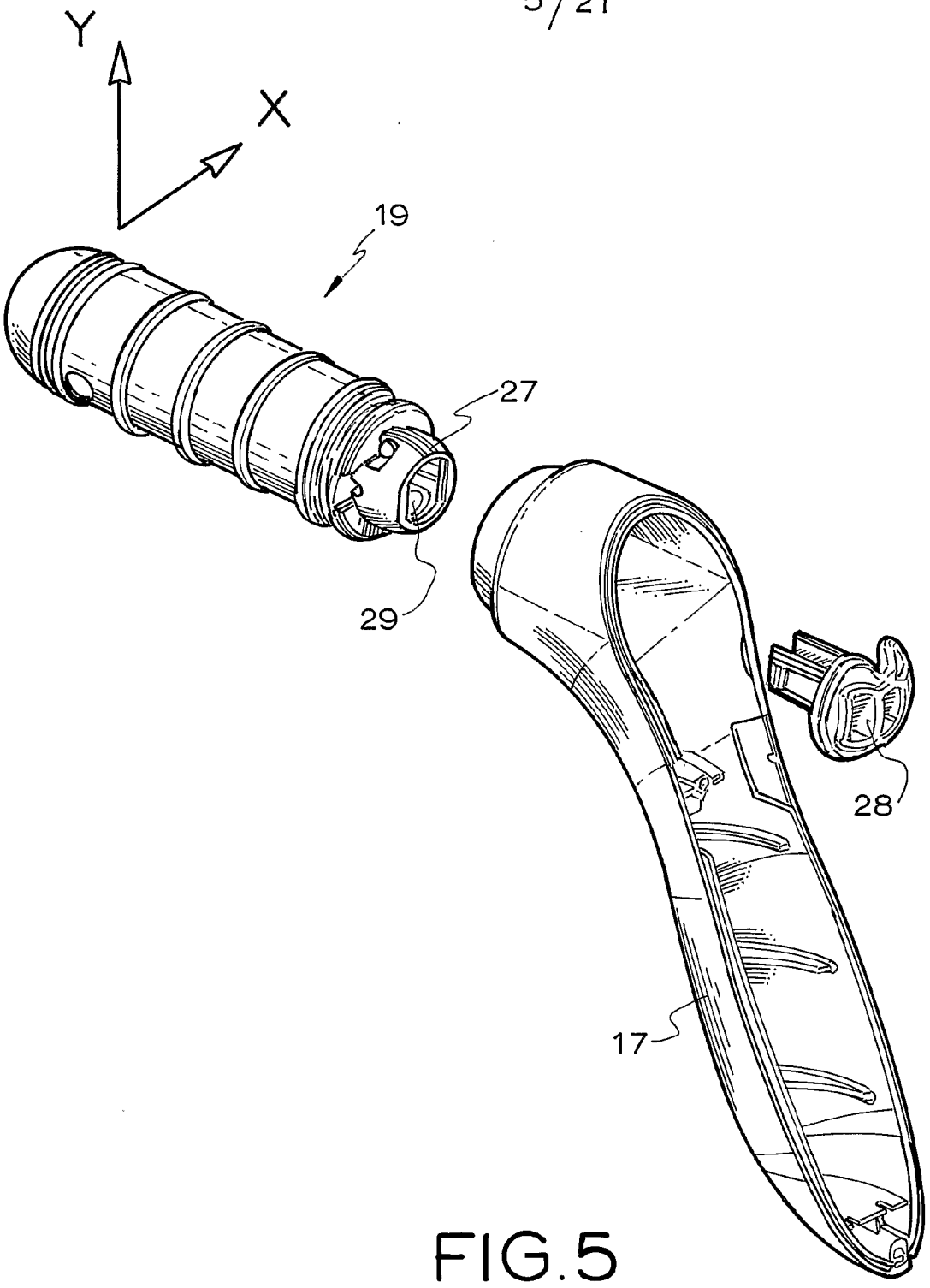


FIG.5

MassagerPriorArt0001647

Petitioner Therabody Ex-1013, 0439

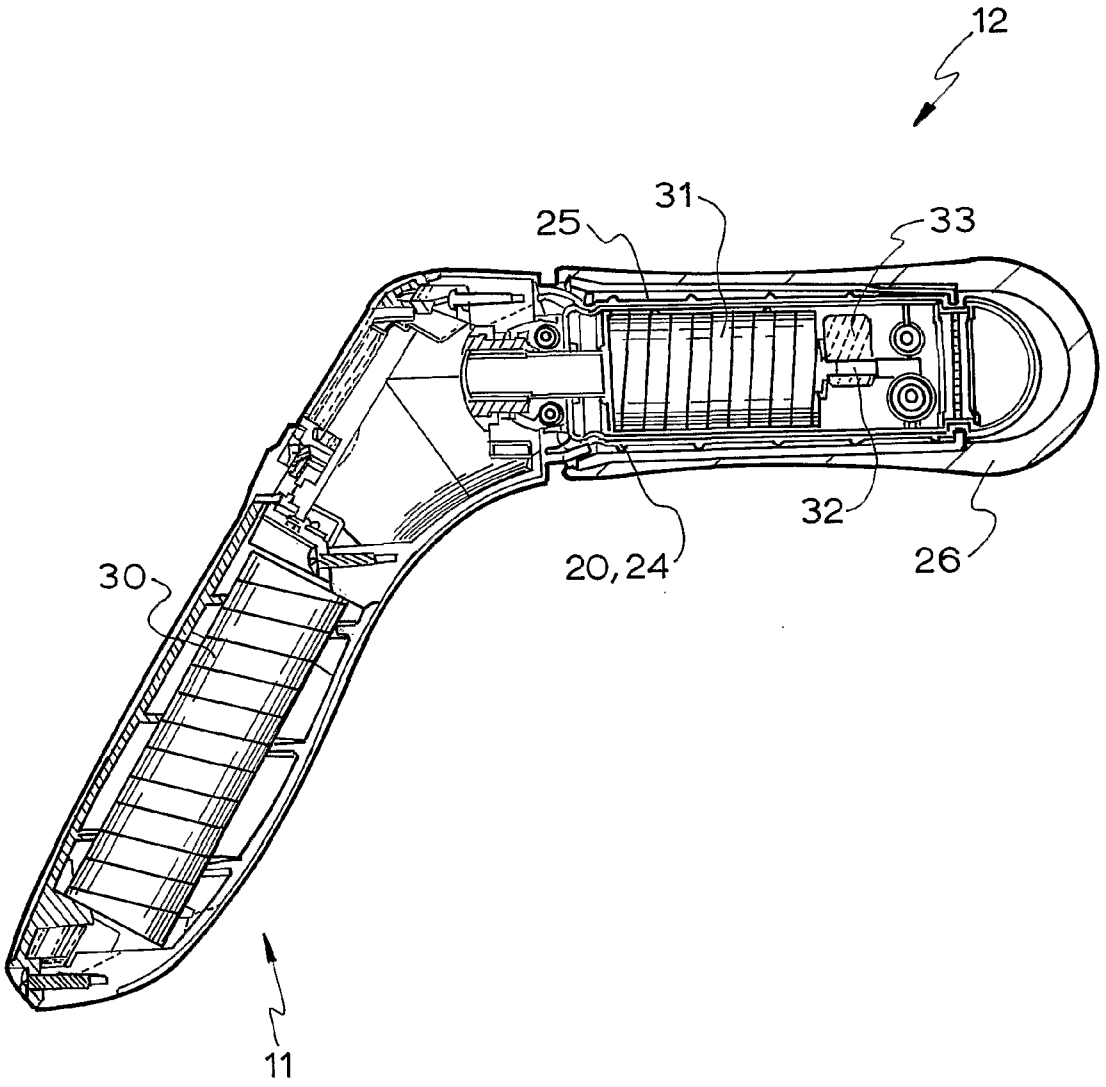


FIG.6

MassagerPriorArt0001648

Petitioner Therabody Ex-1013, 0440

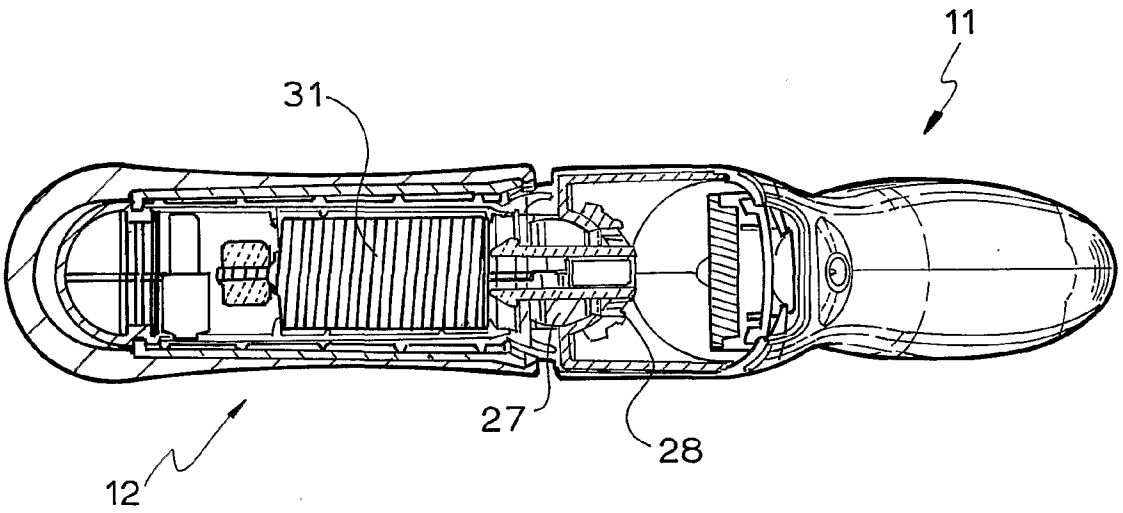


FIG.7

MassagerPriorArt0001649

Petitioner Therabody Ex-1013, 0441

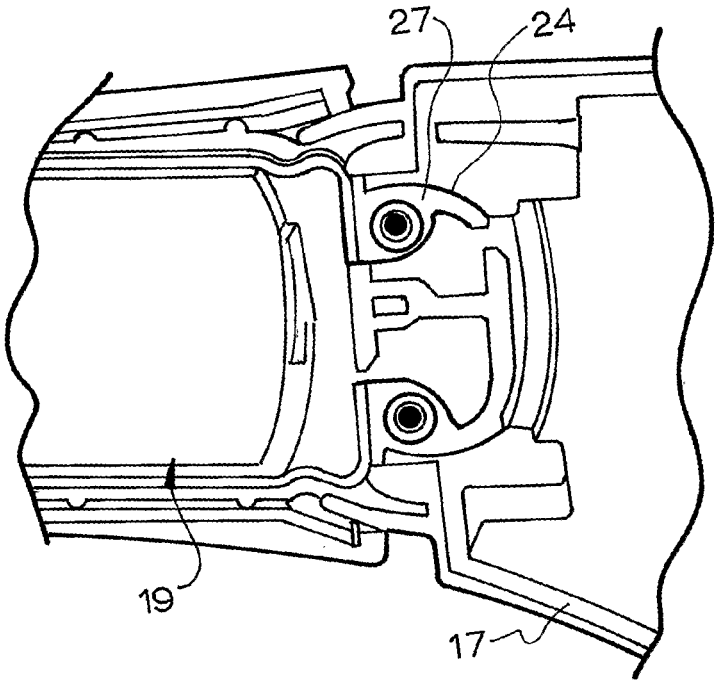


FIG.8

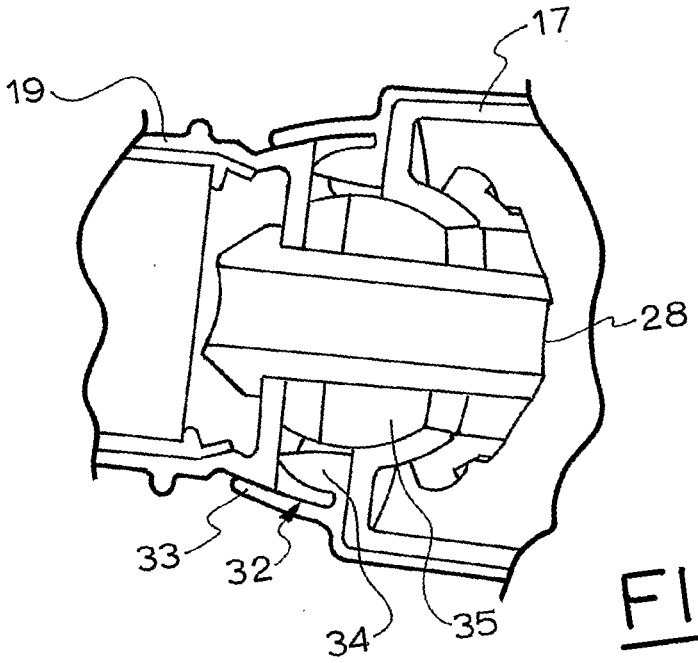


FIG.9

Petitioner Therabody Ex-1013, 0442

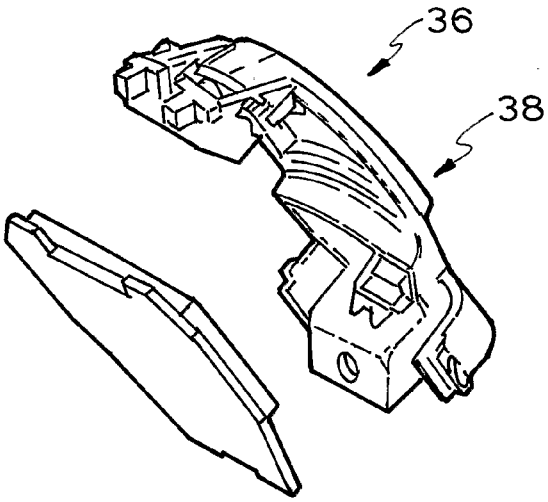


FIG.10

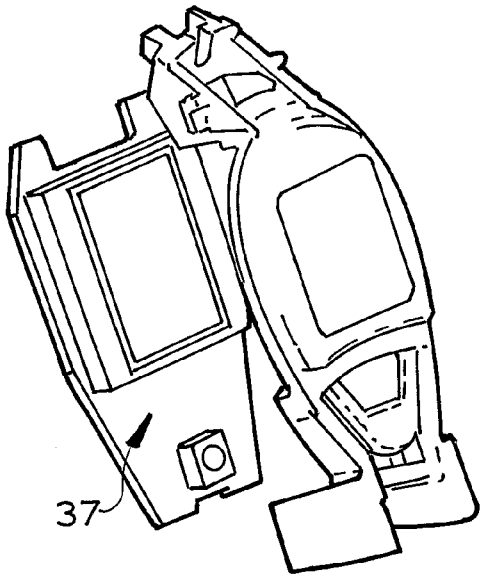


FIG.11

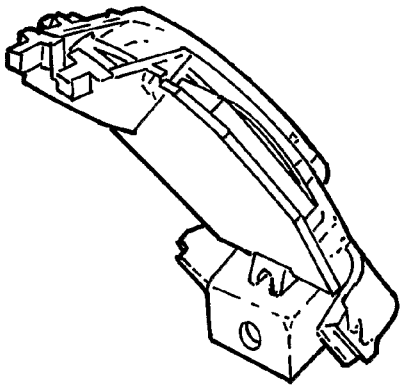


FIG.12

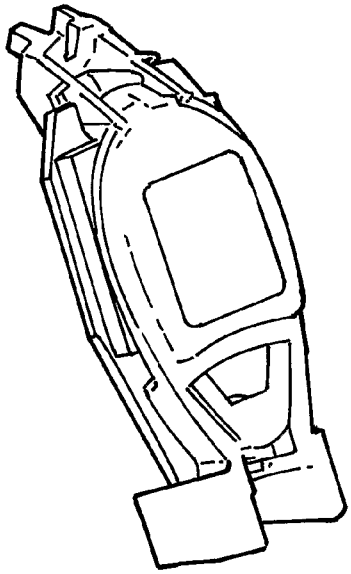


FIG.13

MassagerPriorArt0001651

Petitioner Therabody Ex-1013, 0443

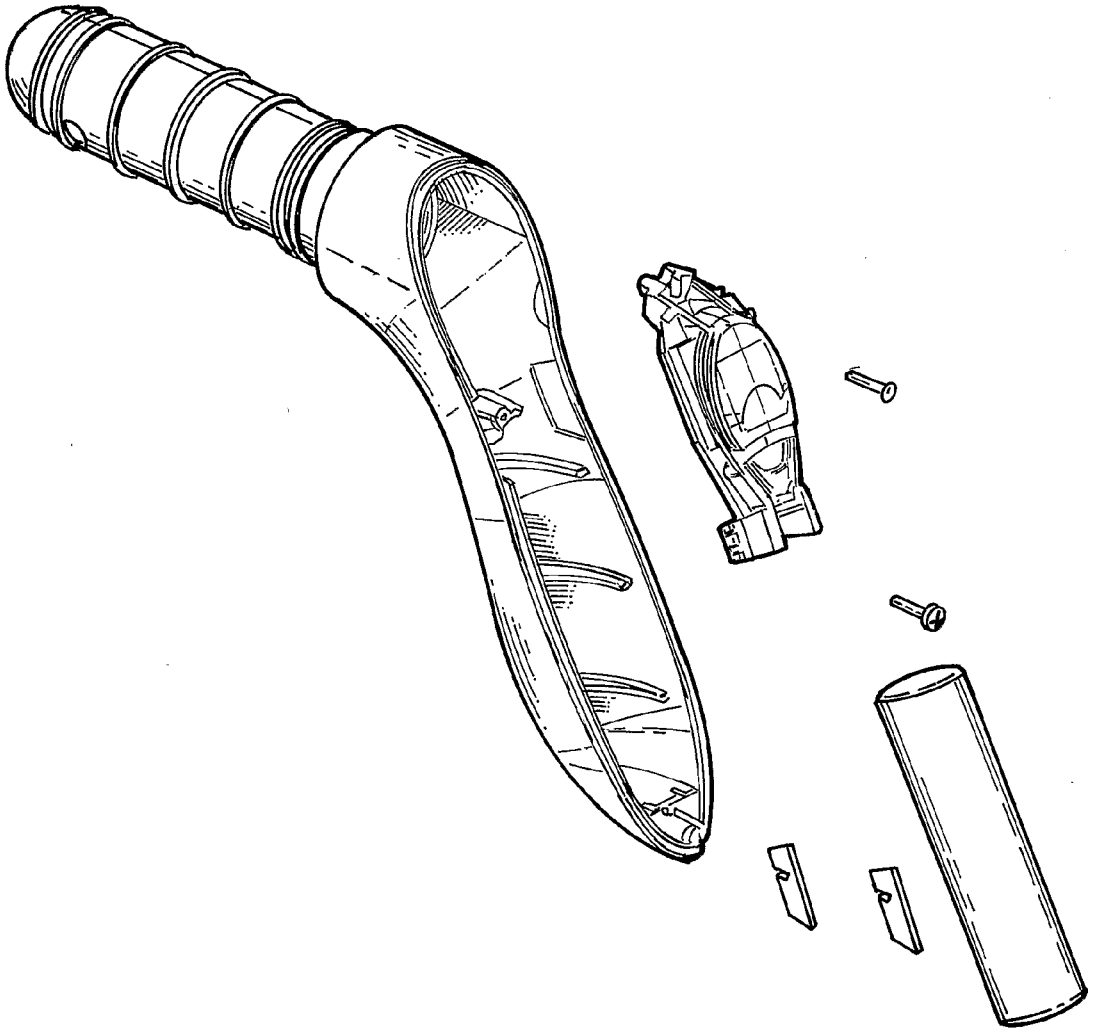


FIG.14

MassagerPriorArt0001652

Petitioner Therabody Ex-1013, 0444

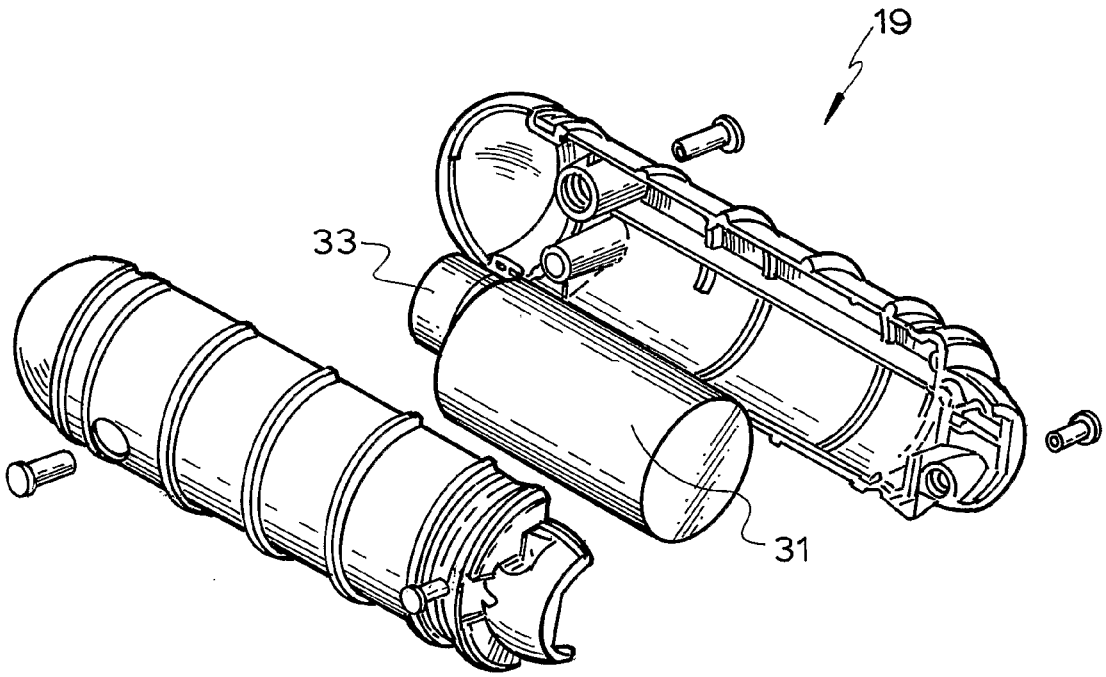


FIG.15

MassagerPriorArt0001653

Petitioner Therabody Ex-1013, 0445

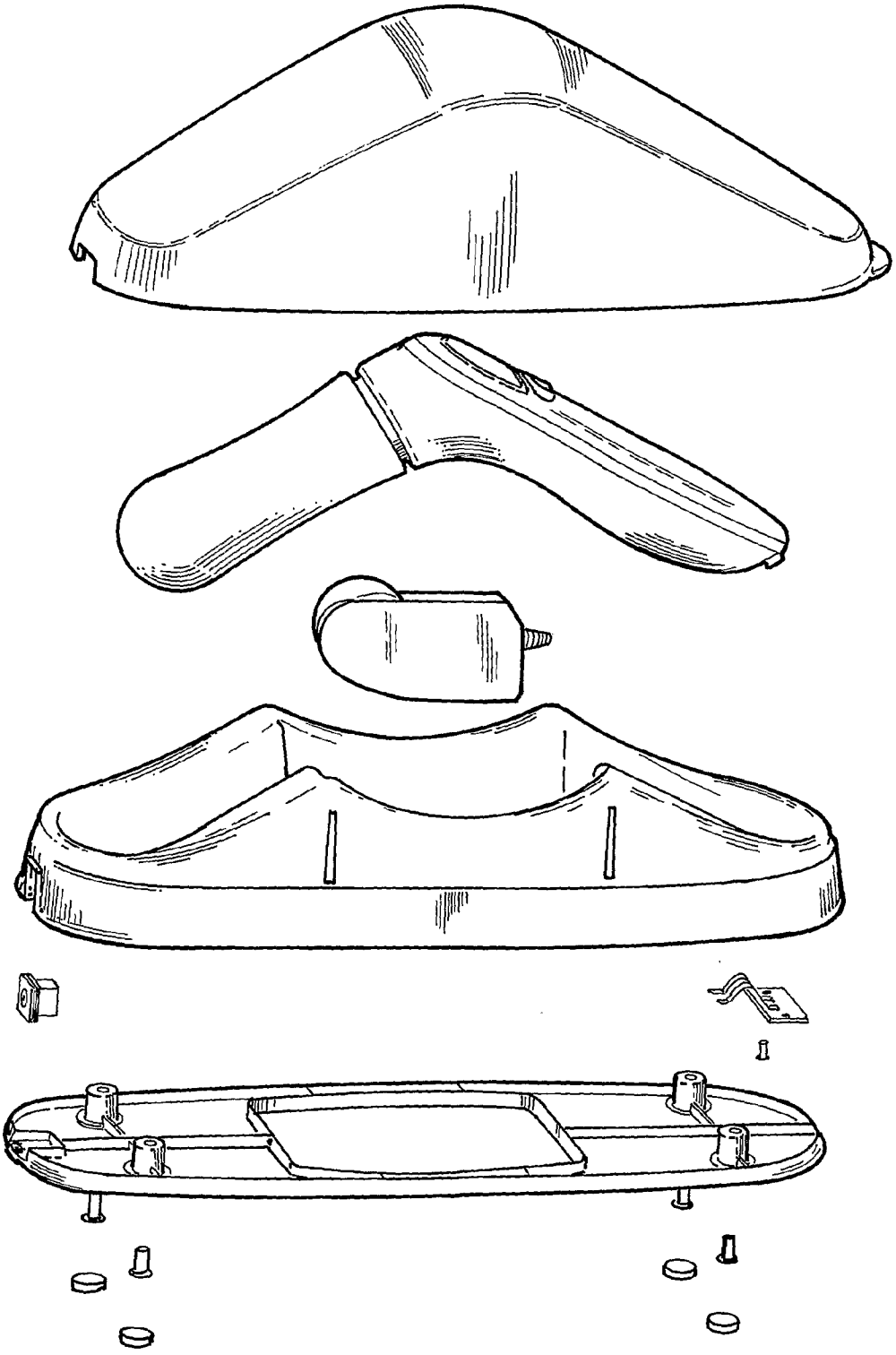


FIG.16

MassagerPriorArt0001654

Petitioner Therabody Ex-1013, 0446

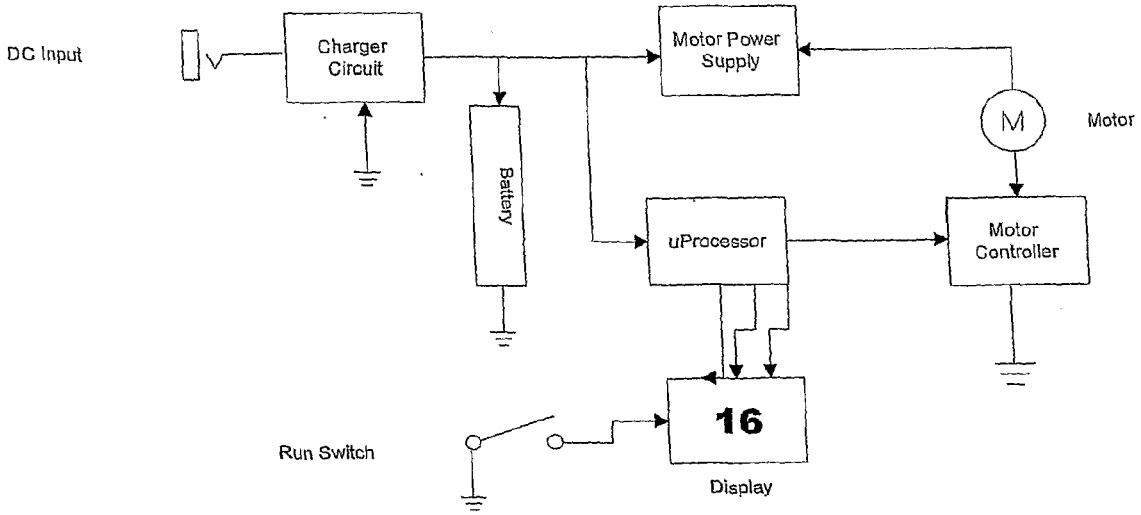


FIG. 17

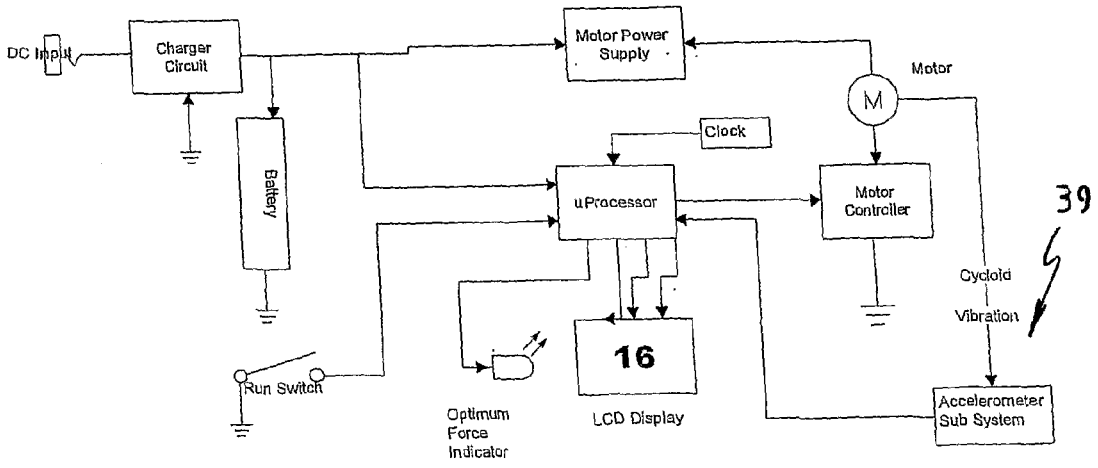


FIG. 18

MassagerPriorArt0001655

Petitioner Therabody Ex-1013, 0447

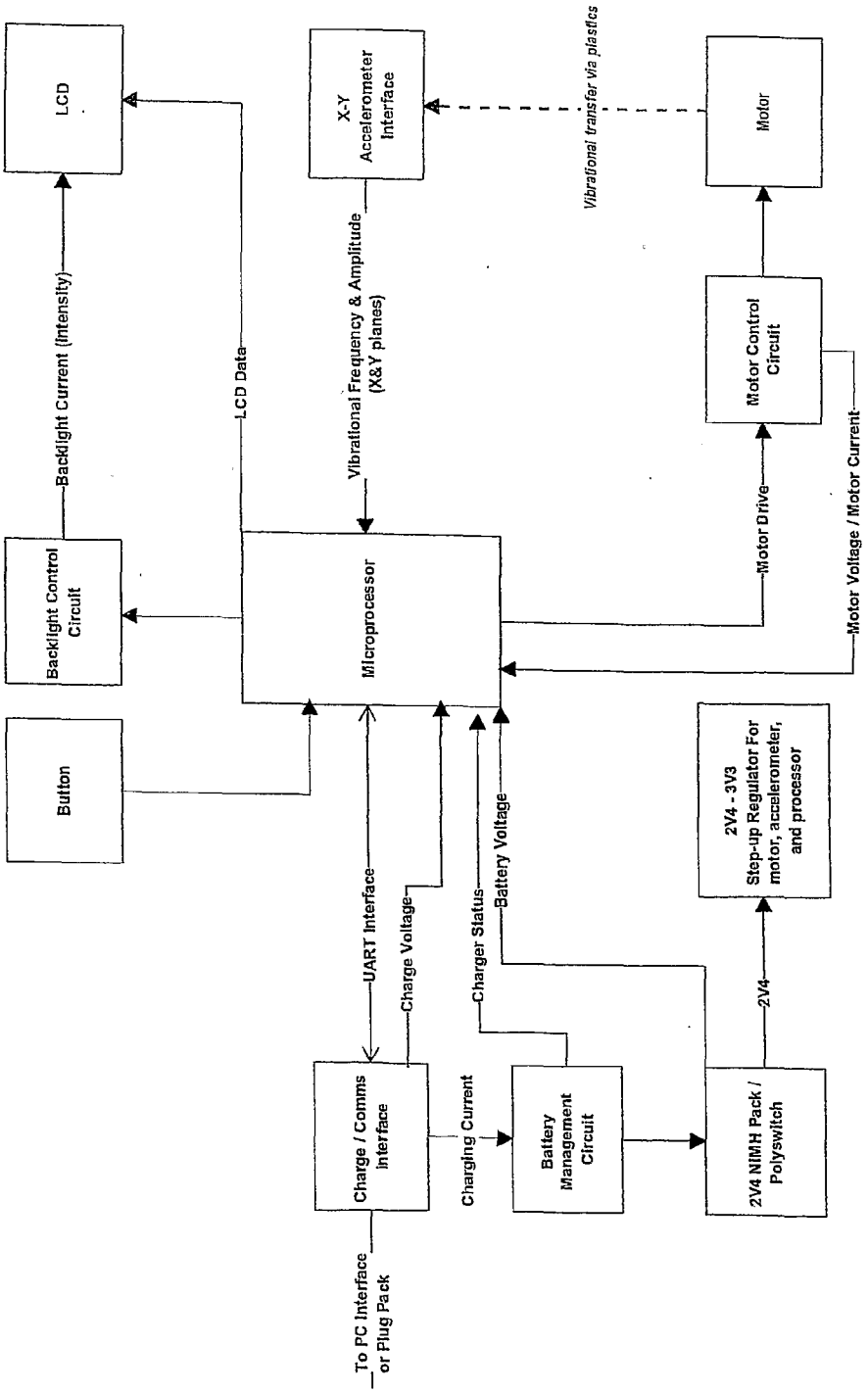


FIG. 19

MassagerPriorArt0001656

Petitioner Therabody Ex-1013, 0448

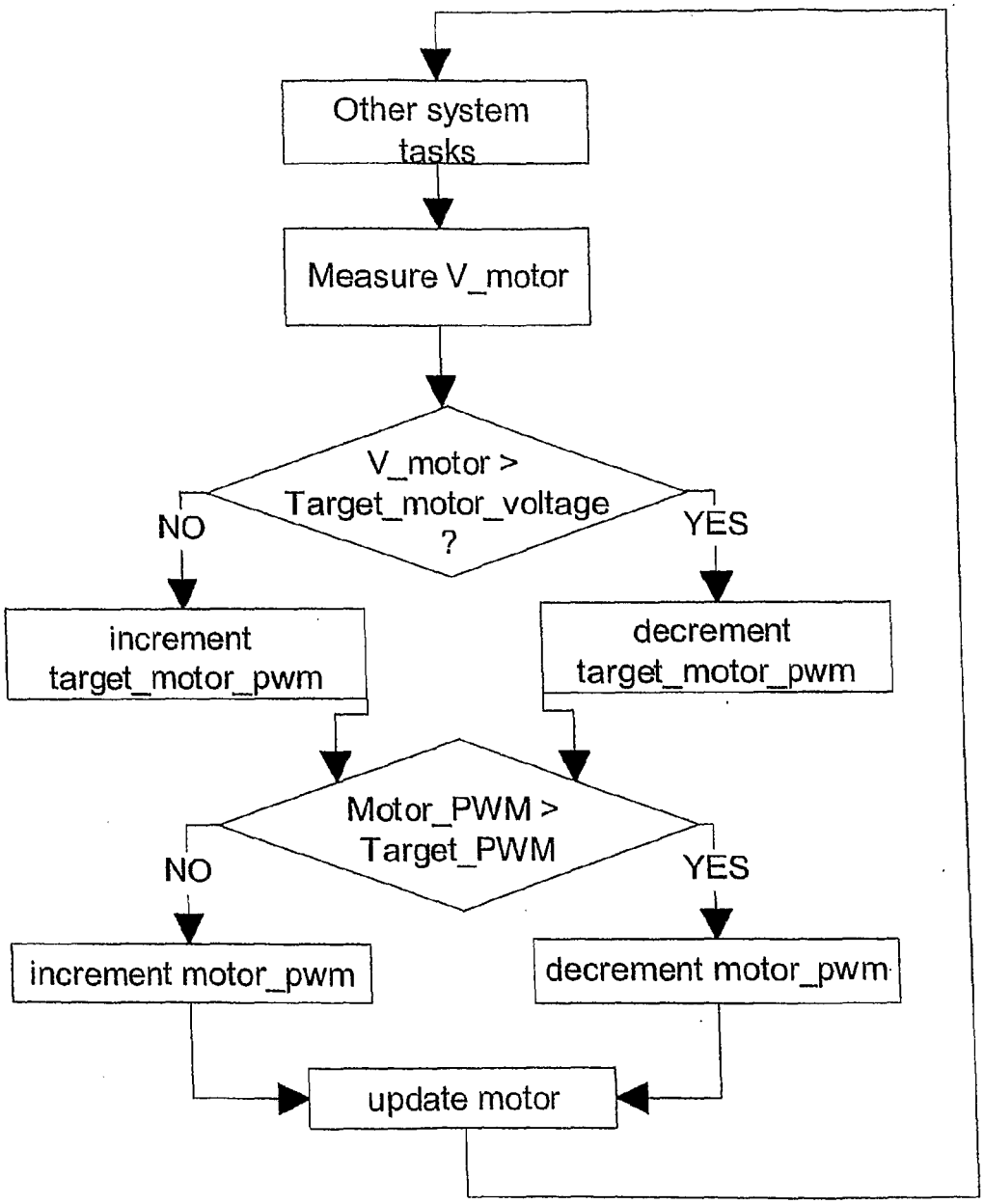


FIG. 20

MassagerPriorArt0001657

Petitioner Therabody Ex-1013, 0449

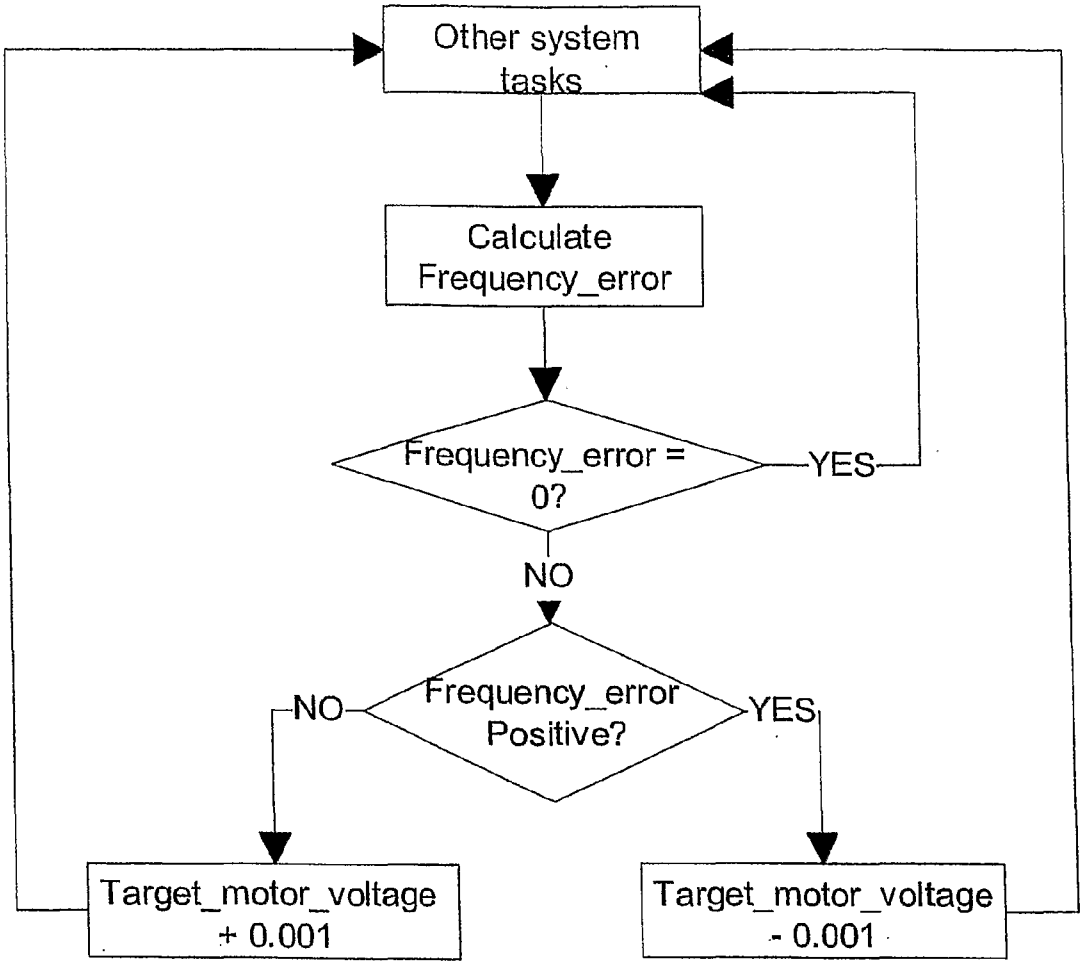


FIG. 21

MassagerPriorArt0001658

Petitioner Therabody Ex-1013, 0450

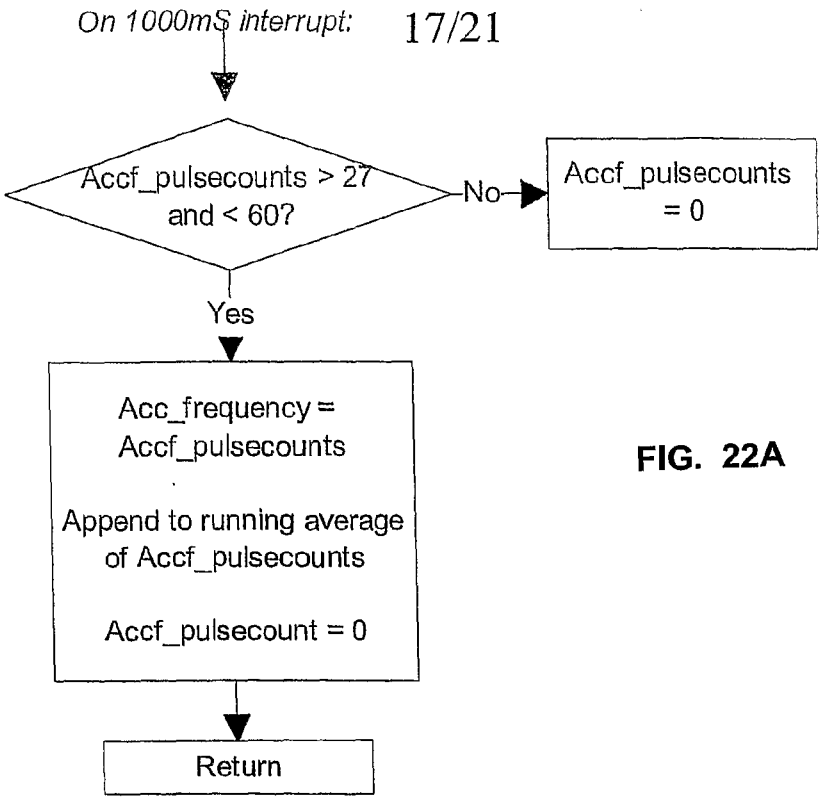


FIG. 22A

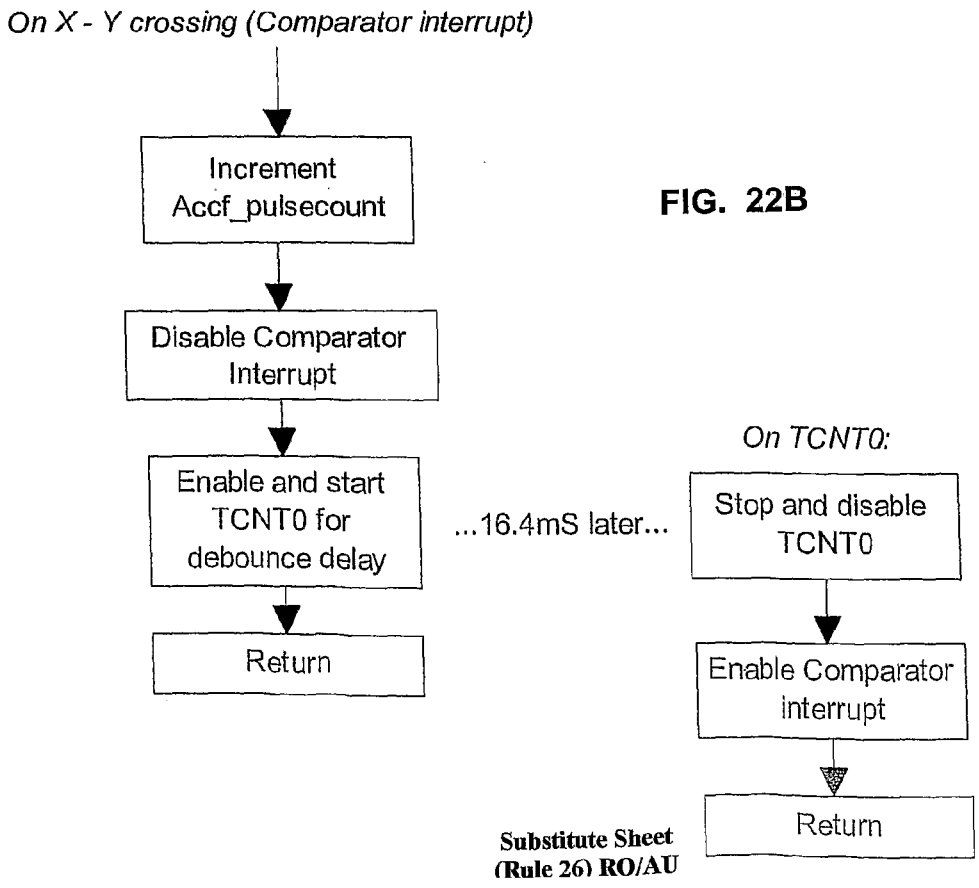


FIG. 22B

MassagerPriorArt0001659

Petitioner Therabody Ex-1013, 0451

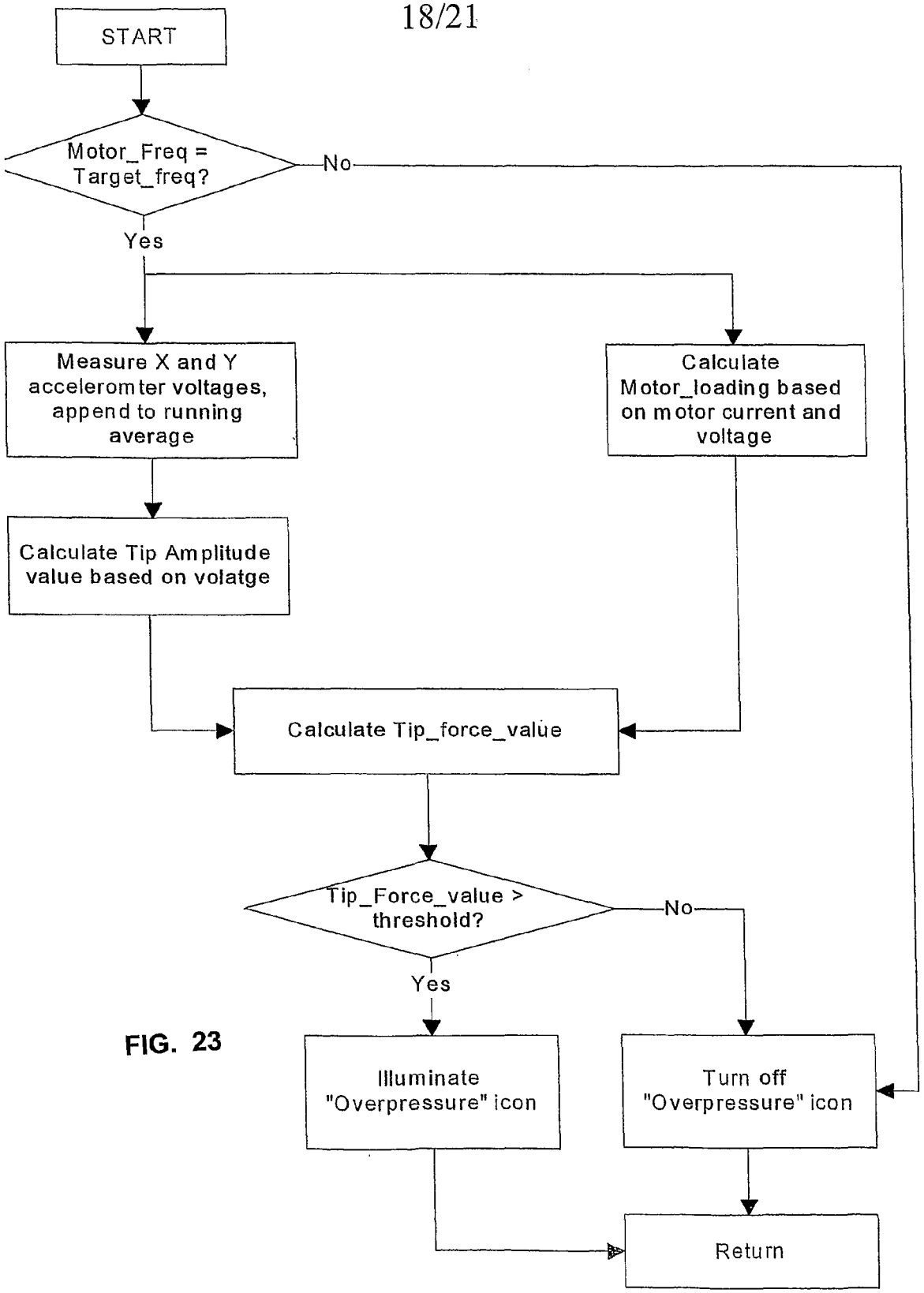
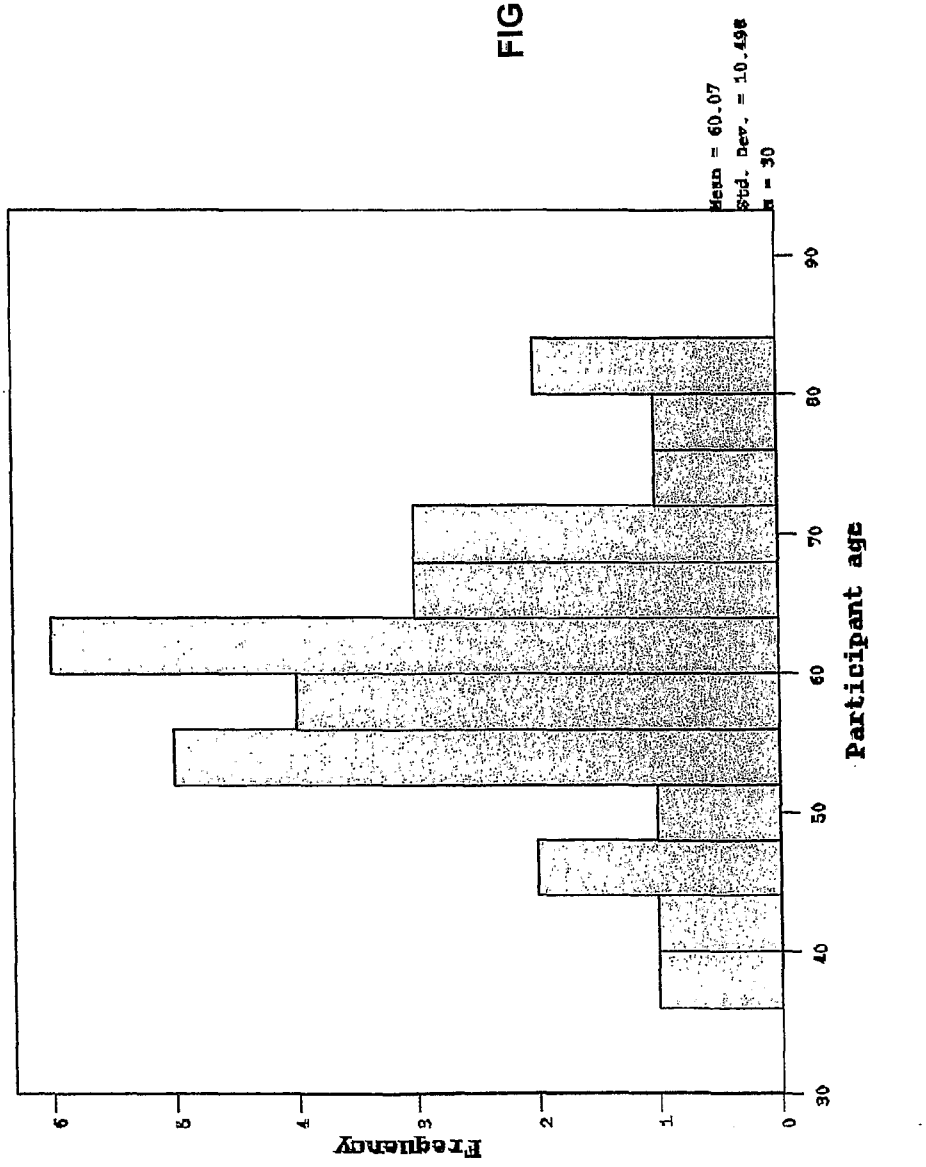


FIG. 23

MassagerPriorArt0001660

Petitioner Therabody Ex-1013, 0452

FIG. 24



MassagerPriorArt0001661

Petitioner Therabody Ex-1013, 0453

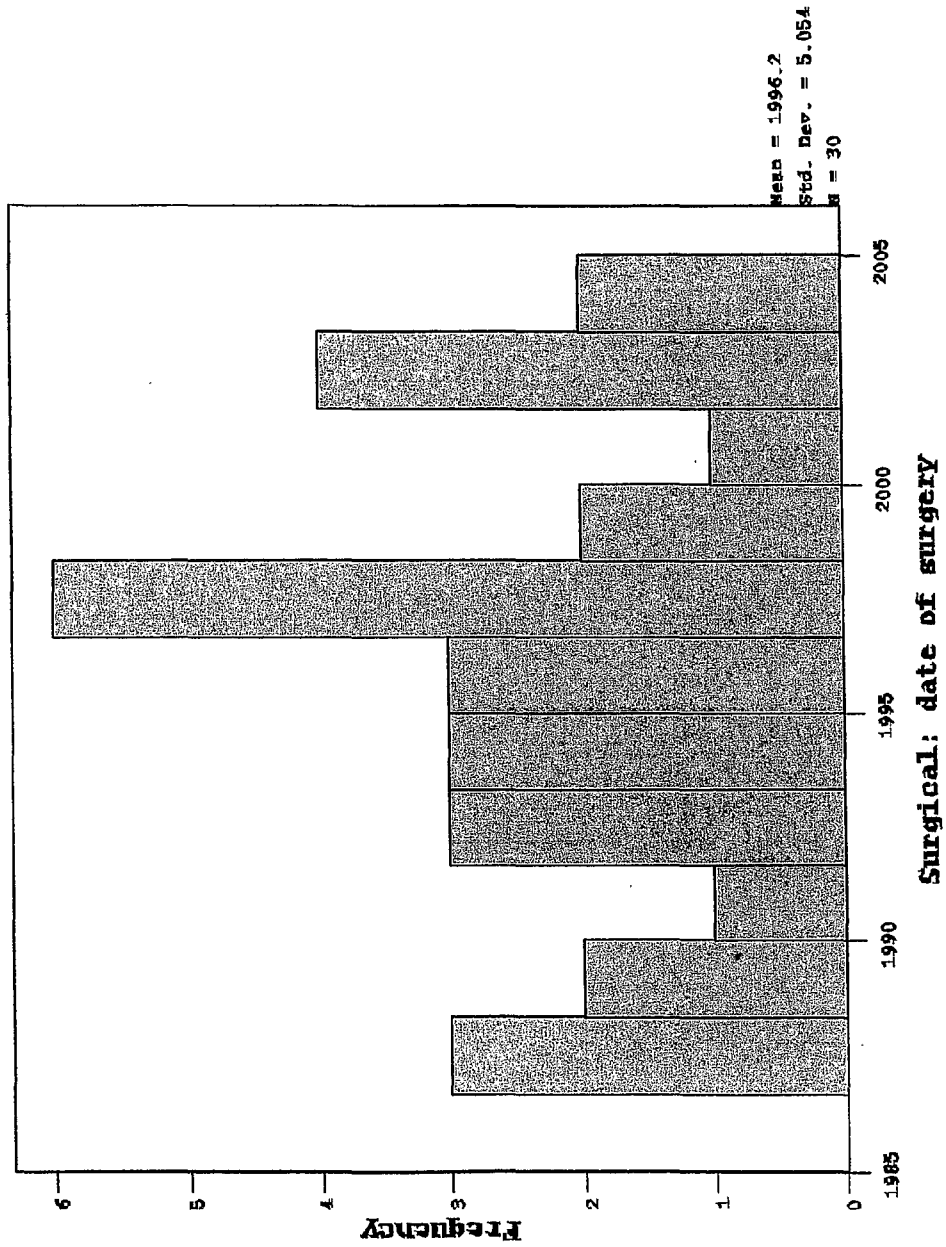


FIG. 25

MassagerPriorArt0001662

Petitioner Therabody Ex-1013, 0454

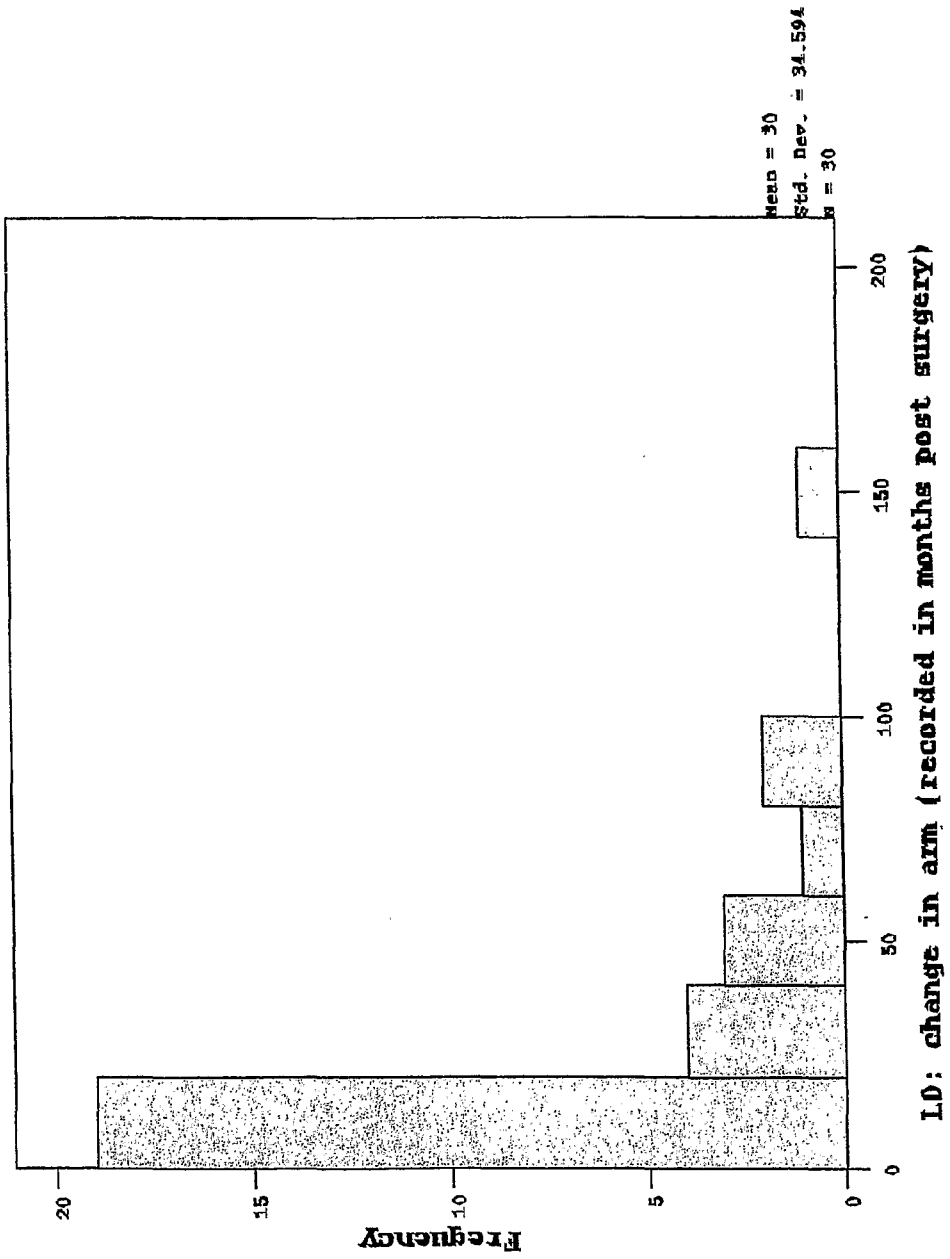


FIG. 26

MassagerPriorArt0001663

Petitioner Therabody Ex-1013, 0455

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2008/000419

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A *61H 15/00* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI and IPC mark A61H and keywords: massage and roll and handheld and motor and lymph and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/0159687 A1 (MIZUUCHI) 21 July 2005 Paragraphs 20 to 23	1,15-17,27
Y		2-13,21,31-35
X	US 2004/0133134 A1 (POLYCHRONIS) 8 July 2004 Paragraphs 29 to 35	1,15,17
Y		2-13,21,31-35
Y	US 2004/0077978 A1 (NELSON et al.) 22 April 2004 Paragraphs 18, 19 and 27	2,4-13

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents;
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 April 2008	30 APR 2008
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **DAVID MELHUISH** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : (02) 6283 2426

Form PCT/ISA/210 (second sheet) (April 2007)

Petitioner Therabody Ex-1013, 0456

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5792080 A (OOKAWA et al.) 11 August 1998 Column 7 lines 13 to 57	3,34
Y	US 6632185 B2 (CHEN) 14 October 2003 Figure 4	21
Y	US 6120468 A (TSENG) 19 September 2000 Column 2 lines 60-61 Column 3 lines 58 to 63	31-33,35

MassagerPriorArt0001665

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2008/000419

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US	2005159687	CN	1644194	JP	2005198951
US	2004133134	CA	24171 15	US	6860861
us	2004077978	EP	1370208	WO	02065973
us	5792080				
us	6632185	US	2003093016		
us	6120468				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX

MassagerPriorArt0001666

Petitioner Therabody Ex-1013, 0458

TWM543692U Portable exercise massage device structure

The EPO does not accept responsibility for the accuracy of data originating from authorities other than the EPO, nor does it guarantee that such data is complete, up-to-date or fit for specific purposes.

[0001] The present invention relates to a structure of a portable sports massager, which comprises a body, a power unit, a heat dissipating component and a power unit, and more particularly, a fan is provided at an outer end of the motor to protect a heat source generated by the motor from being held by the motor. The end hole groove is discharged to reduce the motor temperature, maintain the motor power saving and normal working efficiency, and prolong the life of the motor, and the battery can be removed by replacing the battery, and the charging jack can be provided at the top of the longitudinal body. Or USB cable to charge, which has the effect of being easy to carry out and can be replaced at any time. It can be replaced by the power unit, no need to plug in the power, and there is no power cord to tie up during use, which improves the use. The convenience of the massager design.

[0001] Press, the general hand-held massager, which is mostly connected to the power supply wire, therefore, it must be used in the place with the power socket when going out, and can not be used whenever needed, especially for sports players in training or competition. When the muscles are sore and fatigued, it is necessary to use a massage. However, there is no power supply socket at the scene, and the player cannot be massaged at the appropriate time, thereby affecting the performance of the player, and the conventional hand massager needs to be plugged in, resulting in Inconvenience in use, and the conventional hand-held massager, the motor is sealed and enclosed therein, so that the high temperature generated by the motor during use is not allowed to be dissipated, thereby reducing the operating efficiency of the motor and consuming power. As the amount increases, the life of the motor is shortened, and the other components are indirectly affected, which is liable to cause malfunction.

[0001] <Technical problems to be solved> In view of the practical difficulties of the above-mentioned conventional hand-held massagers and the lack of improvement, the presenter hopes to provide a breakthrough design to enhance practical effects, and is devoted to research and design. In addition, the company has been engaged in the professional technical knowledge and practical experience of related product design and production for many years, and the results of research and design, and finally developed the structure of a portable sports massager to provide users.

[0001] <Technical means for solving the problem> The present invention relates to a structure of a portable exercise massager comprising a body, a power unit, a heat dissipating component and a power unit, wherein the body comprises a longitudinal body and a set of grips on both sides of the longitudinal body The power unit is disposed in one of the grip portions, and the power unit is disposed in the other grip portion. The power unit includes a motor, an eccentric wheel, a drive wheel and a lifting rod. The eccentric wheel is disposed on the motor shaft, and the driving wheel The pivoting rod is disposed at an eccentric position of the eccentric wheel, and the lifting rod is disposed at a middle shaft hole of the lower end of the longitudinal body, and the lower end of the lifting rod is threaded into the shaft hole of the lower end of the longitudinal body, and a ring edge portion is formed at a periphery of the lower end of the lifting rod, and A spring is arranged between the edge portion of the ring body and the peripheral surface of the shaft hole in the longitudinal body, so that the top of the lifting rod is kept in contact with the driving wheel, and the lower part of the shaft hole in the longitudinal body can be worn with a massage element having various shapes and massage effects. And at the bottom of the lifting rod and the top of the massage element, there are corresponding magnetic components, so that the massage element can be quickly disassembled and replaced, in the longitudinal The inner wall of the shaft hole of the body is sleeved with a sleeve made of wear-resistant, smooth sliding and friction reducing material, and the sleeve can be made of Teflon material or ceramic material, and a fan is arranged at the outer end of the motor to The heat source generated during the operation of the motor is discharged from the end slot of the grip portion to reduce the motor temperature, maintain the power saving and normal working efficiency of the motor, and prolong the life of the motor. The power unit is a battery with multiple batteries inside.甲, it can be removed and replaced, or it can be charged by the charging jack on the top of the vertical body, charged by the charger or USB cable, which has the convenience of being carried out and can be replaced at any time, and can be replaced by the battery. The power unit is powered, and does not need to be plugged in, and there is no power cord tie when used, which improves the convenience of use.

[0001] In addition, a control switch and an indicator light are arranged on the top of the longitudinal body, and the adjustment knob of the control switch can be used to control the rotation of the motor, or to turn on or off the power, or the indicator light can display the state of the power supply.

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[0001] <Comparative to the efficacy of the prior art> The main purpose of this creation is to supply power by the power unit, without plugging in, and there is no power cord tie when used, which improves the convenience of use.

[0001] The second purpose of this creation is mainly to provide a fan at the outer end of the motor to discharge the heat source generated by the motor from the end of the grip portion to reduce the motor temperature, maintain the motor power saving and normal working efficiency. And extend the life of the motor.

[0001] A further object of the present invention is to provide corresponding magnetic elements by means of the bottom of the lifting rod and the top of the massaging element, so that the massaging element can be quickly disassembled and replaced.

[0001] In order to make your review board more aware of the structural features and efficacy of this creation, we will cooperate with the schema and elaborate on it later.

[0001] Please refer to the second figure and the third figure of the first figure. The present invention relates to a structure of a portable exercise massager comprising a body (1), a power unit (2), a heat dissipating component (3) and a power unit (4), wherein the body (1) comprises a longitudinal body (11) and a set of grips (12) (13) on both sides of the longitudinal body (11), and the power unit (2) is provided in one of the grips In the portion (12), the power unit (4) is disposed in another grip portion (13), and the power unit (2) includes a motor (21), an eccentric (22), a drive wheel (221), and a lifting rod. (23) The eccentric wheel (22) is disposed on the rotating shaft of the motor (21), the driving wheel (221) is pivoted on the eccentric position of the eccentric wheel (22), and the lifting rod (23) is disposed on the longitudinal body (11) At the lower middle shaft hole (14), the lower end (231) of the lifting rod (23) is threaded into the shaft hole (14) of the longitudinal body (11), and a peripheral edge of the lower end of the lifting rod (23) is formed with a ring edge portion (33), and a spring (24) is disposed between the rim portion (233) and the peripheral plane of the shaft hole (14) in the longitudinal body (11), and the spring (24) restoring force to make the top end of the lifting rod (23) (232) Keeping in contact with the driving wheel (221), in the lower part of the shaft hole (14) in the longitudinal body (11), the massage element (6) of the massage head (61) of various shapes and massage effects can be worn and attached to the lifting rod (23) The bottom and the top of the massage element (6) are provided with magnetic elements (25) (62) corresponding to each other, so that the massage element (6) can be quickly disassembled and replaced, and the longitudinal body (11) The inner wall of the central shaft hole (14) is provided with a sleeve (141) made of wear-resistant, smooth sliding and friction-reducing material, and the sleeve (141) can be made of Teflon material or ceramic material, and is mounted on the motor. (21) The outer end is provided with a heat dissipating component (3), and the heat dissipating component (3) may be a fan to generate a heat source generated by the motor (21) from the end of the grip portion (12) (121) discharging to reduce the temperature of the motor (21), maintaining the power saving and normal working efficiency of the motor (21), and prolonging the life of the motor (21), wherein the power unit (4) is internally provided with at least one battery (42) The battery pack (41) can be removed and replaced, or can be charged by a charger (7) or a USB cable (71) by a charging jack (53) provided at the top of the vertical body (11). It is easy to carry out and can be replaced at any time, and can be replaced by the power unit (4). It does not need to be plugged in, and there is no power cord during use, which improves the convenience of use.

[0001] In addition, a control switch (5) and an indicator light (52) are arranged on the top of the longitudinal body (11), and the rotation speed of the motor (21) can be controlled by the adjustment knob (51) of the control switch (5), or the power can be turned on and off. The indicator light (52) can also indicate the status of the power on, off, and power unit (4) power.

[0001] The power unit (2) can directly move up and down by an eccentric rod driving lifting rod (23) provided on the eccentric (22) of the motor (21).

[0001] In summary, the creation has the advantages of being convenient to carry out and being able to replace the battery or charging at any time, and is powered by the power unit provided, and does not need to be plugged in, but has no power cord tie during use, thereby improving the use. The convenience is a novelty, progressive and industrially applicable creation. It has already met the requirements of the new patent, and has filed a patent application according to law. The review committee can review it in detail and as soon as possible. The patent granted in this case is actually a virtue.

Petitioner Therabody Ex-1013, 0460

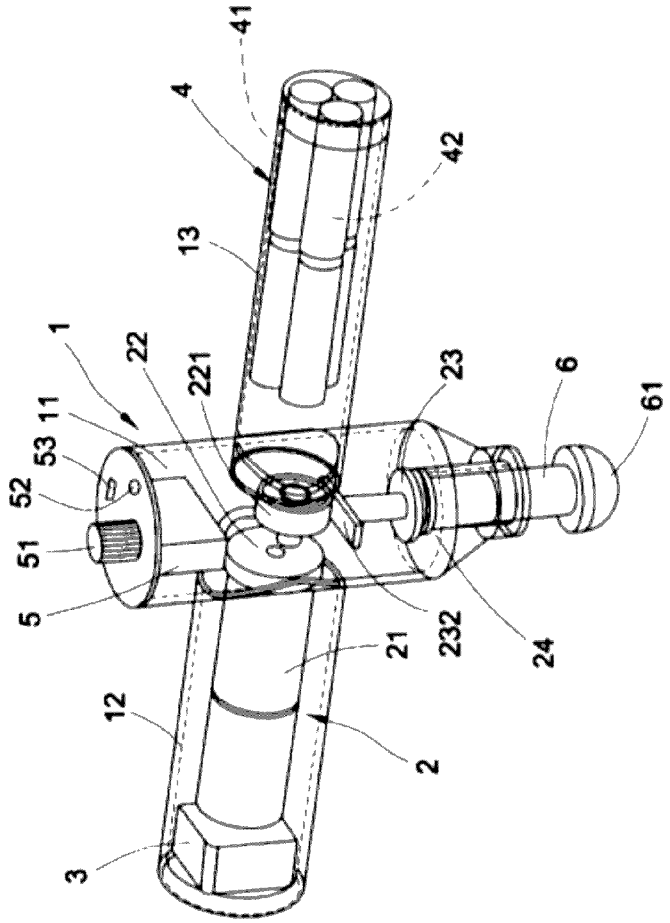
[0001] The above is only the preferred embodiment of the present invention. When it is not possible to limit the scope of this creation, the equivalent changes and modifications made by the patent application scope of this creation should still belong to this creation patent. Within the scope of coverage.

[0001]

[0001] The first figure is a perspective perspective view of one of the preferred embodiments of the present invention. The second picture is a perspective partial exploded view of the creation. The third picture is a combined view of the creation.

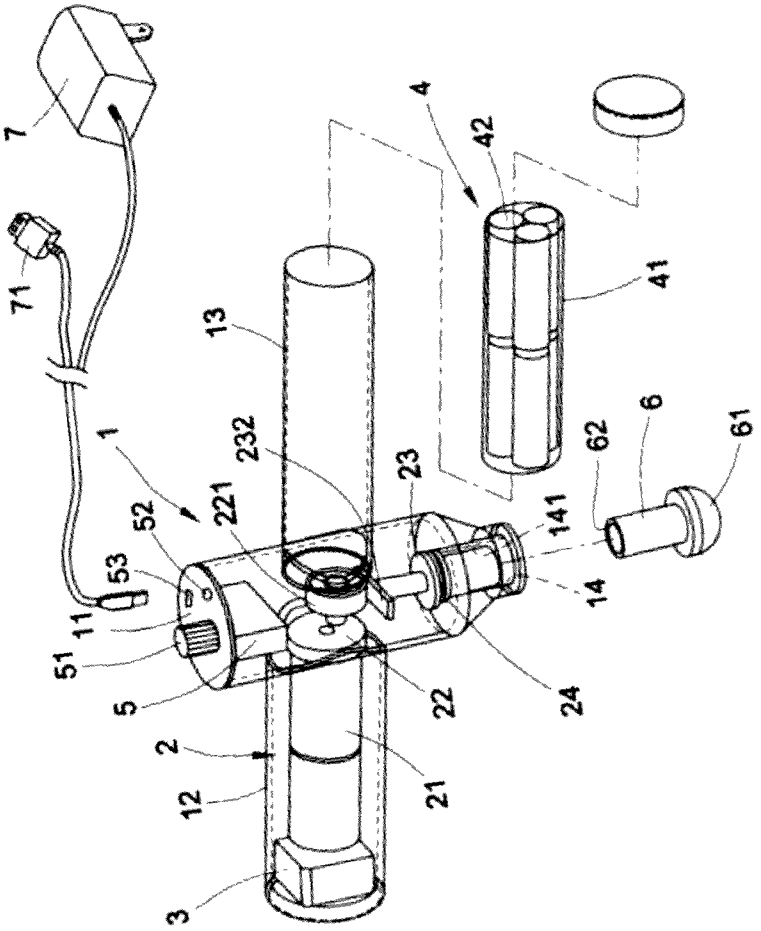
[0001] (1) · · body (11) · · vertical body (12) (13) · · grip (121) · · hole trough (14) · · shaft hole (141) · · tube Set (2) · · power unit (21) · · motor (22) · · eccentric (221) · · drive wheel (23) · · lift rod (231) · · lower end (232) ···Top (233) · · rim (24) · · springs (25) (62) · · magnetic elements (3) · · · heat elements (4) · · power units (41)···Battery匣(42)···Battery(5)···Control Switch (51)···Adjustment Button (52)··· Indicators (53)···Charging Jack (6) ···Massage components (61)···Massage heads (7)···Chargers (71)···USB cable

Drawings

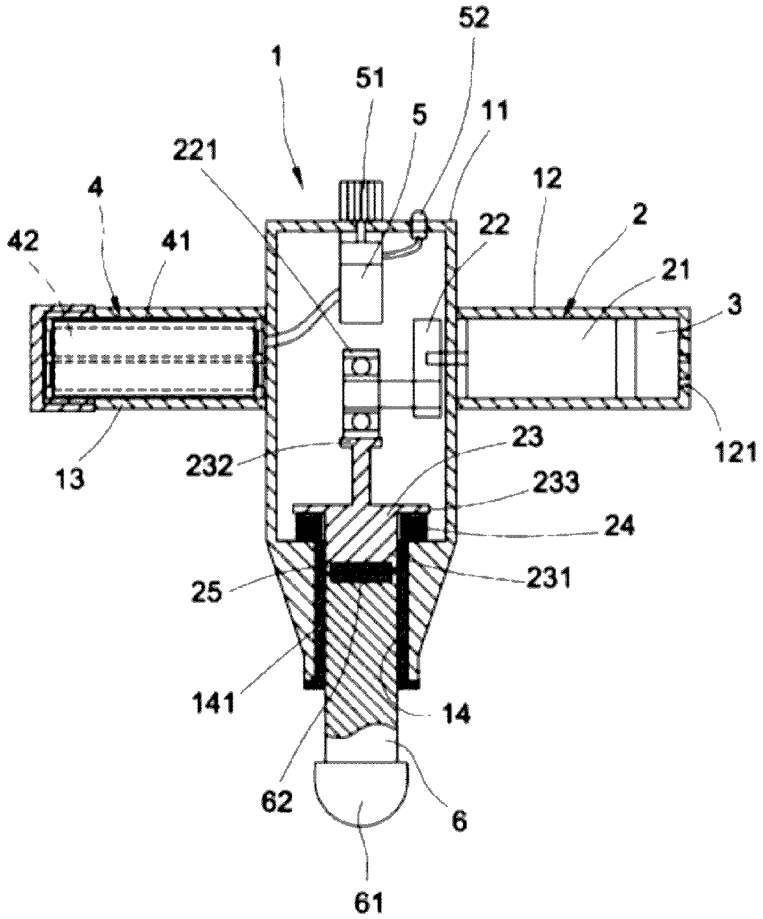


【第一圖】

Petitioner Therabody Ex-1013, 0461



MassagerPriorArt0000



【第一圖】

Petitioner Therabody Ex-1013, 0463

M543692

(19)中華民國智慧財產局

(12)新型說明書公告本 **(11)證書號數：TW M543692 U**

(45)公告日： 中華民國 106 (2017) 年 06 月 21 日

(21)申請案號：106203443 (22)申請日： 中華民國 106 (2017) 年 03 月 10 日

(51)Int. Cl.： *A61H23/02 (2006.01)*

(71)申請人：王桂圓(中華民國) (TW)

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(74)代理人：陳吉隆

申請專利範圍項數：9 項 圖式數：3 共 15 頁

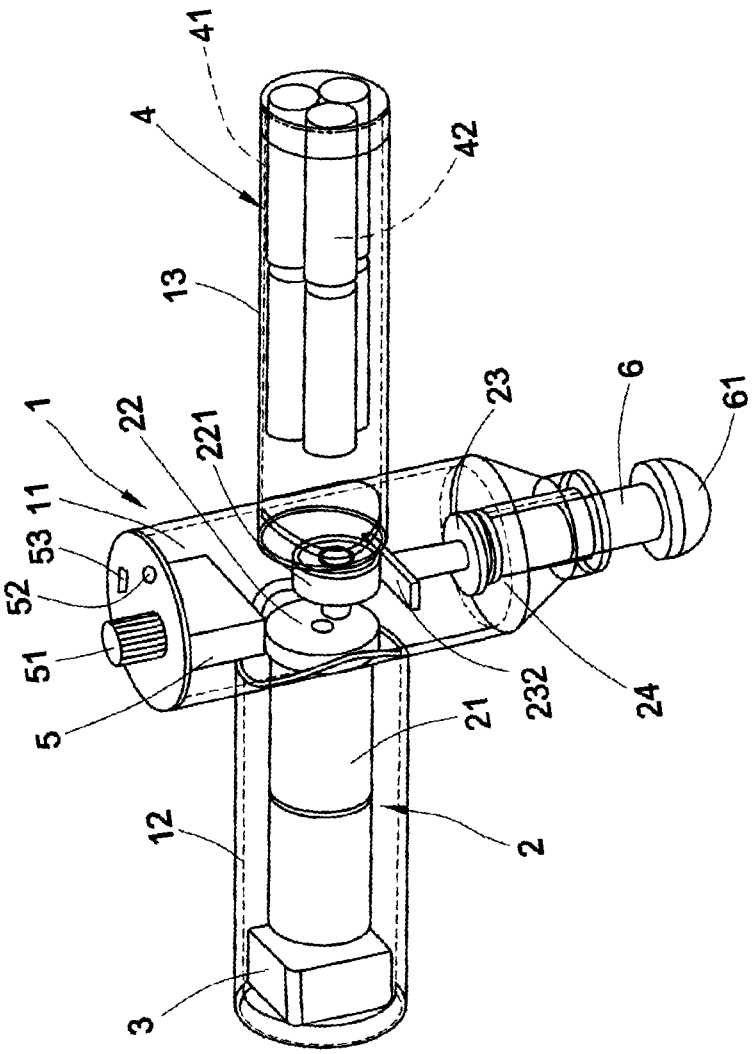
(54)名稱

便攜式運動按摩器之結構

(57)摘要

本創作係有關一種便攜式運動按摩器之結構，其包括一本體、動力單元、散熱元件及電力單元，其中該本體包括一縱向主體及一組位於縱向主體兩側之握持部，動力單元係設於其中一握持部，電力單元則設於另一握持部內，前述動力單元包括馬達、偏心輪、驅動輪及升降桿，偏心輪設於馬達轉軸上，驅動輪則樞設於偏心輪之偏心位置上，升降桿係設於縱向主體下端中軸孔處，升降桿下端周緣環緣部與縱向主體中軸孔周緣平面間設有彈簧，使升降桿之頂部保持與該驅動輪接觸，於縱向主體中軸孔下段，可穿組具各種不同形狀及按摩功效按摩頭之按摩元件，並於升降桿底部及按摩元件之頂部，均設有相對應之磁吸元件，使按摩元件可達快速拆組更換，於馬達外端設有散熱之風扇，前述電力單元可拆出更換，亦可由縱向本體頂部所設充電插孔進行充電，進而於外出攜帶方便，且可隨時充電或更換電池，且不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性。

指定代表圖：



【第一圖】

符號簡單說明：

(1)・・・本體

(11)・・・縱向主體

(12)(13)・・・握持部

(2)・・・動力單元

(21)・・・馬達

(22)・・・偏心輪

(221)・・・驅動輪

(23)・・・升降桿

(232)・・・頂端

(24)・・・彈簧

(3)・・・散熱元件

(4)・・・電力單元

(41)・・・電池匣

(42)・・・電池

(5)・・・控制開關器

(51)・・・調整鈕

(52)・・・指示燈

(53)・・・充電插孔

(6)・・・按摩元件

(61)・・・按摩頭

M543663 專利案號：106203443

公告本

申請日：106/03/10

IPC分類：A61H 23/02 (2006.01)

【新型摘要】

【中文新型名稱】　便攜式運動按摩器之結構

【中文】

本創作係有關一種便攜式運動按摩器之結構，其包括一本體、動力單元、散熱元件及電力單元，其中該本體包括一縱向主體及一組位於縱向主體兩側之握持部，動力單元係設於其中一握持部，電力單元則設於另一握持部內，前述動力單元包括馬達、偏心輪、驅動輪及升降桿，偏心輪設於馬達轉軸上，驅動輪則樞設於偏心輪之偏心位置上，升降桿係設於縱向主體下端中軸孔處，升降桿下端周緣環緣部與縱向主體中軸孔周緣平面間設有彈簧，使升降桿之頂部保持與該驅動輪接觸，於縱向主體中軸孔下段，可穿組具各種不同形狀及按摩功效按摩頭之按摩元件，並於升降桿底部及按摩元件之頂部，均設有相對應之磁吸元件，使按摩元件可達快速拆組更換，於馬達外端設有散熱之風扇，前述電力單元可拆出更換，亦可由縱向本體頂部所設充電插孔進行充電，進而於外出攜帶方便，且可隨時充電或更換電池，且不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性。

【指定代表圖】　第一圖

【代表圖之符號簡單說明】

（１）本體

（１１）縱向主體

（１２）（１３）握持部

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（２）動力單元

（２１）馬達

（２２）偏心輪

（２２１）驅動輪

（２３）升降桿

（２３２）頂端

（２４）彈簧

（３）散熱元件

（４）電力單元

（４１）電池匣

（４２）電池

（５）控制開關器

（５１）調整鈕

（５２）指示燈

（５３）充電插孔

（６）按摩元件

（６１）按摩頭

Petitioner Therabody Ex-1013, 0467

【新型說明書】

【中文新型名稱】　便攜式運動按摩器之結構

【技術領域】

【0001】本創作係有關一種便攜式運動按摩器之結構，其包括一本體、動力單元、散熱元件及電力單元，尤指一種於馬達外端設有風扇，以將馬達工作時所產生之熱源由該握持部端部孔槽排出，以降低馬達溫度，維持馬達省電及正常工作效率，並延長馬達之壽命，並藉可拆出更換之電池，及可由縱向本體頂部所設充電插孔，以充電器或USB連接線進行充電，進而具有於外出攜帶方便及可隨時更換電池或充電之功效，並藉所設電力單元供電，不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性之按摩器設計。

【先前技術】

【0002】按，一般之手持按摩器，其大都連接有供電之電線，因此，於外出使用時需在具有供電插座之地方才可使用，並無法隨時隨地需要按摩時使用，特別是運動選手於訓練或比賽時，因肌肉痠痛疲勞需要藉由按摩時，則因現場並無供電之插座，而無法適時對選手進行按摩，進而影響選手之比賽成績，且習知手持按摩器使用時需插電，而造成使用時的不便，且習知手持按摩器，其馬達係被密封的包覆於內，因此於使用時馬達所產生之高溫均留滯於內無法散出，進而使馬達運轉效率降低、耗電量升高，馬達壽命因此減短，且間接影響其他構件，而易產生故障。

Petitioner Therabody Ex-1013, 0468

【新型內容】

【0003】＜所欲解決之技術問題＞

本創作人有鑑於上述習知手持按摩器之實用困難及有待改善之缺失，盼能提供一突破性之設計，以增進實用效果，乃潛心研思、設計組製，綜集其多年從事相關產品設計產銷之專業技術知識與實務經驗及研思設計所得之成果，終研究出本創作一種便攜式運動按摩器之結構，以提供使用者。

【0004】＜解決問題之技術手段＞

本創作係有關一種便攜式運動按摩器之結構，其包括一本體、動力單元、散熱元件及電力單元，其中該本體包括一縱向主體及一組位於縱向主體兩側之握持部，動力單元係設於其中一握持部，電力單元則設於另一握持部內，前述動力單元包括馬達、偏心輪、驅動輪及升降桿，偏心輪設於馬達轉軸上，驅動輪則樞設於偏心輪之偏心位置上，升降桿係設於縱向主體下端中軸孔處，該升降桿下端係穿組於縱向主體下端之中軸孔內，升降桿下端周緣形成有一環緣部，並於環緣部與縱向主體中軸孔周緣平面間設有彈簧，使升降桿之頂部保持與該驅動輪接觸，於縱向主體中軸孔下段，可穿組具各種不同形狀及按摩功效按摩頭之按摩元件，並於升降桿底部及按摩元件之頂部，均設有相對應之磁吸元件，使按摩元件可達快速拆組更換，於縱向本體中軸孔內壁，套設有耐磨、使滑動順暢及減少摩擦材料製成之管套，該管套可以鐵氟龍材料或陶瓷材料製成，於馬達外端設有風扇，以將馬達工作時所產生之熱源由該握持部端部孔槽排出，以降低馬達溫度，維持馬達省電及正常工作效率，並延長馬達之壽命，前述電力單元係爲一內部具複數電池之電池匣，其可拆出更換，亦可由縱向本體頂部所設充電插孔，以充電器或USB連接線進行充電，進而具有於外出攜帶

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方便，且可隨時更換電池或充電之功效，並藉所設電力單元供電，不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性。

【0005】此外，於縱向本體頂部設有一控制開關器及指示燈，可由控制開關器之調整鈕控制馬達之轉動，或開啓、關閉電源，亦可由指示燈顯示電源之狀態。

【0006】＜對照先前技術之功效＞

本創作之主要目的係藉所設電力單元供電，不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性。

【0007】本創作之次一目的主要係藉於馬達外端設有風扇，以將馬達工作時所產生之熱源由該握持部端部孔槽排出，以降低馬達溫度，維持馬達省電及正常工作效率，並延長馬達之壽命。

【0008】本創作之再一目的在藉於升降桿底部及按摩元件之頂部，均設有相對應之磁吸元件，使按摩元件可達快速拆組更換。

【0009】爲使　貴審查委員能更了解本創作之結構特徵及其功效，茲配合圖式並詳細說明於後。

【圖式簡單說明】

【0010】

第一圖係本創作試舉其中一較佳實施例之透視立體圖。

第二圖係本創作之透視局部立體分解圖。

第三圖係本創作之組合剖示圖。

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【實施方式】

【0011】請參閱第一圖第二圖及第三圖所示，本創作係有關一種便攜式運動按摩器之結構，其包括一本體（１）、動力單元（２）、散熱元件（３）及電力單元（４），其中該本體（１）包括一縱向主體（１１）及一組位於縱向主體（１１）兩側之握持部（１２）（１３），動力單元（２）係設於其中一握持部（１２）內，電力單元（４）則設於另一握持部（１３）內，前述動力單元（２）包括馬達（２１）、偏心輪（２２）、驅動輪（２２１）及升降桿（２３），偏心輪（２２）設於馬達（２１）轉軸上，驅動輪（２２１）則樞設於偏心輪（２２）之偏心位置上，升降桿（２３）係設於縱向主體（１１）下端中軸孔（１４）處，該升降桿（２３）下端（２３１）係穿組於縱向主體（１１）之中軸孔（１４）內，升降桿（２３）下端周緣形成有一環緣部（２３３），並於環緣部（２３３）與縱向主體（１１）中軸孔（１４）周緣平面間設有彈簧（２４），藉彈簧（２４）恢復力使升降桿（２３）之頂端（２３２）保持與該驅動輪（２２１）接觸，於縱向主體（１１）中軸孔（１４）下段，可穿組具各種不同形狀及按摩功效按摩頭（６１）之按摩元件（６），並於升降桿（２３）底部及按摩元件（６）之頂部，均設有相對應可相互吸合之磁吸元件（２５）（６２），使按摩元件（６）可達快速拆組更換，於縱向本體（１１）中軸孔（１４）內壁，套設有耐磨、使滑動順暢及減少摩擦材料製成之管套（１４１），該管套（１４１）可以鐵氟龍材料或陶瓷材料製成，於馬達（２１）外端設有散熱元件（３），散熱元件（３）可以是風扇，以將馬達（２１）工作時所產生之熱源由該握持部（１２）端部孔槽（１２１）排出，以降低馬達（２１）溫度，維持馬達（２１）省電及正常工作效率，並延長馬

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達（２１）之壽命，前述電力單元（４）係爲一內部具至少一個電池（４２）之電池匣（４１），其可拆出更換，亦可由縱向本體（１１）頂部所設充電插孔（５３），以充電器（７）或USB連接線（７１）進行充電，進而具有於外出攜帶方便，且可隨時更換電池或充電之功效，並藉所設電力單元（４）供電，不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性。

【0012】此外，於縱向本體（１１）頂部設有一控制開關器（５）及指示燈（５２），可由控制開關器（５）之調整鈕（５１）控制馬達（２１）之轉速，或開啓、關閉電源，亦可由指示燈（５２）顯示電源開啓、關閉及電力單元（４）電量之狀態。

【0013】其中該動力單元（２）可直接由設於馬達（２１）之偏心輪（２２）上設一偏心桿驅動升降桿（２３）上、下運動。

【0014】綜上所述，本創作具有於外出攜帶方便，且可隨時更換電池或充電之功效，並藉所設電力單元供電，不需插電使用，而於使用時沒有電源線牽絆，提升了使用之便利性，爲一甚具新穎性、進步性及可供產業上應用之創作，實已符合新型專利之給與要件，爰依法提出專利申請，尙祈　貴審查委員能詳予審查，並早日賜准本案專利，實爲德便。

【0015】唯以上所述者，僅爲本創作所舉之其中較佳實施例，當不能以之限定本創作之範圍，舉凡依本創作申請專利範圍所作之均等變化與修飾，皆應仍屬本創作專利涵蓋之範圍內。

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【符號說明】

【0016】

（１）本體

（１１）縱向主體

（１２）（１３）握持部

（１２１）孔槽

（１４）中軸孔

（１４１）管套

（２）動力單元

（２１）馬達

（２２）偏心輪

（２２１）驅動輪

（２３）升降桿

（２３１）下端

（２３２）頂端

（２３３）環緣部

（２４）彈簧

（２５）（６２）磁吸元件

（３）散熱元件

（４）電力單元

（４１）電池匣

（４２）電池

（５）控制開關器

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（５１）調整鈕

（５２）指示燈

（５３）充電插孔

（６）按摩元件

（６１）按摩頭

（７）充電器

（７１）USB連接線

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【新型申請專利範圍】

【第1項】 一種便攜式運動按摩器之結構，其包括一本體、動力單元、散熱元件及電力單元，其主要特徵爲：

其中該本體包括一縱向主體及一組位於縱向主體兩側之握持部，動力單元係設於其中一握持部內，電力單元則設於另一握持部內，前述動力單元包括馬達、偏心輪、驅動輪及升降桿，偏心輪設於馬達轉軸上，驅動輪則樞設於偏心輪之偏心位置上，升降桿係設於縱向主體下端中軸孔處，該升降桿下端係穿組於縱向主體之中軸孔內，升降桿下端周緣與縱向主體中軸孔周緣平面間設有彈簧，藉彈簧恢復力使升降桿之頂部保持與該驅動輪接觸，於縱向主體中軸孔下段，可穿組具各種不同形狀及按摩功效按摩頭之按摩元件，於縱向本體頂部設有一控制開關器，可由控制開關器之調整鈕控制馬達之轉速及開啓、關閉電源，於馬達外端設有散熱元件，以將馬達工作時所產生之熱源由該握持部端部孔槽排出。

【第2項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中於升降桿下端周緣形成有一環緣部，彈簧則設於環緣部與縱向主體中軸孔周緣平面間。

【第3項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中於升降桿底部及按摩元件之頂部，均設有相對應可相互吸合之磁吸元件，使按摩元件可達快速拆組更換。

【第4項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中於縱向本體中軸孔內壁，套設有耐磨、使滑動順暢及減少摩擦材料製成之管套。

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【第5項】 如申請專利範圍第４項所述便攜式運動按摩器之結構，其中該管套可以鐵氟龍材料或陶瓷材料製成。

【第6項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中散熱元件可以是風扇。

【第7項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中電力單元係爲一內部具至少一個電池之電池匣，其可拆出更換。

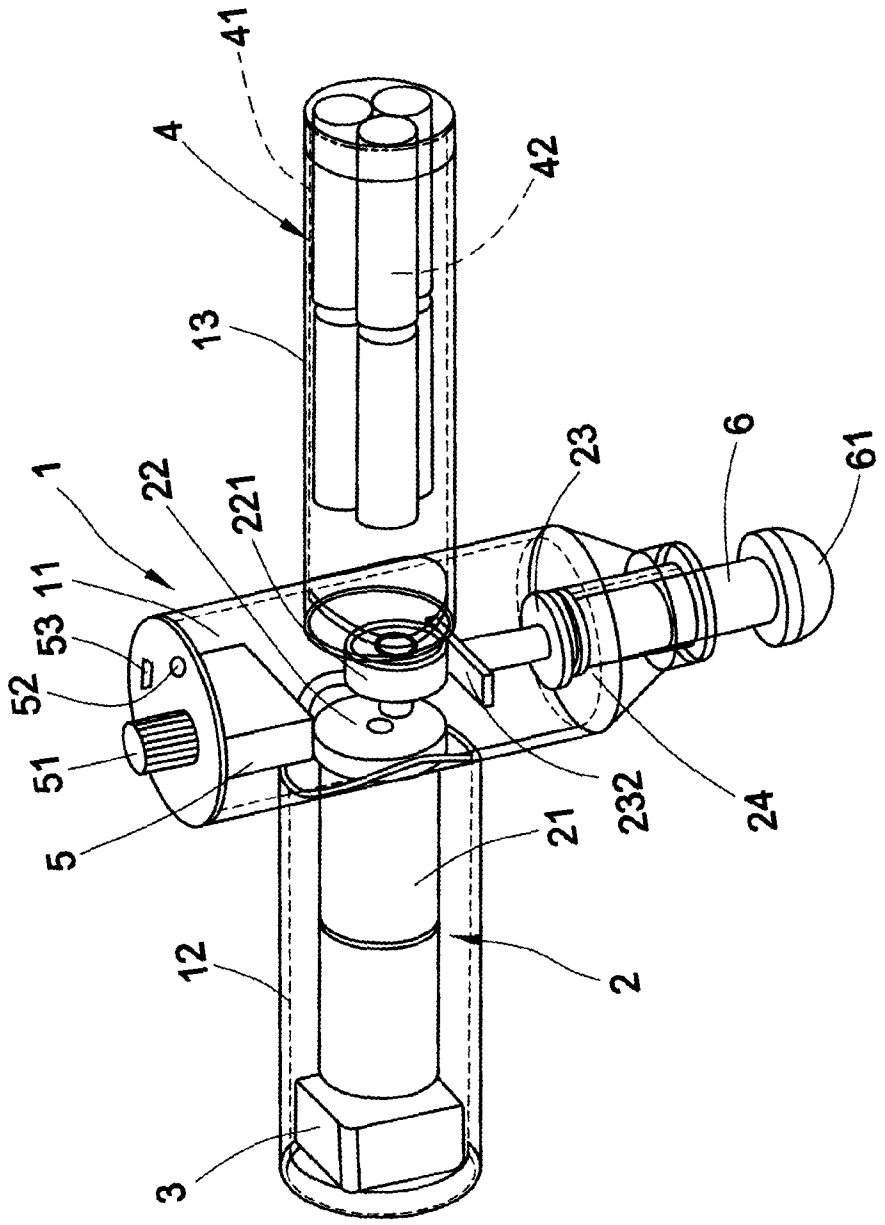
【第8項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中於縱向本體頂部設有充電插孔，可以充電器或USB連接線進行充電。

【第9項】 如申請專利範圍第１項所述便攜式運動按摩器之結構，其中於縱向本體頂部設有指示燈，可由指示燈顯示電源開啓、關閉及電力單元電量之狀態。

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【新型圖式】



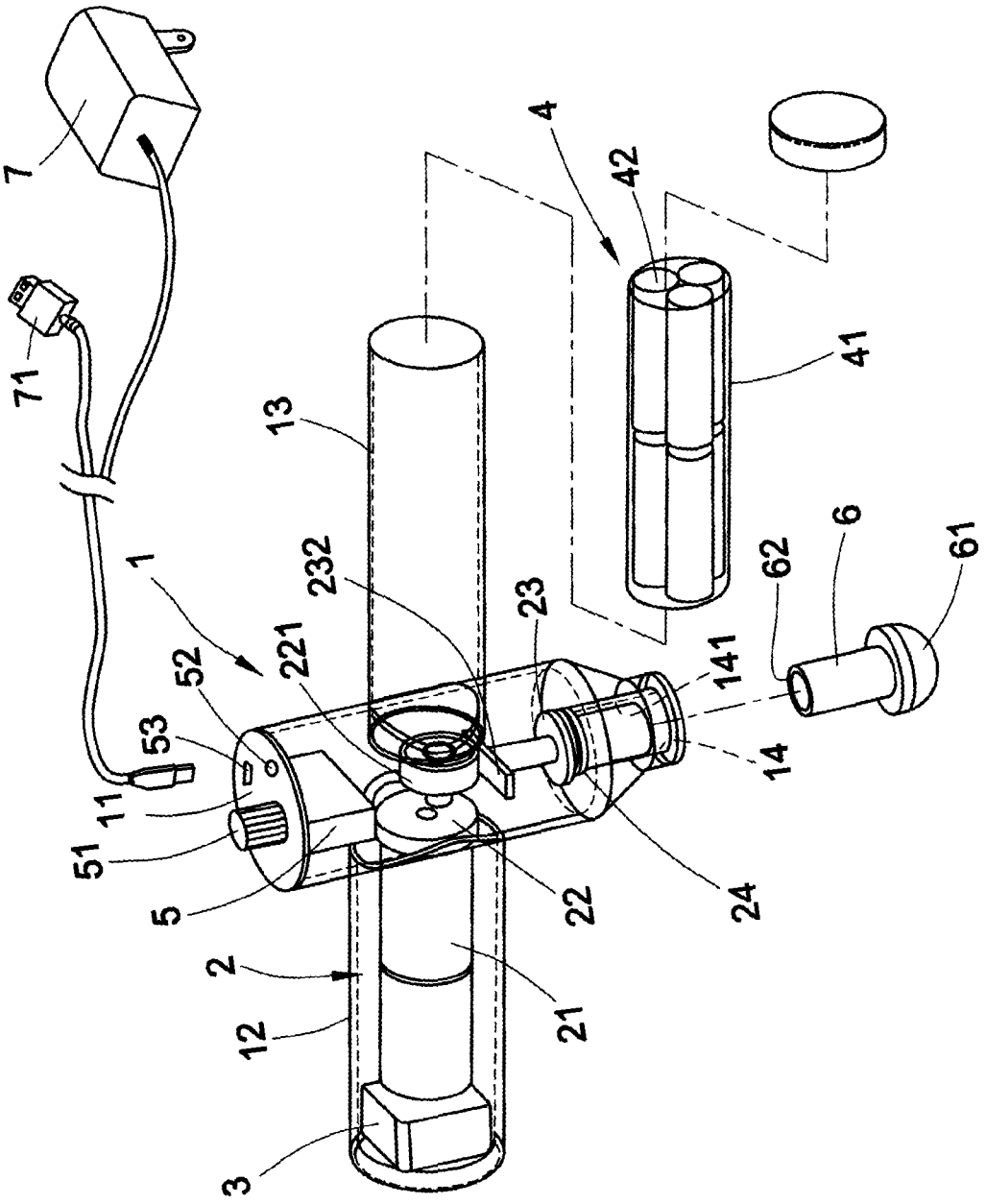
【第一圖】

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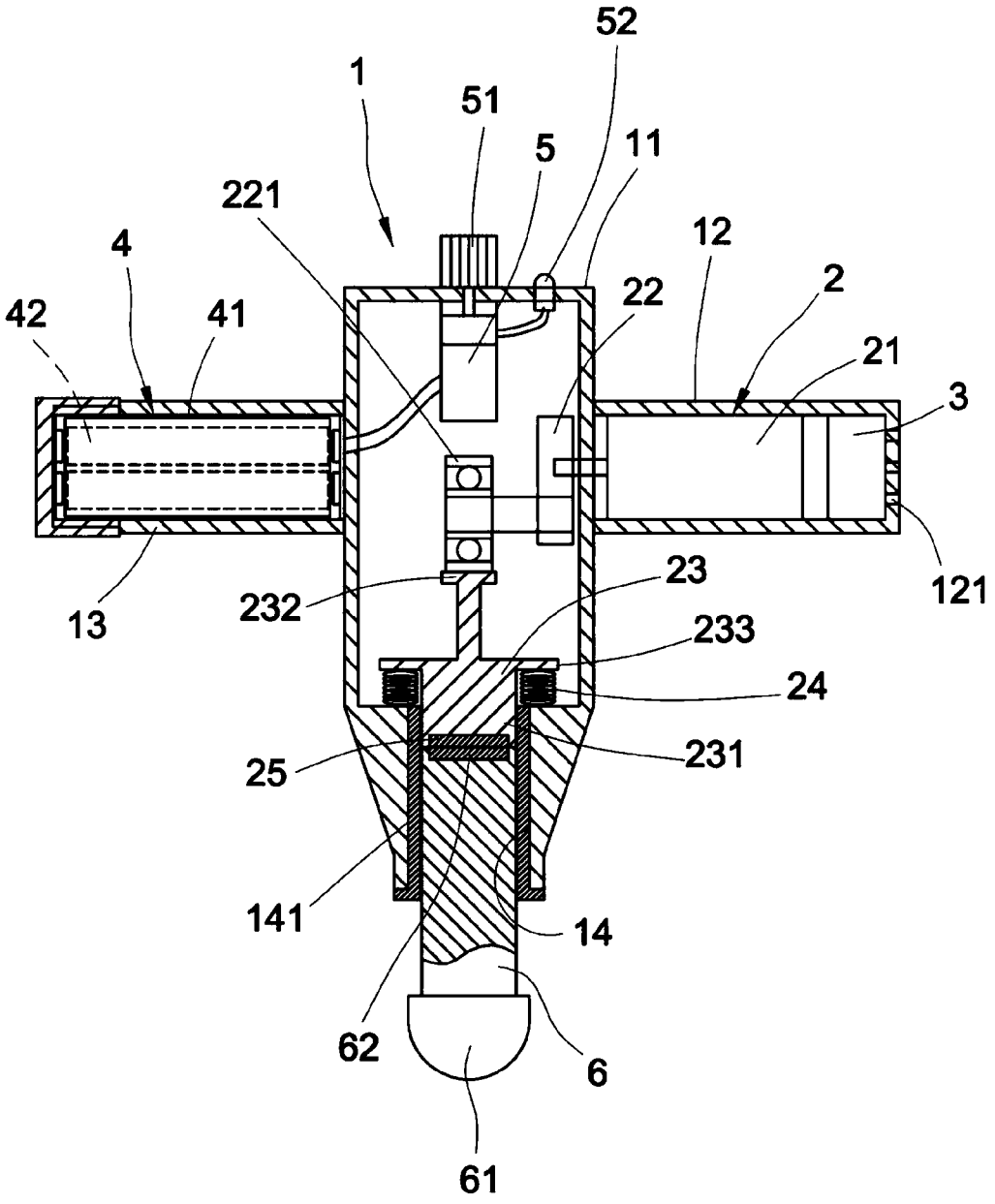
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【第二圖】

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【第三圖】

Petitioner Therabody Ex-1013, 0479

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(54) Title: DISPLAY ASSEMBLIES HAVING INTEGRATED DISPLAY COVERS AND LIGHT PIPES AND HANDHELD POWER TOOLS AND METHODS INCLUDING SAME

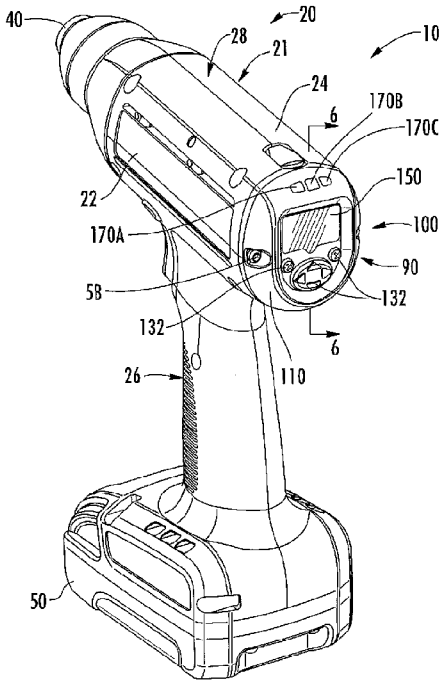


FIG. 1

(57) Abstract: A handheld power tool includes a housing, a display device mounted on the housing, at least one light source mounted in the housing, and an integral, light transmissive lens member. The lens member includes a cover portion covering the display device to protect the display device from the environment, and a light pipe portion positioned and configured to transmit light emitted from the at least one light source to a location on the handheld power tool visible exteriorly of the housing.

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TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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— *of inventorship (Rule 4.17(iv))*

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— *-with international search report (Art. 21(3))*

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DISPLAY ASSEMBLIES HAVING INTEGRATED DISPLAY COVERS AND LIGHT PIPES AND HANDHELD POWER TOOLS AND METHODS INCLUDING SAME

Field of the Invention

[001] The present invention relates to handheld power tools and, more particularly, to handheld power tools having electronic displays and indicator lights.

Background of the Invention

[002] A handheld power tool may include an electronic display device *(e.g.,* a liquid crystal display (LCD) or an organic light emitting diode (OLED) display) and one or more separate indicator lights *(e.g.,* LEDs) to serve as a human-machine interface. LCD and OLED display devices are often manufactured with a plate of glass used as the main structural element holding the LCD/OLED circuitry. The glass can easily break or crack if subjected to mechanical abuse. Therefore, a clear protective lens is often used as a guard for the LCD/OLED display device. This protective lens is often fixed to the tool's housing, usually supported on top of a ledge or lip, so that the protective lens can resist forces applied to the housing. Capture features and/or adhesive are typically used to prevent the protective lens from falling out of the tool.

[003] Many tools that include LCD/OLED display devices also employ LEDs as part of the human-machine interface. To address packaging challenges in confined spaces of the tool, light pipes are often used to transmit light from LEDs mounted on a circuit board located inside the tool housing. This can be a cost-effective solution for delivering control signal lighting to a human-machine interface, as the LEDs do not require individual mechanical mounting and electrical connections.

Summary of the Invention

[004] According to embodiments of the present invention, a handheld power tool includes a housing, a display device mounted on the housing, at least one light source mounted in the housing, and an integral, light transmissive lens member. The lens member includes a cover portion covering the display device to protect the display device from the environment, and a light pipe portion positioned and configured to transmit light emitted

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from the at least one light source to a location on the handheld power tool visible exteriorly of the housing.

[005] According to some embodiments, the lens member is a monolithic member.

[006] According to some embodiments, the lens member includes a lens mounting feature to mechanically couple the lens member to the housing. In some embodiments, the housing includes a housing mounting feature that interlocks with the lens mounting feature to mechanically couple the lens member in the housing.

[007] In some embodiments, the at least one light source includes a light emitting diode (LED).

[008] The display device may include at least one of an organic light emitting diode (OLED) display and a liquid crystal display (LCD) having a display screen. The display screen is viewable through the cover portion.

[009] According to some embodiments, the at least one light source includes a plurality of light sources mounted in the housing, and the lens member includes a plurality of light pipe portions each positioned and configured to transmit light emitted from a respective one of the plurality of light sources to a respective one of a plurality of locations on the handheld power tool visible exteriorly of the housing. In some embodiments, the plurality of light pipe portions collectively define a light pipe array having a first width, the cover portion has a second width, the lens member includes a connector portion extending between and connecting the cover portion and the light pipe array, and the connector portion has a third width that is less than each of the first and second widths.

[0010] In some embodiments, the housing defines a display opening having a housing beveled edge portion, and the cover portion has a lens beveled edge portion complementary to and seated against the housing beveled edge portion.

[0011] According to embodiments of the present invention, an integral, light transmissive lens member is provided for use in a handheld power tool. The integral lens member includes a cover portion and a light pipe portion. The cover portion is configured to cover a display device of the handheld power tool to protect the display device from the environment. The light pipe portion is configured to transmit light emitted from a light source of the handheld power tool to a location on the handheld power tool visible exteriorly of the handheld power tool.

[0012] In some embodiments, the lens member is a monolithic member, and includes: a lens mounting feature to mechanically couple the lens member to a housing of the handheld power tool; and a plurality of light pipe portions each configured to transmit light from a

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respective one of a plurality of light sources of the handheld power tool to a respective one of a plurality of locations on the handheld power tool visible exteriorly of the handheld power tool.

[0013] According to some embodiments, the lens member is provided in combination with a display device and a light source, wherein: the cover portion covers the display device to protect the display device from the environment; and the light pipe portion is positioned adjacent the light source to transmit light emitted from the light source.

[0014] According to the embodiments of the present invention, a method for forming a handheld power tool includes: providing a housing; mounting a display device on the housing; mounting at least one light source in the housing; and mounting an integral lens member including a cover portion and a light pipe portion on the housing. The lens member is mounted on the housing such that: the cover portion covers the display device to protect the display device from the environment; and the light pipe portion is positioned to transmit light emitted from the at least one light source to a location on the handheld power tool visible exteriorly of the housing.

[0015] The method may include unitarily molding the lens member. In some embodiments, the method includes unitarily injection molding the lens member.

[0016] According to some embodiments, the lens member includes a lens mounting feature, the housing includes a housing mounting feature, and mounting the integral lens member on the housing includes interlocking the housing mounting feature with the lens mounting feature to mechanically couple the lens member in the housing.

[0017] According to some embodiments, the at least one light source includes a light emitting diode (LED), and the display device includes at least one of an organic light emitting diode (OLED) display and a liquid crystal display (LCD) having a display screen. The display screen is viewable through the cover portion.

[0018] In some embodiments, the lens member includes a plurality of light pipe portions, and mounting the integral lens member on the housing includes positioning each of the plurality of light pipe portions to transmit light emitted from a respective one of the plurality of light sources to a respective one of a plurality of locations on the handheld power tool visible exteriorly of the housing. According to some embodiments, the plurality of light pipe portions collectively define a light pipe array having a first width, the cover portion has a second width, the lens member includes a connector portion extending between and connecting the cover portion and the light pipe array, and the connector portion has a third width that is less than each of the first and second widths.

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[0019] In some embodiments, the housing defines a display opening having a housing beveled edge portion, the cover portion has a lens beveled edge portion complementary to the housing beveled edge portion, and mounting the integral lens member on the housing includes seating the lens beveled edge portion against the housing beveled edge portion.

[0020] The foregoing and other objects and aspects of the present invention are explained in detail in the specification set forth below.

[0021] It is noted that aspects of the invention described with respect to one embodiment, may be incorporated in a different embodiment although not specifically described relative thereto. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination. Applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to be able to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner. These and other objects and/or aspects of the present invention are explained in detail in the specification set forth below.

Brief Description of the Drawings

[0022] **Figure 1** is a perspective view of a handheld power tool according to embodiments of the present invention from a rear side of the handheld power tool.

[0023] **Figure 2** is an exploded, perspective view of the handheld power tool of **Figure 1** from the rear side of the handheld power tool.

[0024] **Figure 3** is an exploded, front perspective view of a display module according to embodiments of the present invention forming a part of the handheld power tool of **Figure 1**.

[0025] **Figure 4** is an exploded, rear perspective view of the display module of **Figure 3**.

[0026] **Figure 5** is a front perspective view of the display module of **Figure 3** with a display housing of the display module removed for the purpose of explanation.

[0027] **Figure 6** is a cross-sectional view of the display module of **Figure 3** taken along the line **6-6** of **Figure 1**.

[0028] **Figure 7** is an enlarged view of the detail **A** of **Figure 6**.

[0029] **Figure 8** is a front perspective view of an integral lens member according to embodiments of the present invention forming a part of the display module of **Figure 3**.

[0030] **Figure 9** is a rear perspective view of the integral lens member of **Figure 8**.

[0031] **Figure 10** is a rear plan view of the integral lens member of **Figure 8**.

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[0032] **Figure 11** is a cross-sectional view of the integral lens member of **Figure 8** taken along the line **11-11** of **Figure 10.**

Detailed Description of the Embodiments of the Invention

[0033] The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which illustrative embodiments of the invention are shown. In the drawings, the relative sizes of regions or features may be exaggerated for clarity. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

[0034] It will be understood that when an element is referred to as being "coupled" or "connected" to another element, it can be directly coupled or connected to the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly coupled" or "directly connected" to another element, there are no intervening elements present, Like numbers refer to like elements throughout. As used herein the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0035] In addition, spatially relative terms, such as "under", "below", "lower", "over", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "under" or "beneath" other elements or features would then be oriented "over" the other elements or features. Thus, the exemplary term "under" can encompass both an orientation of over and under. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0036] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or

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addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0037] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and this specification and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0038] The term "cordless" power tool refers to power tools that do not require plug-in, hard wired electrical connections to an external power source to operate. Rather, the cordless power tools have electric motors that are powered by on-board batteries, such as rechargeable batteries. A range of batteries may fit a range of cordless tools. Different cordless power tools may have a variety of electrical current demand profiles that operate more efficiently with batteries providing a suitable range of voltages and current capacities. The different cordless *(e.g.,* battery powered) power tools can include, for example, drills, screwdrivers, ratchets, nutrunners, impacts and the like.

[0039] Embodiments of the invention may be particularly suitable for precision power tool that can be used for applications where more exact control of the applied output is desired.

[0040] "Light pipe" refers to a transparent or translucent material that transmits light from one end to another.

[0041] As used herein, "monolithic" means an object that is a single, unitary piece formed or composed of a material without joints or seams.

[0042] With reference to **Figures 1-11,** a handheld power tool **10** according to embodiments of the present invention is shown therein. The power tool **10** may be any suitable type of handheld power tool and, according to some embodiments, is an electrically powered handheld power tool. According to some embodiments, the power tool **10** is a battery powered cordless power tool.

[0043] Turning to the power tool **10** in more detail and with reference to **Figures 1** and **2,** the power tool **10** includes a protective housing assembly **20,** a drive motor assembly **30,** a tool output shaft or drive head **40,** a battery pack **50,** a control system **60,** and a display assembly or module **100.** The display module **100** includes a human-machine interface (HMI) **90.** The display module **100** further includes an integral, light transmissive lens member **150** according to embodiments of the present invention.

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[0044] The housing assembly **20** includes a housing **21** having an upper or main body portion **28** and a pistol grip or handle **26** depending therefrom. The housing **21** can be formed by a left shell member **22** and a right shell member **24,** which define an enclosed cavity **29 (Figure 2)** therebetween. The housing assembly **20** further includes a rear cover or protective display housing **110,** which also forms a part of the display module **100,** as discussed hereinbelow.

[0045] The drive motor assembly **30** and the battery pack **50** are contained in or attached to the housing **21.** The battery pack **50** may be releasably mounted on the lower end of the handle **26.** The construction and operation of drive motor assemblies and battery packs in handheld power tools are well known to those of skill in the art and will not be discussed in detail herein. The drive motor assembly **30** may include an electric motor arranged and configured (directly or via a gearcase, linkage or gear assembly) to selectively drive *(e.g.,* rotate) the drive head **40** using power supplied from the battery pack **50.**

[0046] The control system **60** may be in whole or in part contained in and/or attached to the housing **21.** Control systems for handheld power tools are well known to those of skill in the art and therefore will not be described herein in detail. The exemplary control system **60** as illustrated includes a display printed circuit board (PCB) assembly **70 (Figure 3),** a power PCB (not shown), a control PCB **64 (Figure 2),** and a trigger switch **66** including a trigger member **68.** The control system **60** may be configured to enable an operator to activate and deactivate the drive motor assembly **30** to drive the drive head **40.** The control system **60** may also receive input from the operator and output information to the operator via the HMI **90.**

[0047] With reference to **Figures 3** and **4,** the display module **100** includes the display housing **110,** the display PCB assembly **70,** a keypad/subframe member **120,** and the integral lens member **150.** The components **110, 70, 120, 150** may be coupled to one another by fasteners **5A** to form a unitary module **100.** The module **100** may in turn be secured to the housing **21** with fastener holes **23** by fasteners **5B (Figure 2).**

[0048] The display housing **110** includes a body **112** defining an interior cavity **113 (Figure 4),** a display opening **114,** fastener holes **112A,** threaded bosses **112B (Figure 4),** indicator light openings **116A, 116B, 116C,** and button holes **118A, 118B.** A beveled outwardly facing edge portion **114A** circumscribes the display opening **114.** A cutout or side oriented slot **114B** is defined in the lower periphery of the display opening **114.** An upper portion **112C** of the display housing **110** in the region of the indicator light openings **116A-C** may be rounded as shown. A locator feature or rib **115 (Figure 4)** extends rearwardly from

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the body **112** into the cavity **113.** Integral securing or latch features **119 (Figure 7)** are located inside the body **112** adjacent respective ones of the indicator light openings **116A-C.**

[0049] With reference to **Figure 4,** the display PCB assembly **70** includes a printed circuit board (PCB) **71.** The PCB **71** includes a rigid or semi-rigid circuit board substrate **72** having a suitable electrical circuit **74** thereon. Fastener holes **72A,** fastener cutouts or slots **72B,** and alignment holes **72C** are defined in the substrate **72.** An electrical connector **76A (Figure 3)** is mounted on the front of the PCB **71.** Flex circuits attached to suitable manufacturing structures may optionally be used (not shown).

[0050] A plurality of keypad switches **78 (Figure 3)** are mounted on the PCB **71.** The keypad switches **78** may be, for example, snap dome switches. The keypad switches **78** may be operatively connected to the circuit **74.**

[0051] With reference to **Figure 3,** light sources **80A, 80B** and **80C** are mounted on the PCB **71** adjacent the upper end thereof and a light source **80D** is mounted on the mid¬section of the PCB **71.** According to some embodiments, the light sources **80A-D** are light emitting diodes (LEDs). In some embodiments, two or more of the light sources **80A-D** emit different colors of light from one another. The light sources **80A-D** may be operably connected to the circuit **74.**

[0052] The display PCB assembly **100** further includes an electronic display device **82.** The display device **82** can include a ribbon cable **82B** terminated by a connector **82A,** and a display screen **83 (Figure 3),** The display screen **83** has a display zone or area **83A** where indicia **84** can be dynamically displayed. According to some embodiments, the display area **83A** is at least ten times as great as the light emission area of each of the light sources **80A-D.** The display device **82** may be any electronic display device of any suitable type and construction. According to some embodiments, the display device **82** is a liquid crystal display (LCD). According to some embodiments, the display device **82** is an organic light emitting diode (OLED). According to some embodiments, the display device **82** includes a substantially rigid, breakable, light transmissive substrate *(e.g.,* a glass panel or plate) extending across the display area **83A.**

[0053] With reference to **Figure 4,** the keypad/subframe member **120** is mounted on the circuit board substrate **72** and interposed between the circuit board substrate **72** and the display housing **110.** The keypad/subframe member **120** includes body **122,** a stabilizer feature or tab **122A,** rearwardly extending alignment posts **124,** retention features **126 (Figure 3),** and keypad features or buttons **132 (Figure 3).** A light pipe aperture **128** is defined in the body **122.** The retention features **126** define a slot or seat **126A.**

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[0054] The keypad/subframe member **120** may be monolithic and the portions and features **122, 122A, 124, 126, 128** and **132** may be unitarily molded or otherwise formed such that they form a unitary structure. According to some embodiments, the keypad/subframe member **120** is formed of an elastomeric material such as silicone. Inserts **133 (Figure 4)** may be provided in the buttons **132** to provide the buttons with enhanced rigidity. In other embodiments, the features of the keypad/subframe member **120** may be distributed among two or more discrete members *(e.g.,* a keypad member having the buttons and a subframe member having the retention features).

[0055] With reference to **Figures 8-11,** the integral lens member **150** includes a cover portion **152,** a connector portion **156,** a lower light pipe portion **160,** and a plurality of upper light pipe portions **170A, 170B, 170C.** The light pipe portions **170A-C** collectively form a light pipe array **171.** The sections **152, 156, 160,** and **170A-C** are integral with one another to form a unitary integral lens member **150.** According to some embodiments, the lens member **150** (including the sections **152, 156, 160** and **170A-C)** is monolithic.

[0056] According to some embodiments, the lens member **150** is unitarily formed. According to some embodiments, the lens member **150** is unitarily molded. In some embodiments, the lens member **150** is unitarily injection molded. According to some embodiments, the lens member **150** is unitarily cast.

[0057] The lens member **150** may be formed of any suitable material(s) or compositions(s). According to some embodiments, the entirety of the lens member **150** is formed of the same material or composition. The cover portion **152** and the light pipe portions **160, 170A-C** are formed at least in part by a transparent or translucent material. According to some embodiments, each of the cover portion **152,** the connector portion **156,** the lower light pipe portion **160,** and the upper light pipe portions **170A-C** is transparent or translucent. According to some embodiments, the lens member **150** is formed of a polymeric material. According to some embodiments, the lens member **150** is formed of polycarbonate. The material of the lens member **150** is rigid or semi-rigid at room temperature and, according to some embodiments, has a Young's Modulus of at least about 2.0 GPa and, according to some embodiments, between about 2.0 GPa and 2.8 GPa.

[0058] Still referring to **Figures 8-11,** the cover portion **152** has a front face **154A** and a rear face **154B.** A rearwardly beveled perimeter edge portion **154C** circumscribes the cover portion **152** and is complementary to the beveled edge portion **114A (Figure 3).**

[0059] According to some embodiments, the thickness **D (Figure 11)** of the cover portion **152** is substantially uniform (except in the beveled edge portion **154C).** According to

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some embodiments, the cover portion **152** has a thickness **D** in the range of from about 2 mm to about 4 mm. According to some embodiments, the height **E** and width **F (Figure 10)** of the cover portion **152** are each in the range of from about 10 mm to about 30 mm.

[0060] The lower light pipe portion **160** includes a front section **162** contiguous and coplanar with the cover portion **152.** The front section **162** has a front face **162A** and a lower lip portion **162B.** An elongate extension section **164** extends rearwardly from the front section **162** and terminates at a rear end face **164A.** The lower light pipe portion **160** forms a light pipe or optical conduit extending from the face **164A** to the face **162A.**

[0061] The upper light pipe portions **170A-C** are connected to the cover portion **152** by the connector portion **156,** which extends from a lower end **156A** to an upper end **156B** merged with the cover portion **152** and the light pipe array **171,** respectively. According to some embodiments, at least a midsection **156C** of the connector portion **156** is narrower than both the cover portion **156** and the light pipe array. According to some embodiments and as shown, the connector portion **156** is located rearwardly of the front face **154A** and the beveled edge portion **154C.**

[0062] Each of the upper light pipe portions **170A-C** includes a conduit section **172** terminating in an input face **174** (rearwardly facing) and an opposing output face **176** (forwardly facing). Each of the light pipe portions **170A-C** includes a mounting portion **173** on its front end and a groove **178A** extending from the rear end of the conduit section **172** to the mounting portion **173.** The mounting portion **173** and the groove **178A** define a latch feature **178B** at their interface.

[0063] According to some embodiments, the length **N (Figure 11)** of each light pipe portion **170A-D** is in the range of from about 8 mm to about 12 mm. According to some embodiments, the nominal lateral cross-sectional area (i.e., width **V** x height **U; Figure 10)** of each of the light pipe portions **170A-D** is in the range of from about 10 mm^2 to about 20 mm^2.

[0064] According to some embodiments, the length **P (Figure 11)** of the connector portion **156** is in the range of from about 8 mm to about 12 mm.

[0065] According to some embodiments and with reference to Figure **10,** the width **Q** of the connector portion **156** is less than both the width **R** of the light pipe array **171** and the width **F** of the cover portion **152.** According to some embodiments, the widths **R** and **F** are each at least twice the width **Q.**

[0066] The construction of the display module **100** will be further appreciated from the following description of methods according to embodiments of the invention for

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assembling the display module **100.** It will be understood that various of the steps described herein may be modified and/or executed in a different order.

[0067] Referring to **Figures 3-6,** the keypad/subframe member **120** is mounted on the front side of the circuit board substrate **72** such that the alignment posts **124** seat in the alignment holes **72C.** The display device **82** is mounted in the seat **126A** such that the display device **82** is held in place by the retention features **126.** The display device connector **82A** is engaged with the PCB connector **76** before or after installing the display device **82** in the seat **126A.**

[0068] With reference to **Figure 6,** the integral lens member **150** is mounted in the display housing **110** by inserting the light pipe array **171** and the connector portion **156** through the display opening **114** in a direction **G** from front to rear, directing the light pipe array **171** upwardly (in a direction **H),** and then inserting or pushing the mounting portions **173 (Figure 8)** into respective ones of the indicator light openings **116A-C** (in a direction **I)** until the latch features **119** interlock with the latch features **178B (Figure 7).** The cover portion **152** is seated in the display opening **114** such that the beveled edge portions **114A, 154C** mate and the extension section **164** of the lower light pipe portion **160** extends through the opening **128** in the keypad/subframe member **120.** The connector portion **156** extends behind the display housing **110.** The light pipe portions **170A-C** and **164** are then located adjacent their respective associated light sources **80A-D** while the cover portion **152** covers or overlies the display screen **83.**

[0069] According to some embodiments, the components of the display module **100** are relatively configured such that, when the lens member **150** is fully installed in the display housing **110,** the connector portion **156** is slightly elastically deflected from its released *(i.e.,* unloaded) position and therefore loads the cover portion **152** against the display housing **110** (more particularly, loads the beveled edge portion **154C** against the beveled edge portion **114A).** In this way, the cover portion **152** can be firmly seated.

[0070] According to some embodiments, the lens member **150** is secured to the display housing **110** by the mechanical coupling features **119, 173, 178B** without use of additional supplemental securing devices such as fasteners or adhesive.

[0071] The subassembly of the combined display housing **110** and lens member **150** is placed over the combined display PCB assembly **70** and keypad/subframe member **120** and secured thereto by fasteners **5A** inserted through the holes **72A** and the threaded bosses **112B (Figure 4)** to form the fully assembled display module **100.** The locator rib **115 (Figure 4)**

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may bear against the stabilizer tab **122A (Figure 4)** to limit axial displacement of the keypad/subframe member **120.**

[0072] The display module **100** is in turn secured to the housing **21** by fasteners **5B** inserted through the holes **112A** and openings **23 (Figure 2)** in the shell members **22, 24.**

[0073] In the assembled display module **100,** the input faces **174, 164A (Figure 9)** of the light pipes **170A, 170B, 170C** and **160** are positioned adjacent the light sources **80A, 80B, 80C** and **80D,** respectively. According to some embodiments and as shown in **Figure 7,** the input faces **174** of the upper light pipe portions **170A-C** (light pipe portion **170B** shown) are spaced apart from their associated light sources **80A-C** (light source **80B** shown) a distance **K.** In some embodiments, the distance **K** is at least about 0.5 mm and, according to some embodiments, is in the range of from about 0.5 mm to about 3 mm. According to some embodiments, the input face **164A** of the lower light pipe portion **164** is spaced apart from the light source **80D** a distance **L (Figure 6)** of at least about 0.5 mm and, according to some embodiments, is in the range of from about 0.5 mm to about 5 mm.

[0074] The output faces **176, 162A** may be substantially flush with the outer surface of the display housing **110.** More particularly, the profiles of the output faces **176** may conform to the profile of the rounded corner **112C.**

[0075] The rear face **154B** of the cover portion **152** is spaced apart from the front of the display screen **83** a distance **M (Figure 7).** According to some embodiments, the distance **M** is at least about 0.5 mm and, according to some embodiments, is in the range of from about 0.5 mm to about 5 mm.

[0076] In use, the HMI **90 (Figure 1)** can be used in known or any suitable manner by the operator to input commands to the control system **60** and/or to display data from the control system **60** to the operator. In particular, data can be displayed as indicia **84** on the display screen **83** and viewable by the operator through the cover portion **152,** and the indicator light sources **80A-D** can be activated and deactivated (de-illuminated). The light **86** emitted from the light sources **80A, 80B** and **80C (Figure 5)** is transmitted through the light pipe portions **170A, 170B** and **170C,** respectively, and emitted to the operator through the output faces **176,** *(i.e.,* the light from the light sources **80A-D** is thereby externally visible or visible exteriorly of the housing **21).** For example, the light sources **80A, 80B** and **80C** may be red, yellow, and green LEDs that are selectively illuminated to indicate a status of the tool such as {green LED **80A** = correct torque applied}, {yellow LED **80B** = undertorqued}, {red LED **80C** = overtorqued}, and {blue LED **80D** = tool maintenance required}.

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[0077] The buttons 132 can be manipulated to input commands via the keypad switch assembly 78.

[0078] Integral lens members *(e.g.,* the integral lens member 150), display modules *(e.g.,* the display module 100), and methods according to embodiments of the present invention can provide a number of advantages. By combining the light pipes for the light sources 80A-D with the cover portion 152 for the display screen 83 in a single molded part, assembly of the display module 100 can be greatly simplified while also providing a compact, cost effective HMI 90 in a housing that can withstand mechanical abuse or harsh operating environments.

[0079] The mounting features 119, 173, 178B can provide a convenient and effective mechanism for mechanically coupling the lens member 150 and the display housing 110. A robust coupling can be provided without requiring additional fasteners, adhesive or the like. However, in accordance with some embodiments, fasteners or adhesive may be used in addition to the mechanical coupling features.

[0080] The gap provided between the cover portion 152 and the display screen 83 can prevent the cover portion 152 from striking the display screen 83 when deflected by an impact. The cooperating beveled edge portions 114A, 154C serve to more widely distribute such forces.

[0081] The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited to the specific embodiments disclosed, and that modifications to the disclosed embodiments, as well as other embodiments, are intended to be included within the scope of the invention,

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THAT WHICH IS CLAIMED IS:

1. A handheld power tool comprising:
a housing;
a display device mounted on the housing;
at least one light source mounted in the housing; and
an integral, light transmissive lens member including:
a cover portion covering the display device to protect the display device from the environment; and
a light pipe portion positioned and configured to transmit light emitted from the at least one light source to a location on the handheld power tool visible exteriorly of the housing.

2. The handheld power tool of Claim 1 wherein the lens member is a monolithic member.

3. The handheld power tool of Claim 1 wherein the lens member includes a lens mounting feature to mechanically couple the lens member to the housing.

4. The handheld power tool of Claim 3 wherein the housing includes a housing mounting feature that interlocks with the lens mounting feature to mechanically couple the lens member in the housing.

5. The handheld power tool of Claim 1 wherein the at least one light source includes a light emitting diode (LED).

6. The handheld power tool of Claim 1 wherein the display device includes at least one of an organic light emitting diode (OLED) display and a liquid crystal display (LCD) having a display screen, and the display screen is viewable through the cover portion.

7. The handheld power tool of Claim 1 wherein:
the at least one light source includes a plurality of light sources mounted in the housing; and

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the lens member includes a plurality of light pipe portions each positioned and configured to transmit light emitted from a respective one of the plurality of light sources to a respective one of a plurality of locations on the handheld power tool visible exteriorly of the housing.

8. The handheld power tool of Claim 7 wherein:

the plurality of light pipe portions collectively define a light pipe array having a first width;

the cover portion has a second width;

the lens member includes a connector portion extending between and connecting the cover portion and the light pipe array; and

the connector portion has a third width that is less than each of the first and second widths.

9. The handheld power tool of Claim 1 wherein:

the housing defines a display opening having a housing beveled edge portion; and

the cover portion has a lens beveled edge portion complementary to and seated against the housing beveled edge portion.

10. An integral, light transmissive lens member for use in a handheld power tool, the integral lens member including:

a cover portion configured to cover the display device to protect a display of the handheld power tool device from the environment; and

a light pipe portion configured to transmit light emitted from a light source of the handheld power tool to a location on the handheld power tool visible exteriorly of the handheld power tool.

11. The lens member of Claim 10 wherein the lens member is a monolithic member and includes:

a lens mounting feature to mechanically couple the lens member to a housing of the handheld power tool; and

a plurality of light pipe portions each configured to transmit light from a respective one of a plurality of light sources of the handheld power tool to a

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respective one of a plurality of locations on the handheld power tool visible exteriorly of the handheld power tool.

12. The lens member of Claim 11 in combination with a display device and a light source, wherein:

the cover portion covers the display device to protect the display device from the environment; and

the light pipe portion is positioned adjacent the light source to transmit light emitted from the light source.

13. A method for forming a handheld power tool, the method comprising:

providing a housing;

mounting a display device on the housing;

mounting at least one light source in the housing; and

mounting an integral, light transmissive lens member including a cover portion and a light pipe portion on the housing such that:

the cover portion covers the display device to protect the display device from the environment; and

the light pipe portion is positioned to transmit light emitted from the at least one light source to a location on the handheld power tool visible exteriorly of the housing.

14. The method of Claim 13 including unitarily molding the lens member.

15. The method of Claim 14 including unitarily injection molding the lens member.

16. The method of Claim 13 wherein:

the lens member includes a lens mounting feature;

the housing includes a housing mounting feature; and

mounting the integral lens member on the housing includes interlocking the housing mounting feature with the lens mounting feature to mechanically couple the lens member in the housing.

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17. The method of Claim 13 wherein:

the at least one light source includes a light emitting diode (LED); and

the display device includes at least one of an organic light emitting diode (OLED) display and a liquid crystal display (LCD) having a display screen, and the display screen is viewable through the cover portion.

18. The method of Claim 13 wherein:

the lens member includes a plurality of light pipe portions; and

mounting the integral lens member on the housing includes positioning each of the plurality of light pipe portions to transmit light emitted from a respective one of the plurality of light sources to a respective one of a plurality of locations on the handheld power tool visible exteriorly of the housing.

19. The method of Claim 18 wherein:

the plurality of light pipe portions collectively define a light pipe array having a first width;

the cover portion has a second width;

the lens member includes a connector portion extending between and connecting the cover portion and the light pipe array; and

the connector portion has a third width that is less than each of the first and second widths.

20. The method of Claim 13 wherein:

the housing defines a display opening having a housing beveled edge portion;

the cover portion has a lens beveled edge portion complementary to the housing beveled edge portion; and

mounting the integral lens member on the housing includes seating the lens beveled edge portion against the housing beveled edge portion.

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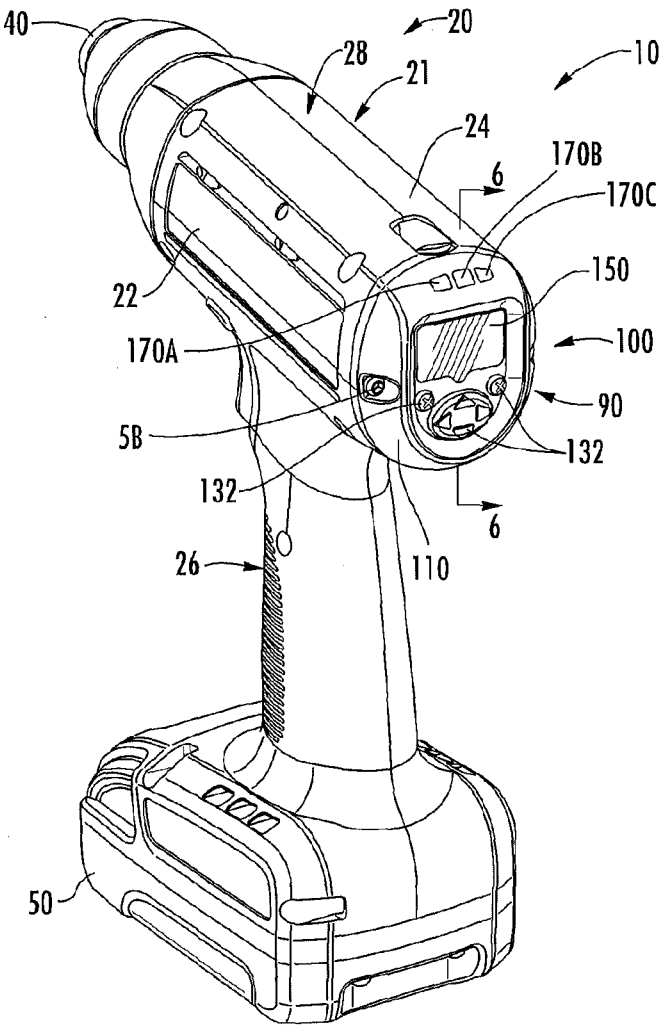


FIG. 1

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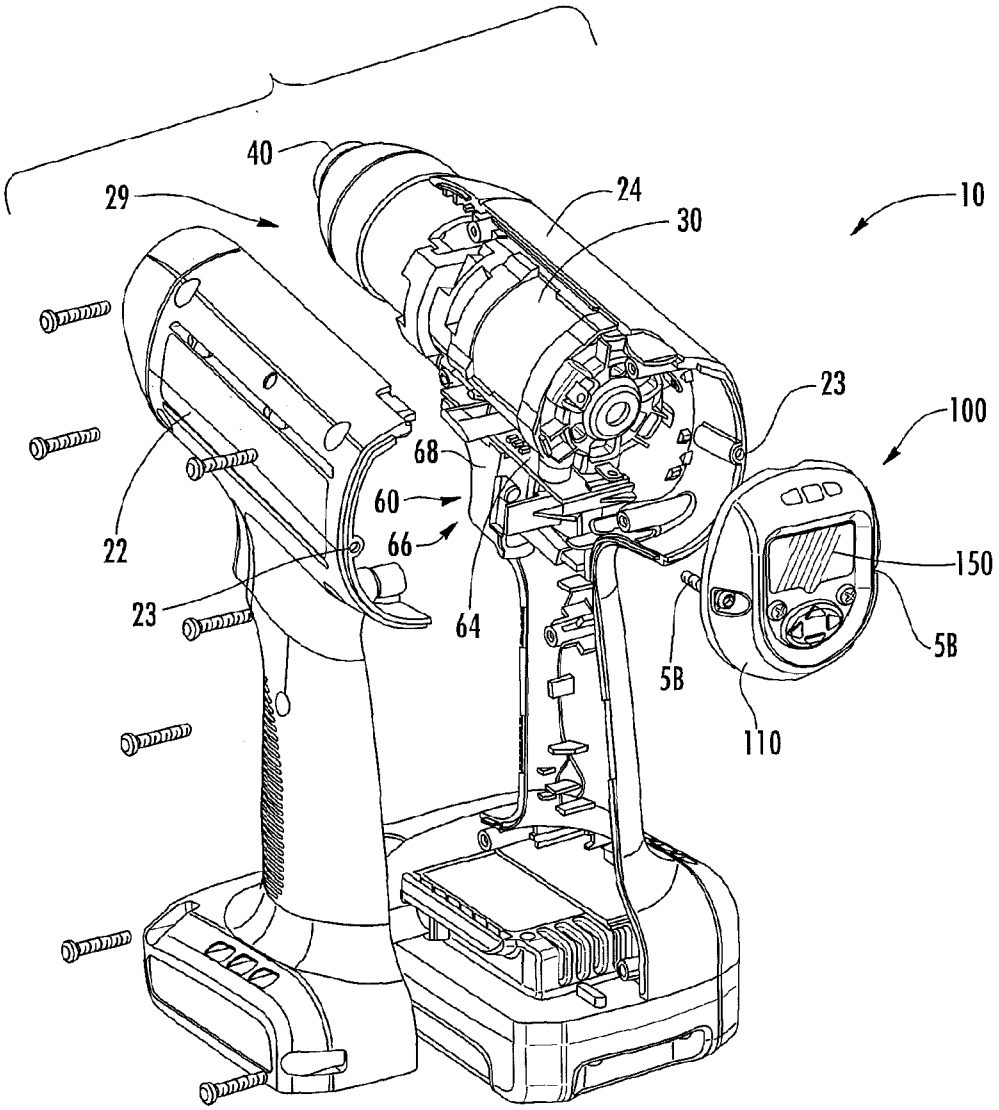


FIG. 2

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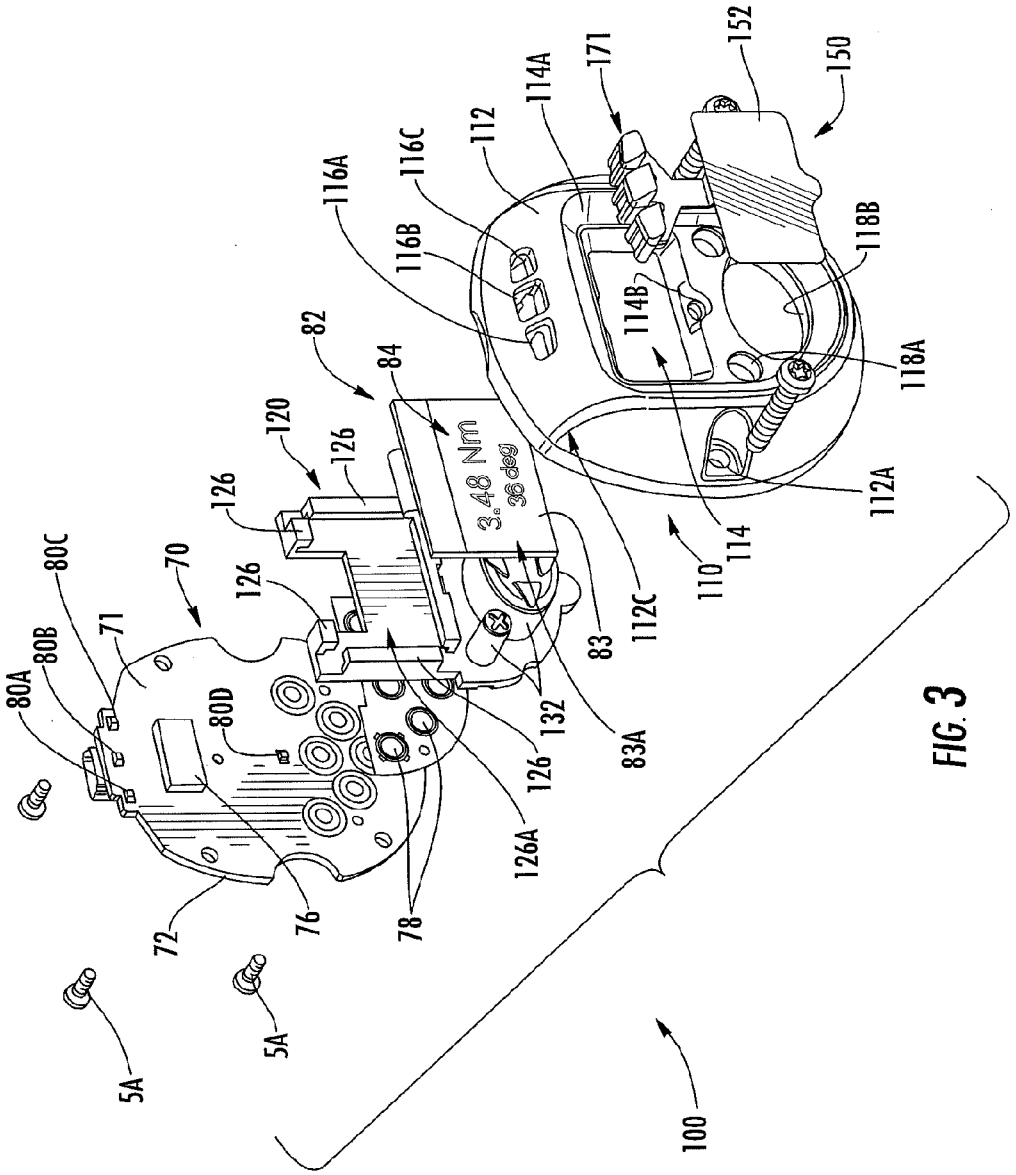


FIG. 3

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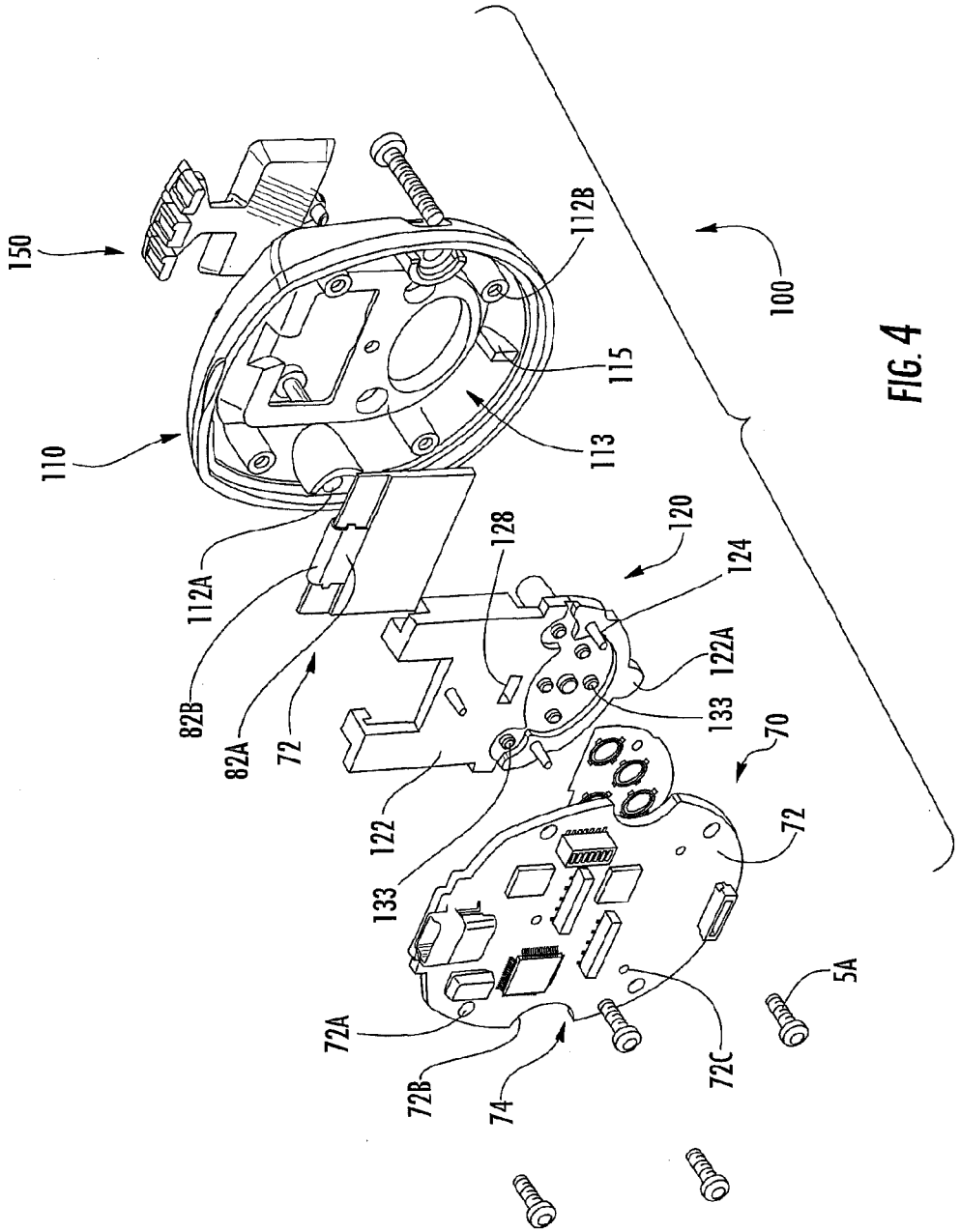


FIG. 4

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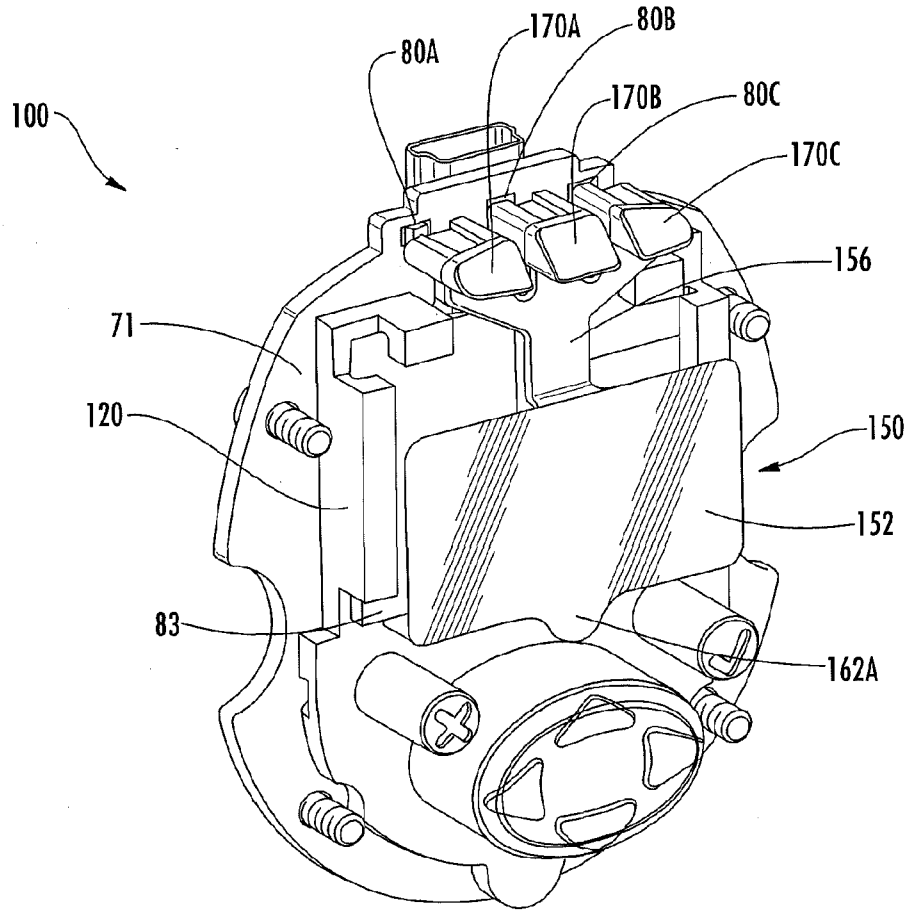


FIG. 5

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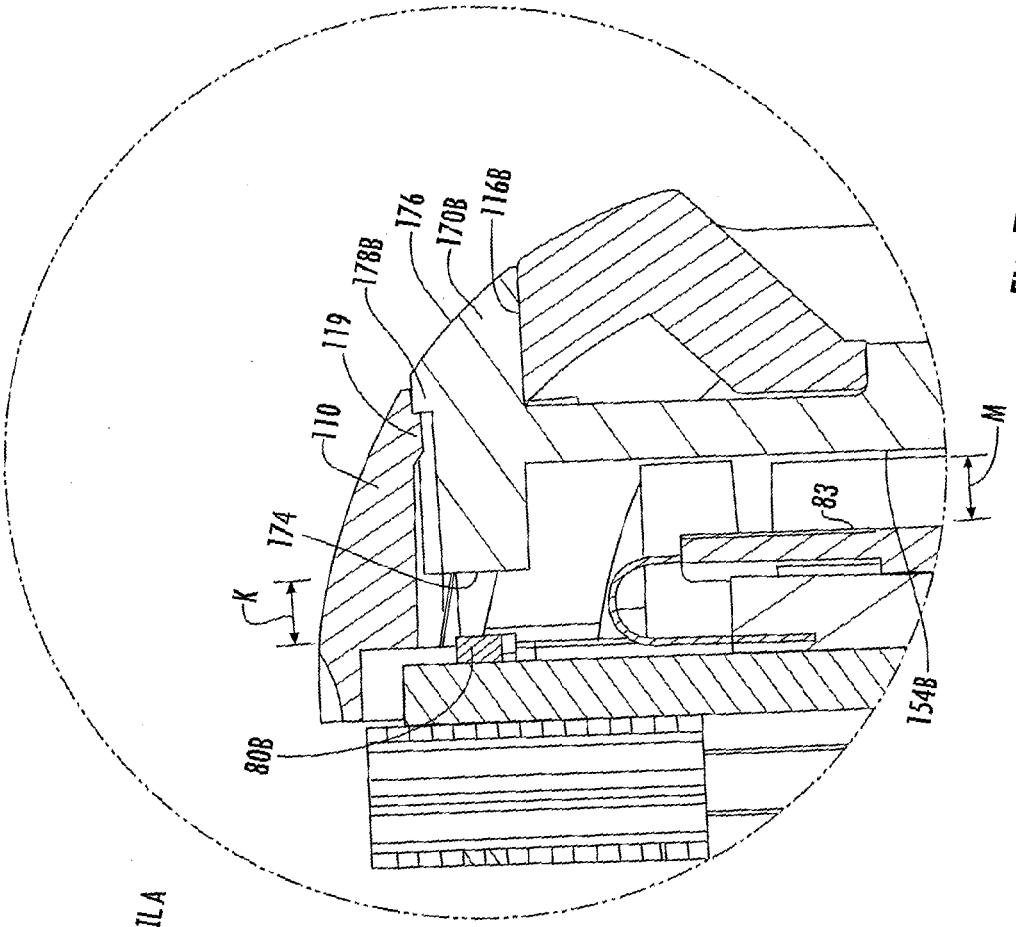

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FIG. 7

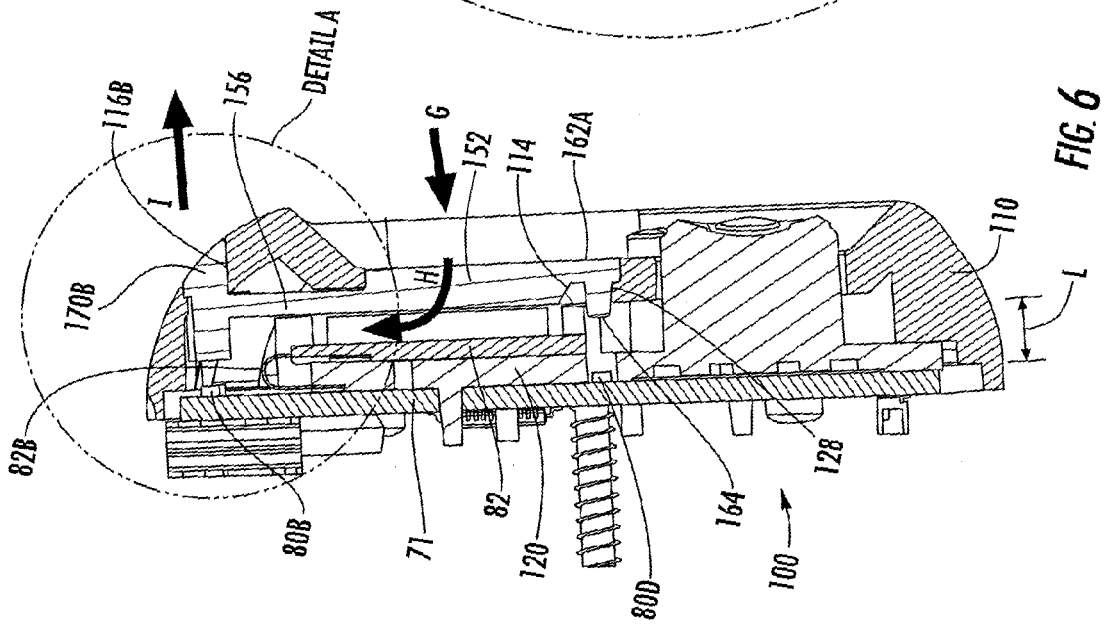

DETAIL A
116B
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FIG. 6

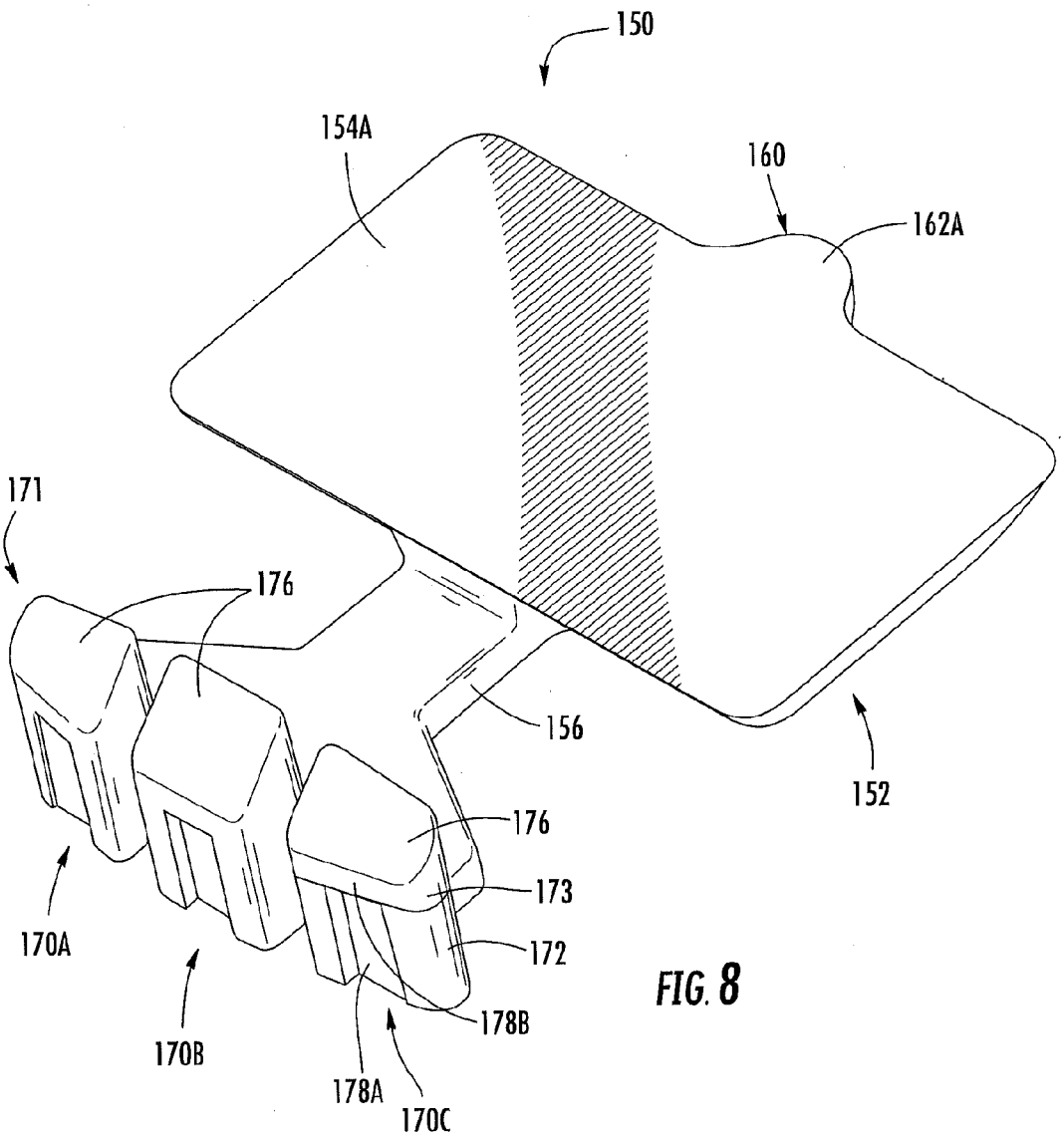


FIG. 8

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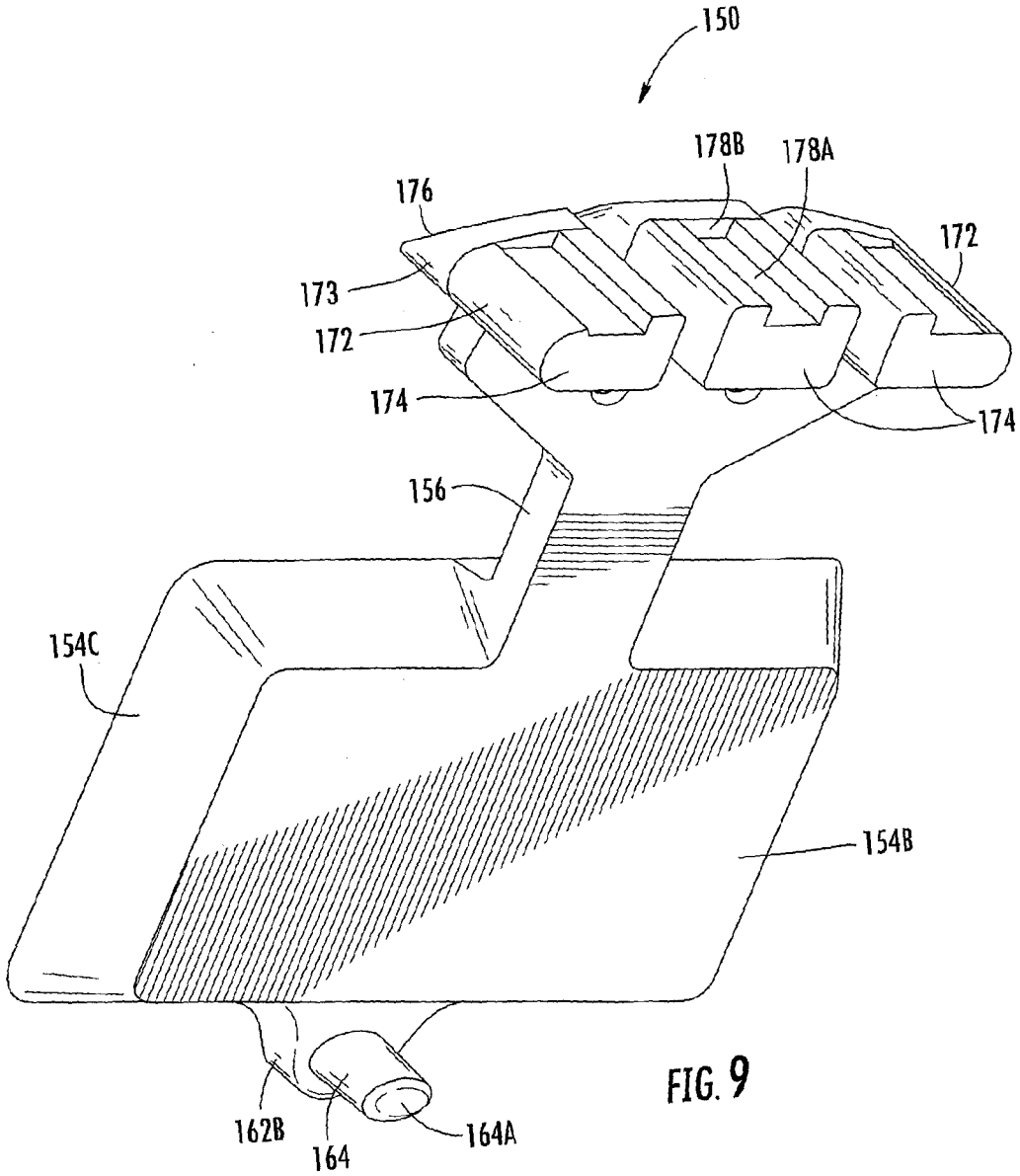


FIG. 9

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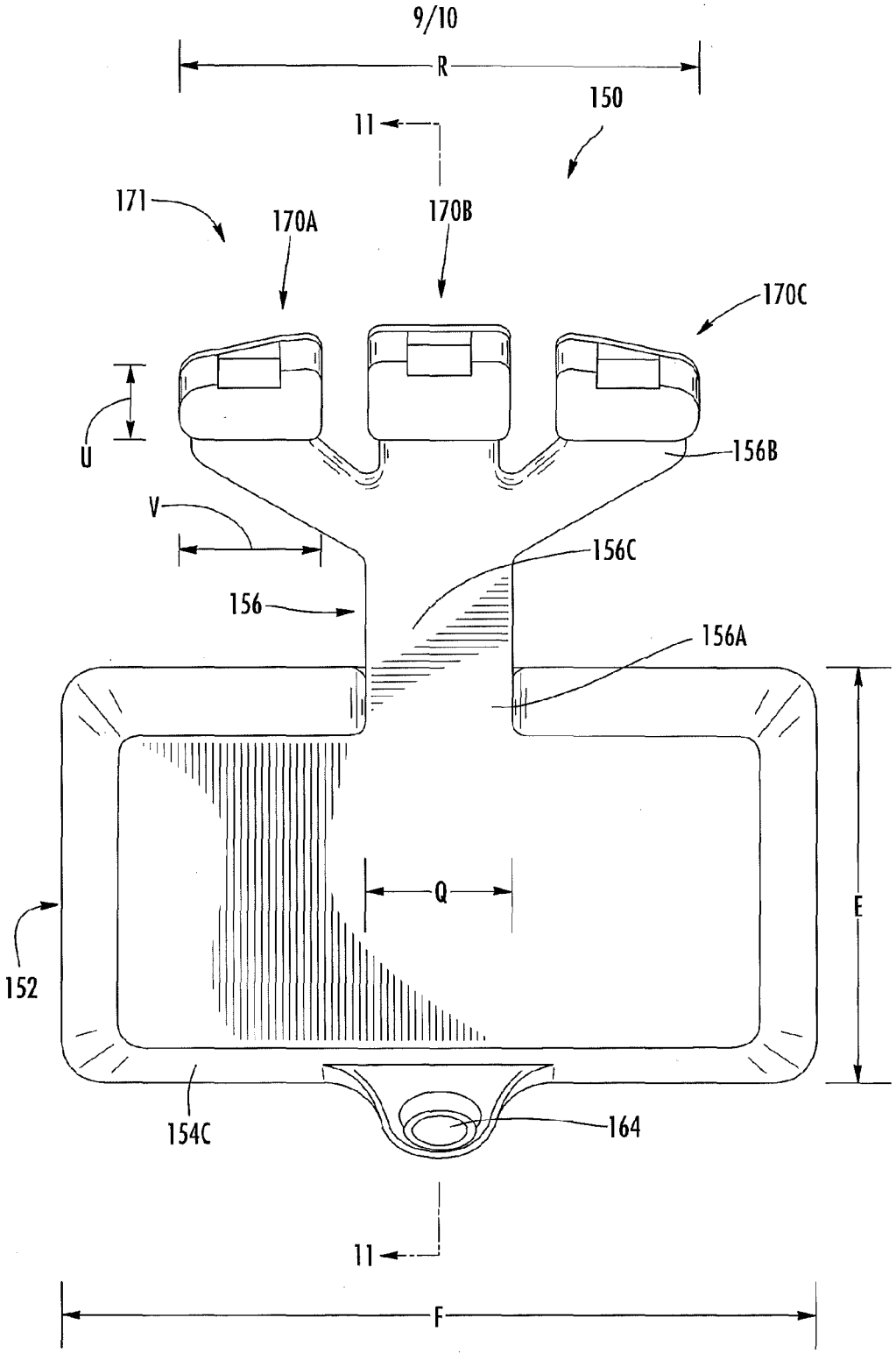


FIG. 10

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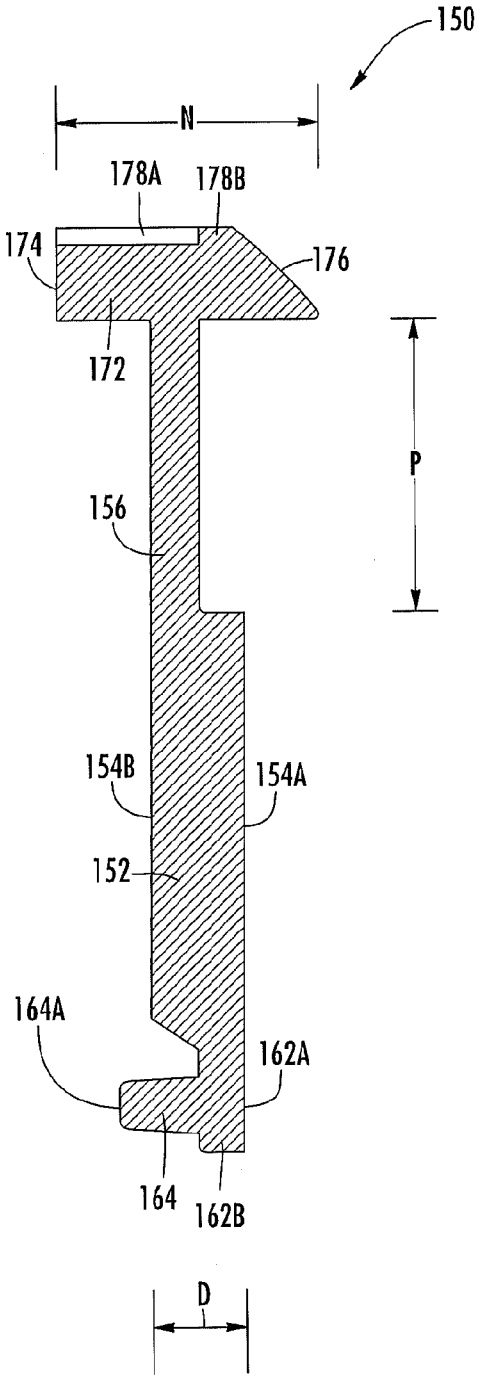


FIG. 11

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US20 11/030640

A. CLASSIFICATION OF SUBJECT MATTER

B25F 5/00(2006.01)i, B25F 5/02(2006.01)1, B25B 21/00(2006.01)1, B25B 23/18(2006.01)i, B25F 3/00(2006.01)1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B25F 5/00; B25B 23/18; B25B 23/00; B25B 23/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: power tool, display, light

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2008-0271904 Al (LIN YUNG-TSUNG) 06 November 2008 See abstract , paragraphs [0015] and [0021] , and figure 1	1-9 , 12-20 10 , 11
X Y	EP 2090399 Al (MAKITA CORPORATION) 19 August 2009 See abstract and figures 1 and 2. See abstract and figures 1 and 2.	10 , 11 1-9 , 12-20
A	US 2010-0038103 Al (UEDA TAKASHI et al.) 18 February 2010 See abstract , paragraphs [0079] and [0092] , and figure 8	1-20
A	US 2007-0012121 Al (CHIH-CHING HSIEH) 18 January 2007 See abstract , paragraph [0025] , and figure 4	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 MARCH 2012 (23.03.2012)	**26 MARCH 2012 (26.03.2012)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daej eon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer P r ng yun a k s a H Telephone No. 82-42-481-5434

Form PCT/ISA/210 (second sheet) (My 2009)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2011/030640

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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EP 2090399 A1	19.08.2009	CN 101508106 A	19.08.2009
		CN 101508106 B	11.05.2011
		EP 2090399 B1	21.09.2011
		JP 2009-190131 A	27.08.2009
		US 2009-0207035 A1	20.08.2009
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		JP 2008-264958 A	06.11.2008
		JP 2009-083030 A	23.04.2009
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		WO 2008-133339 A1	06.11.2008
US 2007-0012121 A1	18.01.2007	US 7249526 B2	31.07.2007

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CII, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,

(54) Title: METHOD FOR OPERATING A SURGICAL INSTRUMENT

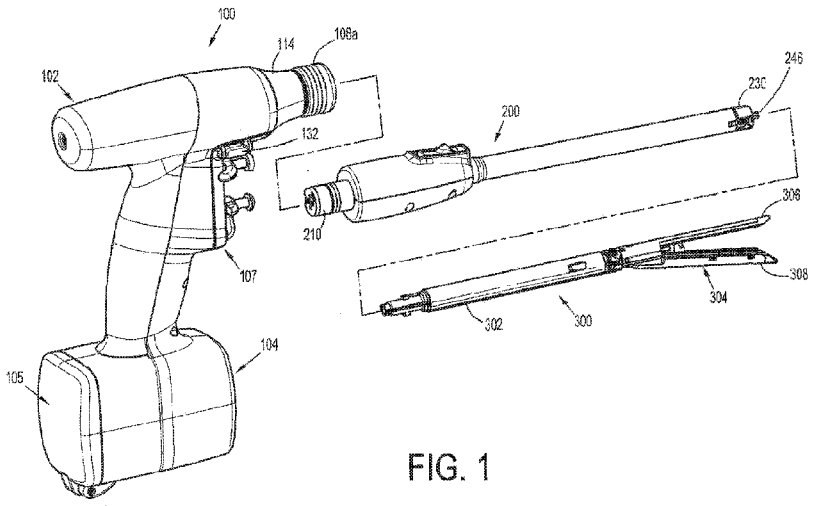


FIG. 1

(57) Abstract: A surgical instrument is configured to compensate for battery pack and drivetrain failures. One method includes generating a firing sequence, determining whether a subset of rechargeable battery cells is damaged during the firing sequence, and stepping-up an output voltage of the battery pack to complete the firing sequence in response to a determination that a subset of the rechargeable battery cells is damaged. Another method includes generating a mechanical output to motivate a drivetrain to transmit a motion to a jaw assembly of the surgical instrument, activating a safe mode in response to an acute failure of the drivetrain, and activating a bailout mode in response to a catastrophic failure of the drivetrain. Another method includes driving a drivetrain, sensing and recording vibration information from the drivetrain, generating an output signal based on the vibration information, and determining a status of the surgical instrument based on the output signal.

[Continued on nextpage]

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SD, SE, SG, SK, SL, SM, ST. SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN. ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS. MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG. CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(H))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(in))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

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TITLE

METHOD FOR OPERATING A SURGICAL INSTRUMENT

BACKGROUND

[0001] The present invention relates to surgical instruments and, in various arrangements, to surgical stapling and cutting instruments and staple cartridges for use therewith that are designed to staple and cut tissue.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The features of the various aspects are set forth with particularity in the appended claims. The various aspects, however, both as to organization and methods of operation, together with advantages thereof, may best be understood by reference to the following description, taken in conjunction with the accompanying drawings as follows:

[0003] FIG. 1 is a perspective, disassembled view of an electromechanical surgical system including a surgical instrument, an adapter, and an end effector, according to the present disclosure;

[0004] FIG. 2 is a perspective view of the surgical instrument of FIG. 1, according to at least one aspect of the present disclosure;

[0005] FIG. 3 is perspective, exploded view of the surgical instrument of FIG. 1, according to at least one aspect of the present disclosure;

[0006] FIG. **4** is a perspective view of a battery of the surgical instrument of FIG. 1, according to at least one aspect of the present disclosure;

[0007] FIG. 5 is a top, partially-disassembled view of the surgical instrument of FIG. 1, according to at least one aspect of the present disclosure;

[0008] FIG. 6 is a front, perspective view of the surgical instrument of FIG. 1 with the adapter separated therefrom, according to at least one aspect of the present disclosure;

[0009] FIG. 7 is a side, cross-sectional view of the surgical instrument of FIG. 1, as taken through 7-7 of FIG. 2, according to at least one aspect of the present disclosure;

[0010] FIG. 8 is a top, cross-sectional view of the surgical instrument of FIG. 1, as taken through 8-8 of FIG. 2, according to at least one aspect of the present disclosure;

[0011] FIG. 9 is a perspective, exploded view of a end effector of FIG. 1, according to at least one aspect of the present disclosure;

[0012] FIG. 10A is a top view of a locking member, according to at least one aspect of the present disclosure;

[0013] FIG. 10B is a perspective view of the locking member of FIG. 10A, according to at least one aspect of the present disclosure;

[0014] FIG. 11 is a schematic diagram of the surgical instrument of FIG. 1, according to at least one aspect of the present disclosure;

[0015] FIG. 12 is a perspective view, with parts separated, of an electromechanical surgical system, according to at least one aspect of the present disclosure;

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[0016] FIG. 13 is a rear, perspective view of a shaft assembly and a powered surgical instrument, of the electromechanical surgical system of FIG. 12, illustrating a connection therebetween, according to at least aspect of the present disclosure;

[0017] FIG. 14 is a perspective view, with parts separated, of the shaft assembly of FIG. 13, according to at least aspect of the present disclosure;

[0018] FIG. 15 is a perspective view, with parts separated of a transmission housing of the shaft assembly of FIG. 13, according to at least aspect of the present disclosure;

[0019] FIG. 16 is a perspective view of a first gear train system that is supported in the transmission housing of FIG. 15, according to at least aspect of the present disclosure;

[0020] FIG. 17 is a perspective view of a second gear train system that is supported in the transmission housing of FIG. 15, according to at least aspect of the present disclosure;

[0021] FIG. 18 is a perspective view of a third drive shaft that is supported in the transmission housing of FIG. 15, according to at least aspect of the present disclosure;

[0022] FIG. 19 is a perspective view of a surgical instrument, according to at least one aspect of the present disclosure;

[0023] FIG. 19A is a top view of the surgical instrument of FIG. 19, according to at least one aspect of the present disclosure;

[0024] FIG. 20 is a circuit diagram of various components of the surgical instrument of FIG. 20, according to at least one aspect of the present disclosure;

[0025] FIG. 21 is logic diagram including steps for responding to drivetrain failures of the surgical instrument of FIG. 19, according to at least one aspect of the present disclosure;

[0026] FIG. 22 is a logic diagram of a safe mode of the surgical instrument of FIG. 19, according to at least one aspect of the present disclosure;

[0027] FIG. 22A is logic diagram including steps for responding to drivetrain failures of the surgical instrument of FIG. 19, according to at least one aspect of the present disclosure;

[0028] FIG. 23 is graph outlining a motor modulation in the safe mode of FIG. 22, according to at least one aspect of the present disclosure;

[0029] FIG. 23A is graph outlining a motor modulation in the safe mode of FIG. 22, according to at least one aspect of the present disclosure;

[0030] FIG. 24 is logic diagram including steps for responding to drivetrain failures of the surgical instrument of FIG. 19, according to at least one aspect of the present disclosure;

[0031] FIG. 25 is a logic diagram of a bailout mode of the surgical instrument of FIG. 19, according to at least one aspect of the present disclosure;

[0032] FIG. 26A is a partial perspective view of a surgical instrument, according to at least one aspect of the present disclosure;

[0033] FIG. 26B is a perspective view of a power pack of the surgical instrument of FIG. 26A, according to at least one aspect of the present disclosure;

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[0034] FIG. 27 is a logic diagram outlining a method of assessing the health of the power pack of FIG. 26B and responding to a detected drop in power-pack health, according to at least one aspect of the present disclosure;

[0035] FIG. 28 is a logic diagram of a module of the surgical instrument of FIG. 26A, according to at least one aspect of the present disclosure;

[0036] FIG. 29 is a logic diagram of steps of the method of FIG. 27, according to at least one aspect of the present disclosure;

[0037] FIG. 30 is a logic diagram of steps of the method of FIG. 27, according to least one aspect of the present disclosure;

[0038] FIG. 31 is a logic diagram of steps of the method of FIG. 27, according to at least one aspect of the present disclosure;

[0039] FIG. 32 is a circuit diagram of a module of the surgical instrument of FIG. 26A, according to at least one aspect of the present disclosure;

[0040] FIG. 33 is a Wheatstone bridge circuit, according to at least one aspect of the present disclosure;

[0041] FIG. 34 is an electronic control circuit coupled to a plurality of battery cells arranged in series, according to at least one aspect of the present disclosure;

[0042] FIG. 35 is a logic diagram for assessing the health status of a power pack based on the sensor readings, according to at least one aspect of the present disclosure;

[0043] FIG. 36 is a perspective view of a surgical instrument, according to at least one aspect of the present disclosure;

[0044] FIG. 36A is a top view of the surgical instrument of FIG. 36, according to at least aspect of the present disclosure;

[0045] FIG. 36B is a partial exploded view of the surgical instrument of FIG. 36, according to at least aspect of the present disclosure;

[0046] FIG. 37 is a perspective view of a motor cartridge, according to at least aspect of the present disclosure;

[0047] FIG. 38 is a circuit diagram of various components of the surgical instrument of FIG. 37, according to at least aspect of the present disclosure;

[0048] FIG. 39 is a logic diagram outlining a method of monitoring the health of a motor cartridge, according to at least aspect of the present disclosure;

[0049] FIG. 40 is a logic diagram outlining a method that employs a current sensor to monitor the health of a motor cartridge, according to at least aspect of the present disclosure;

[0050] FIG. 41 is a logic diagram outlining a module of the surgical instrument of FIG. 37, according to at least aspect of the present disclosure;

[0051] FIG. 42 is a logic diagram outlining a module of the surgical instrument of FIG. 37, according to at least aspect of the present disclosure;

[0052] FIG. 43 is a perspective view of a surgical instrument, according to at least one aspect of the present disclosure;

[0053] FIG. 44 is a circuit diagram of various components of the surgical instrument of FIG. 43, according to at least one aspect of the present disclosure;

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[0054] FIG. 45 is a circuit diagram including a microphone in communication with a plurality of filters coupled to a plurality of logic gates in accordance with at least one aspect of the present disclosure;

[0055] FIG. 46 is a graph of a microphone's output in volts versus time in seconds, the graph representing is a vibratory response of a properly functioning surgical instrument of FIG. 43 recorded by the microphone during operation of the surgical instrument in accordance with at least one aspect of the present disclosure;

[0056] FIG. 46A is a filtered signal of the microphone output of FIG. 46 in accordance with at least one aspect of the present disclosure;

[0057] FIG. 47 is a graph of a microphone's output in volts versus time in seconds, the graph representing is a vibratory response of a malfunctioning surgical instrument of FIG. 43 recorded by the microphone during operation of the surgical instrument in accordance with at least one aspect of the present disclosure;

[0058] FIG. 47A is a filtered signal of the microphone output of FIG. 47 in accordance with at least one aspect of the present disclosure;

[0059] FIG. 48 is a circuit diagram including a sensor of the surgical instrument of FIG. 43 coupled to a plurality of filters in communication with a microcontroller via a multiplexer and an analogue to digital converter in accordance with at least one aspect of the present disclosure;

[0060] FIG. 48A is a circuit diagram including a sensor of the surgical instrument of FIG. 43 coupled to a plurality of filters in communication with a microcontroller via a multiplexer and an analogue to digital converter in accordance with at least one aspect of the present disclosure;

[0061] FIGS. 48B-48D illustrate structural and operational characteristics of a Band-pass filter of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0062] FIG. 49 is graph representing a filtered signal of a sensor output of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0063] FIG. 50 is a graph representing a processed signal of a sensor output of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0064] FIG. 51 is a graph representing the force needed to fire (FTF) the surgical instrument of FIG. 43 in relation to a displacement position of a drive assembly of the surgical instrument from a starting position in accordance with at least one aspect of the present disclosure;

[0065] FIG. 52 is a graph representing the velocity of a drive assembly of the surgical instrument of FIG. 43, during a firing stroke, in relation to the displacement position of the drive assembly from a starting position in accordance with at least one aspect of the present disclosure;

[0066] FIG. 53 is a graph that represents acceptable limit modification based on zone of stroke location during a firing stroke of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0067] FIG. 54 is a graph that represents a processed signal of the output of a sensor of the surgical instrument of FIG. 43 showing a shift in the frequency response of the processed signal due to load and velocity changes experienced by a drive assembly during a firing stroke in accordance with at least one aspect of the present disclosure;

[0068] FIG. 55 is a graph that represents a processed signal of vibrations captured by a sensor of the surgical instrument of FIG. 43 during a zone of operation, the graph illustrating and acceptable limit, marginal limit, and critical limit for the zone of operation in accordance with at least one aspect of the present disclosure;

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[0069] FIG. 56 is a logic diagram of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0070] FIG. 57 is a graph that represents a processed signal of vibrations captured by a sensor of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0071] FIG. 58 is a graph that represents a processed signal of vibrations captured by a sensor of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0072] FIG. 59 is a graph that represents a processed signal of vibrations captured by a sensor of the surgical instrument of FIG. 43 in accordance with at least one aspect of the present disclosure;

[0073] FIG. 60 is a perspective view of a surgical instrument system in accordance with at least one embodiment;

[0074] FIG. 61 is a perspective view of a portion of a rotary driven firing assembly and a sled of a surgical staple cartridge wherein the sled is in a starting position and the firing assembly is in a first "unlocked" position according to at least one embodiment;

[0075] FIG. 62 is another perspective view of the portion of the rotary driven firing assembly embodiment of FIG. 61 in a second "locked" position wherein the sled is not in the starting position;

[0076] FIG. 63 is a side elevational view of a surgical staple cartridge being initially installed in a surgical end effector that is configured to cut and staple tissue in accordance with at least one embodiment;

[0077] FIG. 64 is another side elevational view of the surgical staple cartridge seated in the channel of the surgical end effector of FIG. 63 wherein the sled of the surgical staple cartridge is in a starting position and in engagement with the firing member of the surgical instrument;

[0078] FIG. 65 is another side elevational view of a partially used surgical staple cartridge seated in the channel of the surgical end effector of FIG. 63 wherein the sled of the surgical staple cartridge is not in a starting position;

[0079] FIG. 66 is a perspective view of a portion of a rotary driven firing assembly and channel of a surgical cutting and stapling end effector wherein the firing assembly is in a "locked " position in accordance with at least one embodiment;

[0080] FIG. 67 is another perspective view of a portion of the rotary driven firing assembly of FIG. 66 and a sled of a surgical staple cartridge wherein the sled is in a starting position and the firing assembly is in an "unlocked" position;

[0081] FIG. 68 is a perspective view of a threaded nut portion of in accordance with at least one embodiment;

[0082] FIG. 69 is a perspective view of the threaded nut portion of FIG. 68 being installed into a corresponding channel embodiment shown in cross-section;

[0083] FIG. 70 is a cross-sectional elevational view of a channel and threaded nut portion of FIG. 69 with the threaded nut portion in a locked position;

[0084] FIG. 71 is another cross-sectional elevational view of the channel and threaded nut portion of FIGS. 69 and 70 with the nut portion in an unlocked position;

[0085] FIG. 72 is another cross-sectional elevational view of the channel and threaded nut portion of FIGS. 69-71 with the threaded nut portion in a locked position and illustrating the initial installation of a sled of a surgical staple cartridge into the channel with the cartridge body omitted for clarity;

[0086] FIG. 73 is another cross-sectional elevational view of the channel, threaded nut portion and sled of FIG. 72 with the sled installed so as to move the nut portion to the unlocked position;

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[0087] FIG. 74 is a cross-sectional side elevational view of a surgical cutting and stapling end effector in accordance with at least one embodiment;

[0088] FIG. 75 is an exploded perspective assembly view of an anvil assembly of the surgical end effector of FIG. 74;

[0089] FIG. 76 is a cross-sectional view of the anvil assembly of FIG. 75;

[0090] FIG. 77 is a cross-sectional view of the surgical end effector of FIG. 74 with a firing member assembly thereof in a locked position;

[0091] FIG. 78 is another cross-sectional view of the surgical end effector of FIG. 77 taken at a proximal end thereof with the firing member assembly in an unlocked position;

[0092] FIG. 79 is another cross-sectional view of the surgical end effector of FIG. 77 taken at a position that is distal to the view of FIG. 78;

[0093] FIG. 80 is a perspective view of a surgical stapling instrument comprising a handle and a replaceable loading unit in accordance with at least one embodiment;

[0094] FIG. 81 is a perspective view of the loading unit of FIG. 80 illustrated with a staple cartridge jaw detached from the loading unit;

[0095] FIG. 82 is a perspective view of a surgical stapling instrument comprising a handle and a replaceable loading unit in accordance with at least one embodiment;

[0096] FIG. 83 is a perspective view of the loading unit of FIG. 82;

[0097] FIG. 84 illustrates the connection portions of the handle and loading unit of FIG. 82;

[0098] FIG. 85 is a cross-sectional view of an end effector of the loading unit of FIG. 80;

[0099] FIG. 86 is a detail view of the attachment between the staple cartridge jaw and a frame of the staple loading unit of FIG. 80;

[0100] FIG. 87 is a cross-sectional view of an end effector of a loading unit in accordance with at least one embodiment;

[0101] FIG. 88 is a detail view of the attachment between a staple cartridge jaw and a frame of the loading unit of FIG. 87;

[0102] FIG. 89 is a perspective view of the frame of the loading unit of FIG. 87;

[0103] FIG. 90 is a detail view of the proximal end of the staple cartridge jaw of FIG. 87;

[0104] FIG. 91 is a detail view illustrating the connection between the frame and the staple cartridge jaw of FIG. 87;

[0105] FIG. 92 is an exploded view of a staple cartridge jaw in accordance with at least one embodiment;

[0106] FIG. 93 is a partial perspective view of a loading unit in accordance with at least one embodiment;

[0107] FIG. 94 is a partial elevational view of a frame of a loading unit in accordance with at least one embodiment illustrated without a staple cartridge jaw attached thereto;

[0108] FIG. 95 is a partial elevational view of a staple cartridge jaw attached to the frame of the loading unit of FIG. 94;

[0109] FIG. 96 is a partial elevational view of the loading unit of FIG. 94 illustrated in a clamped configuration;

[0110] FIG. 97 is a partial elevational view of the loading unit of FIG. 94 illustrated in a partially-fired configuration;

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[0111] FIG. 98 is a partial elevational view of a frame of a loading unit in accordance with at least one embodiment illustrated without a staple cartridge jaw attached thereto;

[0112] FIG. 99 is a partial elevational view of a staple cartridge jaw attached to the frame of the loading unit of FIG. 98;

[0113] FIG. 100 is a partial elevational view of the loading unit of FIG. 98 illustrated in a clamped configuration;

[0114] FIG. 101 is a partial elevational view of the loading unit of FIG. 98 illustrated in a partially-fired configuration;

[0115] FIG. 102 is a partial perspective view of the loading unit of FIG. 98 illustrated with a staple cartridge jaw attached to the frame;

[0116] FIG. 103 is a partial perspective view of a staple cartridge jaw being attached to a frame of a loading unit in accordance with at least one embodiment;

[0117] FIG. 104 is a partial elevational view of an attempt to attach the staple cartridge jaw of FIG. 103 to a loading unit configured to receive a different staple cartridge jaw;

[0118] FIG. 105 is a partial elevational view of the staple cartridge jaw of FIG. 103 attached to the frame of the loading unit of FIG. 103;

[0119] FIG. 106 is a partial elevational view of a connection between a staple cartridge jaw and a frame of a loading unit in accordance with at least one embodiment;

[0120] FIG. 107 is a partial elevational view of the loading unit of FIG. 106;

[0121] FIG. 108 is a partial elevational view of a staple cartridge jaw configured to be used with a different loading unit other than the loading unit of FIG. 106 attached to the loading unit of FIG. 106;

[0122] FIG. 109 is a partial elevational view of a surgical instrument system comprising a deflectable lockout arrangement illustrated in a locked configuration;

[0123] FIG. 110 is a partial elevational view of the surgical instrument system of FIG. 109, wherein the lockout arrangement is illustrated in an unlocked configuration;

[0124] FIG. 111 is a partial elevational view of a surgical instrument system comprising a magnetic lockout arrangement illustrated in a locked configuration;

[0125] FIG. 112 is a partial elevational view of the surgical instrument system of FIG. 111, wherein the magnetic lockout arrangement is illustrated in an unlocked configuration;

[0126] FIG. 113 is a partial elevational view of the surgical instrument system of FIG. 111, illustrated in a partially fired configuration;

[0127] FIG. 114 is a partial perspective view of a staple cartridge for a surgical instrument system, wherein the staple cartridge comprises a driver configured to control a lockout arrangement of the surgical instrument system;

[0128] FIG. 115 is a perspective view of a sled for use with the staple cartridge of FIG. 114;

[0129] FIG. 116 is a perspective view of the false driver of the staple cartridge of FIG. 114;

[0130] FIG. 117 is a partial elevational view of the surgical instrument system utilizing the staple cartridge of FIG. 114, wherein the surgical instrument system comprises a lockout arrangement configured to limit the movement of a firing member until a staple cartridge is loaded into the surgical instrument system;

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[0131] FIG. 118 is a partial elevational view of the surgical instrument system of FIG. 117, wherein the lockout arrangement is illustrated in an unlocked configuration;

[0132] FIG. 119 is a partial elevational view of the surgical instrument system of FIG. 117, illustrated in a partially fired configuration;

[0133] FIG. 120 is a partial perspective view of a staple cartridge for use with a surgical instrument system, wherein the surgical instrument system comprises a lockout circuit comprising a severable member;

[0134] FIG. 121 is a cross-sectional plan view of the surgical instrument system of FIG. 120, wherein the surgical instrument system further comprises an electromagnet and a lockout member, wherein the lockout member is illustrated in an unlocked position, and wherein the lockout circuit is in a closed configuration;

[0135] FIG. 122 is a cross-sectional plan view of the surgical instrument system of FIG. 120, wherein the lockout member is illustrated in a locked position, and wherein the lockout circuit is in an open configuration;

[0136] FIG. 123 is a perspective view of a surgical instrument system, wherein the surgical instrument system comprises a circuit lockout arrangement comprising electrical contacts positioned on a sled for use with a staple cartridge;

[0137] FIG. 124 is a partial elevational view of the surgical instrument system of FIG. 123;

[0138] FIG. 125 is a partial cross-sectional view of a firing member lockout illustrating the firing member lockout in a locked configuration;

[0139] FIG. 126 is a cross-sectional view of the firing member lockout of FIG. 125 taken along line 126-126 in FIG. 125;

[0140] FIG. 127 is a partial cross-sectional view of the firing member lockout of FIG. 125 illustrating the firing member lockout in an unlocked configuration;

[0141] FIG. 128 is a cross-sectional view of the firing member lockout of FIG. 125 taken along line 128-128 in FIG. 127;

[0142] FIG. 129 is a cross-sectional plan view of the firing member lockout of FIG. 125 taken along line 129-129 in FIG. 127;

[0143] FIG. 130 is a partial elevational view of a stapling assembly comprising an unspent staple cartridge in accordance with at least one embodiment;

[0144] FIG. 131 is a partial plan view of the stapling assembly of FIG. 130;

[0145] FIG. 132 is a partial elevational view of the stapling assembly of FIG. 130 illustrated in a spent condition;

[0146] FIG. 133 is a partial plan view of the stapling assembly of FIG. 130 illustrated in the condition of FIG. 132;

[0147] FIG. 134 is a partial perspective view of a stapling assembly comprising an unspent staple cartridge in accordance with at least one embodiment;

[0148] FIG. 135 is a partial perspective view of the stapling assembly of FIG. 134 illustrated in a spent condition;

[0149] FIG. 136 is a partial perspective view of a stapling assembly illustrated with components removed for the purpose of illustration;

[0150] FIG. 137 illustrates a pin of the stapling assembly of FIG. 136 configured to affect a detection circuit of the stapling assembly;

[0151] FIG. 138 is a partial perspective view of certain components of the stapling assembly of FIG. 136;

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[0152] FIG. 139 is a partial perspective view of a shaft housing of the stapling assembly of FIG. 136;

[0153] FIG. 140 is a partial plan view of a staple cartridge in accordance with at least one embodiment;

[0154] FIG. 140A illustrates a firing force profile that is experienced when firing a staple cartridge in at least one embodiment;

[0155] FIG. 141 is a partial cross-sectional view of a stapling assembly comprising a lockout in accordance with at least one embodiment;

[0156] FIG. 142 is a partial cross-sectional view of the stapling assembly of FIG. 141 illustrated in a locked out configuration;

[0157] FIG. 143 is a partial cross-sectional view of a stapling assembly comprising a lockout in accordance with at least one embodiment;

[0158] FIG. 144 is a partial cross-sectional view of a stapling assembly comprising a lockout in accordance with at least one embodiment;

[0159] FIG. 145 is a partial cross-sectional view of a stapling assembly comprising a brake in accordance with at least one embodiment;

[0160] FIG. 146 is a partial cross-sectional view of a stapling assembly comprising a damping system in accordance with at least one embodiment;

[0161] FIG. 147 is a schematic illustrating a stapling assembly comprising an electromagnetic brake in accordance with at least one embodiment;

[0162] FIG. 148 is a partial cross-sectional view of a stapling assembly comprising a damping system in accordance with at least one embodiment;

[0163] FIG. 149 is an electrical circuit configured to detect the position and progression of a staple firing member illustrating the staple firing member in a fully fired position;

[0164] FIG. 150 illustrates the staple firing member of FIG. 149 in a fully retracted position;

[0165] FIG. 151 is a cross-sectional view of a stapling assembly comprising a lockout in accordance with at least one embodiment illustrated in an unlocked configuration;

[0166] FIG. 152 is a cross-sectional end view of the stapling assembly of FIG. 151 illustrated in its unlocked configuration;

[0167] FIG. 153 is a cross-sectional view of the stapling assembly of FIG. 151 illustrated in a locked configuration; and

[0168] FIG. 154 is a cross-sectional end view of the stapling assembly of FIG. 151 illustrated in its locked configuration.

DESCRIPTION

[0169] The Applicant of the present application owns the following U.S. Patent Applications that were filed on even date herewith and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. _____, entitled SURGICAL INSTRUMENT COMPRISING A LOCKOUT; Attorney Docket No. END7828USNP/150542;

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- U.S. Patent Application Serial No. _____, entitled SURGICAL INSTRUMENT COMPRISING A PRIMARY FIRING LOCKOUT AND A SECONDARY FIRING LOCKOUT; Attorney Docket No. END7787USNP/150522;
- U.S. Patent Application Serial No. _____, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING A MAGNETIC LOCKOUT; Attorney Docket No. END7789USNP/150503;
- U.S. Patent Application Serial No. _____, entitled SURGICAL INSTRUMENT COMPRISING A REPLACEABLE CARTRIDGE JAW; Attorney Docket No. END7790USNP/150504; and
- U.S. Patent Application Serial No. _____, entitled CARTRIDGE LOCKOUT ARRANGEMENTS FOR ROTARY POWERED SURGICAL CUTTING AND STAPLING INSTRUMENTS; Attorney Docket No. END7791USNP/150505.

[0170] Applicant of the present application owns the following patent applications that were filed on April 15, 2016 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 15/130,575, entitled STAPLE FORMATION DETECTION MECHANISMS;
- U.S. Patent Application Serial No. 15/130,582, entitled SURGICAL INSTRUMENT WITH DETECTION SENSORS;
- U.S. Patent Application Serial No. 15/130,588, entitled SURGICAL INSTRUMENT WITH IMPROVED STOP/START CONTROL DURING A FIRING MOTION;
- U.S. Patent Application Serial No. 15/130,595, entitled SURGICAL INSTRUMENT WITH ADJUSTABLE STOP/START CONTROL DURING A FIRING MOTION;
- U.S. Patent Application Serial No. 15/130,566, entitled SURGICAL INSTRUMENT WITH MULTIPLE PROGRAM RESPONSES DURING A FIRING MOTION;
- U.S. Patent Application Serial No. 15/130,571, entitled SURGICAL INSTRUMENT WITH MULTIPLE PROGRAM RESPONSES DURING A FIRING MOTION;
- U.S. Patent Application Serial No. 15/130,581, entitled MODULAR SURGICAL INSTRUMENT WITH CONFIGURABLE OPERATING MODE;
- U.S. Patent Application Serial No. 15/130,590, entitled SYSTEMS AND METHODS FOR CONTROLLING A SURGICAL STAPLING AND CUTTING INSTRUMENT; and
- U.S. Patent Application Serial No. 15/130,596, entitled SYSTEMS AND METHODS FOR CONTROLLING A SURGICAL STAPLING AND CUTTING INSTRUMENT.

[0171] The Applicant of the present application owns the following U.S. Patent Applications that were filed on April 1, 2016 and which are each herein incorporated by reference in their respective entireties:

- U.S. Patent Application Serial No. 15/089,325, entitled METHOD FOR OPERATING A SURGICAL STAPLING SYSTEM;
- U.S. Patent Application Serial No. 15/089,321, entitled MODULAR SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY;
- U.S. Patent Application Serial No. 15/089,326, entitled SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY INCLUDING A RE-ORIENTABLE DISPLAY FIELD;

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