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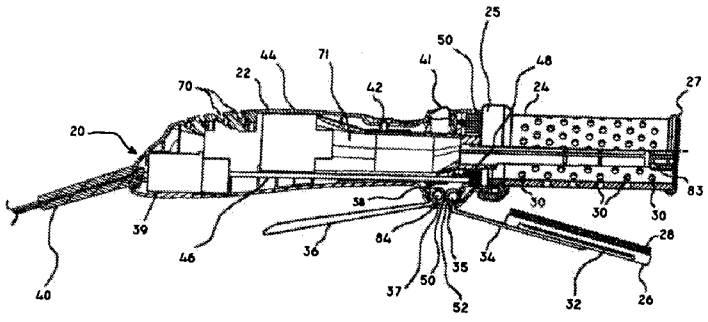


Fig. 1

(57) Abstract: A hair styling tool 20, 149, 120, 310, 320, 1300 includes a body 22, 122, 152, 322, 1302, a cylinder 24, 124, 157, 324, 1322, 1400, 1522 extending from the body, the cylinder rotatable relative to the body, a motor 39, 1308, 1502 for rotating the cylinder, a heater 1324 to heat the cylinder, and a styling arm 200, 151, 1314 pivotally attached to the body. The hair styling tool having a generally clam shell configuration, wherein the styling arm is movable between an open position and a closed position in which the styling arm contacts the cylinder. The styling arm may also include a brush head 26, 100, 110, 150, 200, 326, 400, 1316, 1317 with fixed or retractable bristles and/or a smoothing plate 108, 115, 208, 412, 1318. The hair styling tool also includes a detector for detecting the direction of movement of the styling arm along a user's hair, the detector being in communication with the motor for causing the motor to automatically rotate the cylinder in a direction corresponding to the direction of movement of the styling arm along the user's hair.

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HAIR STYLING TOOL WITH AUTOMATICALLY REVERSING CYLINDER

CROSS-REFERENCE TO RELATED APPLICATION

This International Application is related to and claims priority from United States Patent Application No. 13/487,216, entitled, "Hairstyling Tool With Automatically Reversing Cylinder" filed June 3, 2012, the contents of which are incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0001] This invention relates to a hair styling tool, and more specifically, to a hair styling tool with an automatically reversing cylinder allowing a user to more efficiently and more effectively brush and style hair by optimizing the brushing, smoothing and styling of each hair section.

[0002] This invention relates to a hair styling tool, and more specifically, to a hair styling tool with an automatically reversing cylinder allowing a user to more efficiently and more effectively brush and style hair by optimizing the brushing, smoothing and styling of each hair section.

BACKGROUND OF THE INVENTION

[0003] Brushing hair pulls oil from the scalp region and spreads it throughout the hair, adding body and sheen to the hair and keeping the hair healthy. To add even more body or to style hair in particular shapes, many people blow dry their hair as they brush it. When simultaneously blow drying and brushing hair, desirable results are achieved by pulling the bristles of a hair brush through the hair while heat, such as in the form of hot air, is applied directly to the hair. One method of brushing involves partially rotating the brush so that the bristles move through the hair. A user can usually rotate a brush about one half turn manually and, after each half turn, the user pulls the brush from the hair. The brush is then replaced in a new location, usually adjacent to the preceding location, and the process is repeated. Various brushes have been developed as an improved hair brushing means. Exemplary embodiments of such brushes are described in U.S. Patent No. 6,098,635 to Marino, and U.S. Patent No. 7,631,646 to Ragosta both of which are hereby incorporated in their entirety by reference.

[0004] Each of the brushes described have different ways of determining the direction and rotation for a cylinder associated with the brush. For example, in one embodiment the cylinder direction is changed manually using a switch. In another embodiment the direction of the cylinder is changed using either a mechanical means or an opto-electric sensor.

[0005] However, all of these methods, while functional, are either slow to react to a change in direction or cumbersome by forcing the user to stop styling and change the direction.

[0006] Therefore, there is a need for an automatically reversing cylinder allowing a user to more efficiently and more effectively brush and style hair by optimizing the brushing, smoothing and styling of each hair section.

SUMMARY OF THE INVENTION

[0007] In one exemplary embodiment, a hair styling tool is provided including a body, a cylinder extending from the body, the cylinder rotatable relative to the body, a motor for rotating the cylinder, and a styling arm attached to the body. The styling arm may be adapted to make contact with the cylinder and the styling arm may be movable between an open position in which the styling arm does not contact the cylinder and a closed position in which the styling arm contacts the cylinder. In a preferred embodiment, there is a spacing means between the styling arm and the cylinder so that in the closed position the styling arm does not touch the surface of the cylinder. The styling arm may include a brush head and/or a smoothing plate. In one exemplary embodiment, the hair styling tool may have a hinged or clam shell configuration.

[0008] A brush head of the hair styling tool may include a brush head housing, a smoothing plate housed within the brush head housing and a blade on which bristles are formed, the blade located between the housing and the smoothing plate. The bristles may be movable between an extended position in which the bristles protrude past the smoothing plate and a collapsed position in which the bristles are retracted with respect to the smoothing plate. The brush head housing may also include a bristle release knob, wherein the bristle release knob is adapted to contact the blade to maintain the blade in the extended position and wherein the bristle release knob is movable to be spaced from the blade to permit the blade to be placed in the collapsed position with the bristles retracted.

[0009] The hair styling tool may further include a heater adapted to heat the cylinder. The cylinder may have surface holes to dissipate heat and may include grooves or other types of indentations to provide additional friction between the cylinder and the brush head or smoothing plate.

[0010] In one exemplary embodiment, the blade is removable from the brush head and replaceable with one of a plurality of different blades having, for example, varying bristle patterns, densities and lengths or having no bristles at all. Additionally, in another exemplary embodiment, the brush head is removable and replaceable with one of a plurality of different brush heads.

[0011] In one exemplary embodiment there is provided a tool suitable for hair styling having an elongated body and a cylinder that rotates relative to the body in both a clockwise direction and a counterclockwise direction. The cylinder can also have a heater to heat the cylinder and/or a styling arm heater for heating the styling arm. The tool also has a motor to rotate the cylinder and a pivotal non-rotating styling arm that can be opened and closed on the cylinder for hair styling. The styling arm can have a brush head at its distal end for hair brushing and styling. The brush head can have a removable blade, from which the bristles extend, that allows for a plurality of interchangeable blades for the user to style their hair, each blade having a different bristle configuration. The brush head includes a smoothing plate, between two sets of bristles, and at least some of the bristles extend beyond the smoothing plate. The smoothing plate also has a concave surface curved the same degree as the cylinder.

[0012] The styling arm is supported by the body, and is movable between an open position and a closed position proximate to the cylinder for hair styling. A spring can be used for biasing the styling arm into the open position. A switch activates the motor to rotate the cylinder when the styling arm is moved toward the closed position from the open position. There is a spacing means for preventing the styling arm from overloading the motor or from contacting the cylinder. In one exemplary embodiment, the spacing means comprises a projection that engages a detent in the body, on the styling arm. Alternatively, the spacing means can comprise a projection on the body to engage a detent in the spacing arm.

[0013] The tool also has a detector for detecting the direction of movement of the styling arm along a user's hair. The detector is a rotatable member that is mechanically coupled to a shaft that is movable in and out of an air gapped inductor coil. Preferably, the shaft is made from a magnetic field inducing material, such as, for example, iron. Nominal inductance of the air gapped inductor coil will vary between 75 *u*h to 185 *u*h depending on

the shaft location with respect to the air gapped inductor coil. The inductor is designed as a part of an RLC tank oscillator that will change the oscillation frequency output by an operational amplifier between 8 KHz to 8.88 KHz.

[0014] In one exemplary embodiment, there is provided a method to style a person's hair using the hair styling tool. First, allowing the heater to heat the cylinder. Then, placing the hair between the cylinder and the styling arm near the scalp with the styling arm in its open position. Next, moving the styling arm to its closed position and causing the switch to activate the motor to rotate the cylinder. Finally, while the cylinder is rotating, pulling the tool toward the tips of the hair, thereby styling the hair.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These and other features, aspects and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying figures where:

[0016] FIG. 1 is a partial cross-section, side elevation view of an exemplary hair styling tool of the present invention having a rotatable cylinder and a movable styling arm;

[0017] FIG. 2 is a semi-schematic perspective view of an exemplary hair styling tool of the present invention with the rotating cylinder removed;

[0018] FIGs. 3A, 3B, 3C and 3D are schematic side views of exemplary smoothing plates and cylinders of the present invention;

[0019] FIG. 4 is a semi-schematic perspective view of an exemplary distal end of the hair styling tool of FIG. 1;

[0020] FIG. 5 is a side view of an exemplary hair styling tool of the present invention with a styling arm in the closed position;

[0021] FIG. 6 is a semi-schematic, partial cross-section, side elevation view of another exemplary hair styling tool of the present invention;

[0022] FIG. 7 is a side elevation view of yet another exemplary hair styling tool of the present invention;

[0023] FIG. 8A is a partially schematic front view of the distal end of an exemplary hair styling tool of the present invention with compressible bristles in an extended position;

[0024] FIG. 8B is a semi-schematic front view of the distal end of FIG. 8A with the bristles in a collapsed position;

[0025] FIG. 8C is a side view of a styling arm and a cylinder of a hair styling tool of the present invention;

[0026] FIG. 8D is a semi-schematic front view of a distal end of a hair styling tool of the present invention having a smoothing plate without bristles;

[0027] FIG. 9A is a semi-schematic front view of a distal end of a hair styling tool of the present invention with retractable bristles in the extended position;

[0028] FIG. 9B is a semi-schematic front view of the distal end of FIG. 9A with retractable bristles in the collapsed position;

[0029] FIG. 9C is a side view of a brush head and a cylinder of a hair styling tool of the present invention;

[0030] FIG. 10 is a partial cross-section, side elevation view of yet another exemplary hair styling tool of the present invention;

[0031] FIG. 11 is a semi-schematic side view of yet another exemplary embodiment of a hair styling tool of the present invention;

[0032] FIG. 12 is a front view of a distal end of an exemplary hair brush of the present invention having a fixed bristles brush head incorporating an integral smoothing plate;

[0033] FIG. 13 is another exemplary embodiment of a tool suitable for hair styling. ;

[0034] FIG. 14 is a cross-sectional view of a cylinder useful for styling hair according to one embodiment of the present invention;

[0035] FIG. 15 is a diagram of an air gapped inductor coil detector for detecting the direction of movement of the styling arm;

[0036] FIG. 16 is a circuit diagram for controlling the direction of the cylinder using the detector of FIG. 15;

[0037] FIG. 17 is a graph of a tank circuit and output frequency when an inductor L1 in the circuit of FIG. 16 is 185*u*h;

[0038] FIG. 18 is a graph of a tank circuit and output frequency when the inductor L1 in the circuit of FIG. 16 is 75.5*u*h; and

[0039] FIG. 19 is a flowchart diagram of an induction sensor system.

DETAILED DESCRIPTION

[0040] In previous systems, mechanical and opto-electrical devices where used to determine the direction that a user was using the hair tool to style their hair. Although these system did reverse the direction of the cylinder, users often had to pause while styling their hair for the change in direction to take place. The present invention obviates this problem by quickly and efficiently determining the direction that the user is moving the hair styling tool and automatically changing direction. The system is so effective, that motion and direction of the hair styling tool along a single strand of hair is detectable.

[0041] The system, methods, circuits and devices that implement the embodiments of the various features and advantages of the invention will now be described with reference to the drawings.

[0042] The drawings and the associated descriptions are provided to illustrate embodiments of the invention and not to limit the scope of the invention. Reference in the specification to "one embodiment" or "an embodiment" is intended to indicate that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least an embodiment of the invention. The appearances of the phrase "in one embodiment" or "an embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0043] Throughout the drawings, reference numbers are re-used to indicate correspondence between referenced elements. In addition, the first digit of each reference number indicates the figure where the element first appears.

[0044] As used in this disclosure, except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised" are not intended to exclude other additives, components, integers or steps.

[0045] In the following description, specific details are given to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific detail. Well-known circuits, structures and techniques may not be shown in detail in order not to obscure the embodiments. For example, circuits may be shown in block diagrams in order not to obscure the embodiments in unnecessary detail.

[0046] Also, it is noted that the embodiments may be described as a process that is depicted as a flowchart, a flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be rearranged. A process is terminated when its operations are completed. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination corresponds to a return of the function to the calling function or the main function.

[0047] Moreover, a storage may represent one or more devices for storing data, including read-only memory (ROM), random access memory (RAM), magnetic disk storage mediums, optical storage mediums, flash memory devices and/or other machine readable mediums for storing information. The term "machine readable medium" includes, but is not limited to portable or fixed storage devices, optical storage devices, wireless channels and various other mediums capable of storing, containing or carrying instruction(s) and/or data.

[0048] Furthermore, embodiments may be implemented by hardware, software, firmware, middleware, microcode, or a combination thereof. When implemented in software, firmware, middleware or microcode, the program code or code segments to perform the necessary tasks may be stored in a machine-readable medium such as a storage medium or other storage(s). One or more than one processor may perform the necessary tasks in series, concurrently, distributed or in parallel. A code segment may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or a combination of instructions, data structures, or program statements. A code segment may be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted through a suitable means including memory sharing, message passing, token passing, network transmission, etc.

[0049] In the following description, certain terminology is used to describe certain features of one or more embodiments of the invention.

[0050] The term “tank circuit” refers to an RLC circuit (or LCR circuit) that is an electrical circuit consisting of a resistor, an inductor, and a capacitor, connected in series or in parallel.

[0051] Various embodiments provide a system, circuit and a method for an automatically reversing cylinder allowing a user to more efficiently and more effectively brush and style hair by optimizing the brushing, smoothing and styling of each hair section. One embodiment of the present invention provides a system comprising one or more detection circuits for determining motion and direction of a hair styling tool. In another embodiment, there is provided a method for using the system. The system, circuit and method will now be disclosed in detail.

[0052] Referring to FIG. 1, a hair styling tool 20 includes an elongated body 22. The specific dimensions of the body are not critical, but the body should generally allow a user to comfortably hold the hair styling tool during use. In one exemplary embodiment, the body 22 may be adapted to house other mechanical and electrical components of the hair styling tool 20, as described in more detail below.

[0053] With reference also to FIG. 2, in one exemplary embodiment of the hair styling tool 20, a mounting channel 72 extends from a distal end of the body 22. As used herein, "distal" shall generally refer to a position or direction away from a base of the body 22 or towards a tip of the mounting channel 72. Conversely, "proximal" shall generally refer to a position or direction toward the base of the body 22 or away from the tip of the hot air channel 72. As described in more detail below, the mounting channel 72 serves to provide additional support to a cylinder 24 rotatably mounted on the mounting channel.

[0054] Referring again to FIG. 1, in one exemplary embodiment, a hot air channel 71 may be connected to a hot air fan assembly 44 housed in the body 22 such that hot air provided by the hot air fan assembly travels through the body via the hot air channel. Intake ports 70 in the body 22 admit outside air to an inlet of the hot air fan assembly 44. An opening 82 at a distal end of the hot air channel 71 allows the air to escape the body 22 and enter, for example, a cylinder attached to a distal end of the body as described below. A hot air switch 42 electrically connected to the hot air fan assembly 44 allows a user to control the hot air supply provided by the hot air fan assembly.

[0055] An elongated hollow cylinder 24 may be rotatably mounted over the mounting channel 72. The mounting channel 72 may include a groove 81 into which teeth 83 protruding from a cap 27 of the cylinder 24 may be snapped to mount the cylinder to the mounting channel. A base 25 of the cylinder may be adapted to be connected to a distal portion of the body 22. In one exemplary embodiment, the base 25 of the cylinder 24 is connected to the body 22 by a slip fit. In one exemplary embodiment, teeth (not shown) on an

inner circumference of the base 25 mesh with teeth on a cylinder drive gear 50 at a distal end of the body 22 to align the cylinder 24 to the body. A distal end of the cylinder 24 may include the cap 27 to seal the distal end of the cylinder and prevent, for example, hot air provided through the hot air channel 71 from escaping from the distal end of the cylinder. The cap 27 may contain teeth 83 to allow the cylinder to be mounted and secured by an interference fit to the mounting channel 72 as described above. The specific shape or dimensions of the cap 27 are not critical as long as the cap substantially covers the distal end of the cylinder 24 and prevents a significant amount of air from escaping from the distal end.

[0056] In one exemplary embodiment, the cylinder 24 includes a plurality of holes 30 which allow a flow of hot air from the hot air channel 72 to an exterior of the hair styling tool 20 and to contact hair adjacent the cylinder. In one exemplary embodiment, the holes 30 are circular and arranged in rows, evenly spaced throughout the cylinder 24. The even spacing of the holes 30 throughout the cylinder 24 allows for even distribution of hot air throughout the cylinder and also for uniform heating of the cylinder, thus providing uniform drying when the cylinder is applied to hair, as described in more detail below. Although one configuration of the holes 30 is described herein, the specific configuration of the holes is not critical, and the holes may be arranged in any configuration allowing hot air to travel from the hot air channel 72 through the cylinder 24. Additionally, although the described holes 30 are circular, the shape of the holes is not critical. The holes 30 also serve to increase the friction between the brush head housing and the cylinder, increasing the brushing effectiveness on the hair.

[0057] With reference to FIGs. 3A-3D, alternate exemplary surface patterns of the cylinder 24 are shown. The alternate surface patterns, which are generally wave-shaped grooves 54a, 54b, 54c, 54d, allow for varying friction along the cylinder's surface to provide different styling options when hair is placed between the cylinder 24 and a smoothing plate 108 as described in more detail below. The grooves may also be used on a cylinder 24 having holes 30 (holes not shown for clarity). With reference to FIG. 3D, the smoothing plate 108 adapted to contact the cylinder 24 may include grooves 55 to further increase the friction between the brush head housing and the cylinder.

[0058] The rotation assembly of the hair styling tool 20 will now be described with further reference to FIG. 1. An electric motor 39 may be housed within the body 22, the motor being adapted to rotate the cylinder 24. In one exemplary embodiment, the motor powers a drive shaft 46 which extends along a length of the body 22. A drive gear 48 may be located at a distal end of the drive shaft 46, the drive gear adapted to interact with the cylinder gear drive 50 such when the drive gear 48 is rotated by the drive shaft, the cylinder gear drive

50 rotates as well. When the cylinder 24 interfaces with the cylinder gear drive 50, the cylinder rotates in the same direction and at the same rate as the cylinder gear driver. In one exemplary embodiment, the electric motor 39 is adapted to power the drive shaft 46 at different rates, depending on a setting adjusted by a user.

[0059] In one exemplary embodiment, the electric motor 39 is reversible such that it can rotate the drive shaft 48 in either direction. A rotation direction switch 41 may be electrically connected to the motor 39 to allow the direction of the motor to be set by a user. The motor 39 may be powered by, for example, electricity from an electrical power cord 40, a rechargeable battery, or by other means sufficient to generate enough energy to power the motor. An activation switch 38 may be used to activate the motor 39 to drive rotation of the cylinder 24. The activation switch 38 may be located anywhere on the brush, but in exemplary embodiment, the rotation switch is located in a position such that it is activated when a pivot handle 36 is in a closed position, as described in more detail below. Although a specific system including gears is described to allow the motor 39 to rotate the cylinder 24, one of ordinary skill in the art will appreciate that many other similar configurations of the driving system will achieve the same result in substantially the same way.

[0060] An elongated styling arm may be attached to the body 22 of the hair styling tool 20. In one exemplary embodiment, the styling arm may be a brush head 26. The brush head 26 may include an array of bristles 28 mounted on a surface of the brush head and protruding toward an outer surface of the cylinder 24. The brush head 26 may also include vent holes 32 to allow hot air to enter or hot air and/or steam to escape to prevent the brush head from becoming dangerously hot. An exemplary brush head 26 venting pattern is shown in FIG. 4.

[0061] In one exemplary embodiment, as shown in FIG. 4, the brush head 26 has a concave structure such that the brush head generally conforms to the curvature of the cylinder 24, maximizing the effective brushing surface. In a further exemplary embodiment, the brush head 26 may have a width such that it extends around part of the cylinder circumference to subtend an angle between about 20° and about 45°. The brush head 26 may be adapted to receive and secure an interchangeable bristle blade 31, allowing users to choose from a variety of blades having, for example, different widths, different bristle densities and different bristle textures. The brush head 26 may include a groove 29 located along each interior side of the brush head, the grooves 29 adapted to slidingly receive and secure the interchangeable bristle blade 31.

[0062] With reference again to FIG. 1, the brush head 26 may be pivotally or otherwise movably attached to the body 22. More specifically, the brush head 26 may be attached to a distal end of a lever arm 34, the lever arm being pivotally attached to the body 22 by, for example, a transverse brush head pivot pin 35. The brush head 26 may have an open position wherein the brush head 26 is spaced from the cylinder 24, and a closed position (FIG. 5) wherein the brush head 26, and specifically, the bristles 28, are in contact with the cylinder. A bias means 84, such as a spring, may bias the brush head 26 into an open position. The pivot handle 36 may be provided to allow a user to move the brush head 26 from the open position to the close position, the pivot handle being pivotally attached to the body 22 by a pivot handle pivot pin 37. In one exemplary embodiment, a pivot handle gear 50 rotatably connected to the pivot handle pivot pin 37 is coupled with a brush head gear 52 rotatably coupled to the brush head pivot pin 35. The pivot handle 36 is oriented such that the pivot handle is in an open position (i.e., a proximal end of the pivot handle is spaced from the body 22) when the brush head 26 is in an open position and the pivot handle is in a closed position (i.e., a proximal end of the pivot handle is in contact or substantially in contact with the body) (FIG. 5) when the brush head is in a closed position. Accordingly, when the brush head 26 is biased to be in the open position, the pivot handle 36 is also biased to be in the open position. Due to the interaction of the pivot handle gear 50 and the brush head gear 52, when the pivot handle 26 is moved from the open position to the closed position, the brush head 26 simultaneous moves from the open position to the closed position.

[0063] Referring now to FIG. 6, another exemplary embodiment of a hair styling tool 120 includes a heating element such as a heating rod 60 which is adapted to provide heat to a cylinder 124 rotatably attached to a mounting channel similarly to the previous embodiment. The heating rod 60 may be electrically connected to a power source, such as the power cord 40, which provides the heating rod 60 with the ability to generate heat. A heating element switch 62 located on a body 122 allows a user to activate and deactivate the heating rod 60.

[0064] The cylinder 124 includes a heat transfer assembly 64 attached to an inner circumferential surface of the cylinder and adapted to allow the cylinder to slide over and make contact with the heating rod 60. The heat transfer assembly 64 may be any suitable heat transfer material, for example, plastic, metal, ceramic, or any combination thereof. Accordingly, when the heating rod 60 is heated, the heat is transferred by conduction from the heating rod to the heat transfer assembly 64 and to an exterior surface of the cylinder 124. The cylinder 124 includes holes 66, for example, concave indentations or convex protrusions, which enhance hair engagement as the cylinder rotates. In one exemplary embodiment, an

exterior surface of the cylinder 124 is slightly corrugated to increase the friction between the hair and the cylinder as the cylinder rotates. Although a specific heating system, including a heat transfer assembly 64 is described to allow the heating rod 60 to conduct heat to the rotating cylinder 124, one of ordinary skill in the art will appreciate that many other similar configurations of the heating system will achieve the same result in substantially the same way, including using a radiant heating element instead of heating rod 60, which may eliminate the need for a heat transfer assembly such as 64.

[0065] Referring to FIG. 7, the styling arm includes a brush head 100 having a collapsible bristle assembly. With reference also to FIGs. 8A, 8B, and 8C, the brush head 100 includes a brush head housing 104 adapted to slidingly receive the smoothing plate 108 into grooves 121 extending longitudinally along both sides of the brush head housing. The smoothing plate is heatable and in one exemplary embodiment the brush head housing may include an integrated plug electrically connected to the smoothing plate 108. When power is supplied to the plug, the plug heats the smoothing plate 108 allowing the smoothing plate to act similar to a curling iron or a straightening iron, as described in more detail below.

[0066] With further reference to FIGs. 8A-8C, the brush head housing 104 is also adapted to slidingly receive a blade 105 including bristle clusters 106 and rigid posts 107. In one exemplary embodiment, the blade 105 includes a plurality of collapsible members 123 extending longitudinally along the blade and having a generally concave cross-section. The collapsible members 123 have an extended position in which they provide for the bristles 106 to protrude from the smoothing plate 108 (FIG. 8A) and a collapsed position in which they provide for the bristles to be retracted with respect to the smoothing plate, i.e., recessed within or substantially flush with the smoothing plate (FIG. 8B). The collapsible members 123 are biased into the extended position, but may be transformed into the collapsed position by a force to overcome the bias. Specifically, when a sufficient compression force as indicated by the arrow in FIG. 8A is applied to the rigid posts 107 generally perpendicular to a planar surface of the blade 105, the collapsible members 123 bend to allow the bristles 106 and posts 107 to be recessed within the brush head housing 104 and to allow the smoothing plate 108 to have a relatively smooth surface. As such, the hair brush may also serve as a straightening iron or a curling iron.

[0067] Another exemplary embodiment of the hair styling tool is shown with respect to FIG. 8D. A styling arm 200 includes a housing 223 adapted to slidingly receive a smoothing plate 208 into grooves 221 extending longitudinally along both sides of the housing. The smoothing plate 208 does not include bristles and is heatable, and in one

exemplary embodiment, the housing 223 may include an integrated plug to electrically heat the smoothing plate. When power is supplied to the plug, the heater heats the smoothing plate 208 allowing the smoothing plate to be used to more effectively style hair.

[0068] Yet another exemplary embodiment of a brush head 110 is shown with reference to FIGs. 9A, 9B and 9C. Similarly to the brush head 100, brush head 110 includes a brush head housing 112 adapted to slidingly receive a heatable smoothing plate 115 into grooves 131 extending longitudinally along both sides of the brush head housing. The brush head housing 112 may include an integrated plug 103 electrically connected to the smoothing plate 108.

[0069] The brush head housing 112 is also adapted to slidingly receive a blade 113 including bristles 114. The brush head housing 112 includes a bristle release knob 111a/111b adapted to be received into a release knob slot 133 located on a planar surface of the brush head housing. Specifically, with reference to FIG. 9C, a hull 116 of the release knob 111a contacts a spine 134 of the blade 113 to place the blade in an extended position such that the bristles 114 protrude through the smoothing plate 115. The spine 134 may extend along only a portion of the blade 113. When the release knob 111b is slid distally along the release knob slot 133 to a release position, (i.e., a position along the blade portion absent a spine), a compression force applied generally perpendicular to a planar surface of the blade allows the bristles 114 to be recessed into the brush head housing 112 (FIG. 9B). As such, the hair brush may also be used as a curling iron or a straightening iron.

[0070] Still another exemplary embodiment of a brush head 400 of the present invention is shown with respect to FIG. 12. The brush head 400 is directed to a brush head which incorporates a brush and an integrated smoothing plate without changing a configuration of the brush head. More specifically, the brush head 400 includes a plurality of brush head housing sections 402, each housing section adapted to slidingly receive a blade 404 including bristles 408 into grooves 410 extending longitudinally along the housing section. In one exemplary embodiment, the brush head 400 includes two housing sections 404, but the specific number of housing sections is not critical. The brush head 400 may further include a smoothing plate section 412 disposed between adjacent housing sections 404, the smoothing plate section configured to provide a planar surface contact with the cylinder 24 when the brush head is in a closed configuration as shown in FIG. 12. In one exemplary embodiment, the smoothing plate section 412 has a concave surface curved to substantially the same degree as the cylinder such that the smoothing plate section makes substantially complete contact with the cylinder when the brush head is in the closed

position. The brush head 400 may further include an integrated plug and heating element enabling the brush head to be electrically heated.

[0071] Another exemplary embodiment of the present invention is shown with reference to FIG. 10. A hair styling tool 320 substantially similar to the previously described hair styling tools is provided. The hair styling tool 320 includes a one-piece movable brush head assembly 330. The brush head assembly 330 includes a brush head 326 attached to a distal end of a lever arm 390. The lever arm 390 is generally in the shape of an "S" or an upside down "Z." The lever arm 390 is rotatably connected to the hair styling tool 310 by a transverse pivot pin 391. A pivot preload spring 392 biases the lever arm 390 into an open position such that the brush head 326 is spaced from a cylinder 324. When a force to overcome the spring bias is applied to the lever arm 390, the lever arm is movable from the open position to a closed position wherein the brush head 326 contacts the cylinder 324. The body 322 of the hair styling tool 320 may include slots 323 which permit the lever arm 390 to be moved between the open position and the closed position. A cylinder rotation switch 338 may be located such that it is activated when the lever arm is in the closed position and deactivated when the lever arm is in the open position.

[0072] As will understood by those of ordinary skill in the art, the "S" shaped lever arm configuration may also be used with any of the exemplary styling arms described above.

[0073] Yet another exemplary embodiment of the present invention is shown with reference to FIG. 11. A hair styling tool 149 has a hinged or "clam-shell" configuration including a body 152 and a styling arm 151 pivotally or otherwise movably attached to the body. In one exemplary embodiment, the styling arm 151 may be attached by a pivot pin 153. The pivot pin 153 may be designed so as to allow only a limited degree of rotation between the styling arm 151 and the body 152. For example, the maximum amount of rotation may about 60 degrees. Similarly to the previously described hair styling tool embodiments, the body 152 includes a rotatable cylinder 157 and the styling arm 151 includes a brush head 150. In one exemplary embodiment, a heating element switch 155 to control heating of the cylinder 157 and the brush head 150, and a rotation switch 156 to control rotation of the cylinder are located on the styling arm 151. However, the location of such switches is not critical, and the switches may be located anywhere that is convenient for user access. The hair styling tool 149 may be electrically powered through a power cord 154.

[0074] In one exemplary embodiment, the styling arm 151 may be biased, for example, by a spring, into an open position such that the styling arm is not in contact with the cylinder 24. A force to overcome the bias may be applied to the styling arm 151 to place the styling arm in a closed position wherein the styling arm contacts the cylinder.

[0075] The operation and use of the hair styling tool 20 will now be described with reference to FIGs. 1 and 5. The hair styling tool may be used by placing a selected portion of hair between the brush head 26 and the cylinder 24 when the brush head is in the open position (FIG. 1). The pivot handle 36 may then be moved from the open position to the closed position, resulting in the simultaneous movement of the brush head 26 from its open position to its closed position. Placing the brush head 26 in the closed position allows the brush head to clamp the selection portion of hair between the cylinder 24 and the bristles 28 of the brush head. Additionally, in one exemplary embodiment, placing the pivot handle 36 in the closed position triggers the rotation switch 38 to activate rotation of the cylinder 24. Accordingly, almost any length of hair may be brushed, shaped and styled without significant tangling in this manner. As is apparent, the various other exemplary embodiments of the hair styling tools described may be used in a similar manner. Namely, hair may be placed between the styling arm and the cylinder when the styling arm is in the open position. Once the hair is in place, the styling arm may be moved to the closed position to capture and style the hair. In an exemplary embodiment where the rotation direction of the cylinder is reversible, a user can use the brush with either hand or from either side of the head while having the cylinder rotate in the same general direction with respect to the hair.

[0076] The brushing, shaping and styling effects may be enhanced by using the heat apparatus associated with exemplary embodiments of the brush. Specifically, the hot air fan assembly 44 or the heating rod may be activated to heat the cylinder 24 as it rotates. Additionally or alternatively, the heatable smoothing plates 108,115, 208 or 412 of the brush heads 100,110, 200 or 400 may be heated. The heat applied to the hair by the cylinder 24 and/or the brush heads 100,110, 200 or 400 not only allows the hair to dry more quickly, but also provides the hair with smoothing volume and a healthy shine.

[0077] With reference to FIGs. 8A-8C, if a user wants to use the device as a curling iron or a flat iron, a compression force generally perpendicularly to the smoothing plate 108 may be applied to the blade 105 to place the bristles 106 in the collapsed position. In the collapsed position, the bristles 106 of the brush head are retracted with respect to the smoothing plate 108, i.e. recessed within or flush with the smoothing plate. Accordingly, the smoothing plate will have a smooth surface which, along with heat provided through the

cylinder 24 and/or through the brush head, allows the device to be used as a smoothing, straightening or curling iron. In an alternate embodiment with reference to FIGs. 9A-9C, the user slides the release knob 111 distally along the slot 133 from position 111a to position 111b such that the spine 134 of the blade 113 does not make contact with the hull 116 of the release knob 111. Then, the user can apply a compression force to the blade 113 to cause ends of the bristles 114 to be retracted with respect to the smoothing plate.

[0078] With reference to FIGs. 11 and 12, the combination of bristle clusters 408 fixed in relationship to the heated flat iron section 412 allows the user to simultaneously brush and smooth, straighten or curl hair without having to change a configuration of the brush head 400.

[0079] With reference to FIG. 13, there is shown another embodiment of a tool 1300 suitable for hair styling. The tool 1300 comprises an elongated body 1302 having a proximal and distal end that houses a switch 1304, a control circuit 1306 and a motor 1308. A cylinder 1322 is rotatably attached to the elongated body 1302 for polishing the user's hair. Optionally the cylinder 1322 can have one or more heaters 1324 to increase the polishing effect on a user's hair when using the tool 1300. A non-rotatable styling arm 1314 is pivotally attached to the elongated body 1302 with a pivot mechanism 1312. The styling arm 1314 can move between an open position distant from the cylinder 1322 and a closed position proximate to the cylinder 1322. A biasing means such as, for example, a spring, can be used for biasing the styling arm into the open position. The styling arm 1314 can also have a heater to increase the effectiveness of the styling tool.

[0080] The tool 1300 also has a spacing means 1320, such as, for example, an adjustable screw, a projection on the styling arm 1314, or a fixed plastic stop among others, positioned to engage a detent 1309 in the body 1302 or a spacing arm 1321 prevents the styling arm 1314 from contacting the cylinder 1322. The distance between the cylinder 1322 and the styling arm 1314 can be between 0.001mm and 0.5mm. In a particularly preferred embodiment, the distance is 0.3mm. Preferably, the motor 1308 has current overload protection as is known in the art. If current drawn by the tool 1300 exceeds a target level, such as, for example, 7 amps of current provided from a standard electrical socket, or if too much current is being drawn by the tool 1300, the command circuit 1306 can intermittently turn off motor 1308 or deactivate the tool 1300 completely, like a fuse, as a safety precaution.

For example, an excessive current load can happen from a short circuit in a heating element, or from a user clamping the tool 1300 down on the hair with too much pressure, thereby bypassing the spacing means, and causing the styling arm 1314 and the cylinder 1322 to forcefully contact one another.

[0081] The styling arm 1314 can have interchangeable brush heads 1316 and 1317, at its distal end for evenly spacing the user's hair between the styling arm 1314 and the cylinder 1322. The brush heads 1316 and 1317 can each have a plurality of bristles and variety of bristles to suit the hair type of the user. For example, a user with coarser hair can use larger bristle brush heads 1316 and 1317 to more easily move through the coarse hair. In another embodiment, the brush heads 1316 and 1317 also have a bristle release knob (not shown) with a first and second position to move the bristles 1317 into the extended position in the first knob position, and to collapse the bristle 1317 in the second knob position.

[0082] In another embodiment, a smoothing plate 1318 can be located between the brush heads 1316 and 1317. The smoothing plate 1318 has a curved concave surface, substantially the same as the cylinder 1322, to maximize the effectiveness of the smoothing plate 1318 and the rotating cylinder 1322. In one embodiment, at least some of the bristles 1316 and 1317 can extend beyond the smoothing plate 1318. In yet another exemplary embodiment, the bristles 1316 and 1317 are movable between an extended position protruding past the smoothing plate 1318 and a collapsed position in which the bristles 1316 and 1317 are retracted with respect to the smoothing plate 1318.

[0083] In one embodiment, the switch 1304 can turn the optional cylinder heater 1324 on or off and can turn the motor 1308 on or off to rotate the cylinder 1322 relative to the body in a clockwise or counter-clockwise direction. In a preferred embodiment, the control circuit 1308 can automatically detect the direction of movement of the styling arm 1314 along a user's hair when the styling arm 1314 is in a closed position and automatically rotate the cylinder 1322 in the correct direction. Optionally, the styling arm 1314 can have a projection 1315 that can engage a switch detent 1303 in the body 1302 that can signal the control circuit 1306 to automatically rotate the cylinder 1322 when the user places the styling arm 1314 in the closed position.

[0084] With reference to FIG. 14, there is shown a cross sectional view of a cylinder 1400 useful for styling hair. The surface 1402 of the cylinder 1400 polishes hair shafts as they pass over the cylinder 1400. When the heating elements 1404 and 1406 are turned and the cylinder is rotated, a consistent amount of heat is applied that amplifies the polishing effect on the hair. The cylinder 1400 can be manually or automatically set to rotate and to

heat according to various embodiments. The interchangeable brush heads 1316 and 1317 distribute the hair shafts evenly over the surface 1402 of the cylinder 1400 to decrease the time required to polish and style the users hair.

[0085] With reference to FIG. 15, there is shown a diagram 1500 of an air gapped inductor coil detector for detecting the direction of movement of the styling arm according to one embodiment. As can be seen, the diagram 1500 comprises a motor 1502 for turning a cylinder 1522. A gear box 1504 is attached to the motor 1502 for adjusting the turning speed of the cylinder 1522. A spring plate inductor 1506 is connected to the gearbox to change turning directions of the cylinder 1522. A bearing bracket 1508 connects the spring plate inductor 1506 to an inductor coil assembly 1510 and is used to determine the direction that the user is moving the hair styling tool. A magnetic conductor cover 1512 covers a contact covers a magnetic conductor pole 1514 that is used in conjunction with the inductor coil assembly 1510 to determine the direction that the user is moving the hair styling tool. A contact cover 1516 is affixed to the magnetic conductor pole 1514 and to a sensor contact bracket 1518 to move the magnetic conductor pole along the inductor coil assembly 1510 generating electrical impulses that indicate a direction of movement of the cylinder 1522. A barrel shaft 1520 is affixed to the contact cover 1516, the cylinder 1522 and an end cap 1524 to support the cylinder 1522 during hair styling or brushing.

[0086] In a preferred embodiment, the inductor coil assembly 1510 is an air spaced inductor coil. Additionally, the magnetic conductor pole is selected from the group of magnetic field inducing materials and preferably iron.

[0087] The air gapped inductor coil detector automatically identifies and selects the proper rotation direction of the cylinder 1522 for each pass through the user's hair ensuring optimum brushing, smoothing and styling of each hair section. This frees the user from having to deliberately determine and select the direction of rotation in a manual or semi-automated manner or having the device select a default direction of rotation regardless of true optimal direction.

[0088] In one embodiment of this invention the barrel shaft 1520, the cylinder 1522 and the end cap 1524 are is mechanically coupled to an iron magnetic conductor pole 1514 that is movable in and out of an air gapped inductor coil 1510. Nominal inductance of the air gapped inductor coil varies between 75uh to 185uh depending on the location of the iron magnetic conductor pole 1514 with respect the air gapped inductor coil 1510. The inductor coil 1510 is designed as a part of an RLC tank oscillator that will change the oscillation frequency output of an operational amplifier 1608 between 8 KHz to 8.88 KHz.

[0089] With reference to FIG. 16, there is shown a circuit diagram 1600 for controlling the direction of the cylinder using the detector of FIG. 15. The circuit comprises at least one microcontroller 1602 used to control the motor's 1502 speed and direction during styling or brushing. Outputs 1604 and 1606 are used to change the direction of the cylinder 1522. An operational amplifier 1608 is used to increase the electrical field created by movement of the iron magnetic conductor pole 1514 in relation to the inductor coil assembly 1510. When sufficient change in the induced frequency is detected by the RLC tank circuit 1612 the operational amplifier drives the output 1606 overriding output 1604 thereby changing direction of the motor 1502 and the cylinder 1522.

[0090] When the user places as little as a single strand of hair into the hair styling tool 1300 and begins to move the hair styling tool 1300 in a direction, the magnetic conductor pole 1514 changes position and an electricity is conducted through the inductor coil assembly 1510. The amount of electricity generated by the movement of the magnetic conductor pole 1514 in proximity to the inductor coil assembly 1510 is detected by the RLC tank 1612, the operational amplifier 1608 and the microcontroller 1602. Once the amount of movement has been determined by the circuit 1600, the motor is driven in the same direction as the movement of the hair styling tool 1300.

[0091] With reference to FIGs. 17 and 18, there is shown a graph 1700 of a tank circuit and output frequency when an inductor L1 in the circuit of FIG. 18 is 185uh and output frequency when the inductor L1 in the circuit of FIG. 16 is 75.5uh respectively. Each graph 1700 and 1800 show the amount of change in a typical embodiment of the inductor coil assemble 1510 and the magnetic conductor pole 1514 for directional movement of the hair styling tool 1300 when used by the user.

[0092] With reference to FIG. 19, there is shown a flowchart diagram 1900 of an induction sensor system for automatically reversing direction of a hair styling tool 1300. First, the hair styling tool 1300 is plugged into an outlet 1902. Then, the user presses the on/off button 1904 into the on position. Next, the sensor is reset 1906. Then, inductor limits, L-Max and L-Min are determined 1908. Due to variation of absolute inductor value due to environmental conditions, manufacturing variance and component tolerances, the extreme frequency ranges are examined by a microcontroller 1602 at the beginning of each operation where the microcontroller 1602 monitors and measures the output frequency of tank oscillator circuitry 1612. Once power up calibration is completed, the microcontroller 1602 then automatically place the inductor 1510 in the center location and frequency variation with respect to the center frequency is then detected as counter-clock-wise (CCW) or clock-wise

(CW) rotation. Next, the motor is stopped 1910. If the user closes the handle 1912, then begins pulling hair 1914 through the hair styling tool 1300, the motor rotates in the related sensor direction 1916. If the user releases the handle 1918, then the motor is reset and the inductor limits for L-Max and L-Min are determined 1920 again. Each step from the motor stop is repeated until the user releases the handle 1918 and is finished hair styling 1922.

[0093] In another embodiment, there is provided a method to style a person's hair using the styling tool 1300. The user can style their hair by first selecting the tool 1300. Next, turning on the switch 1304 and allowing the heater to heat the cylinder 1322, the styling arm 1314 or both the cylinder 1322 and the styling arm 1314. Then, placing the user's hair between the cylinder 1322 and the styling arm 1314 near the scalp with the styling arm 1314 in an open position. Next, moving the styling arm 1314 to a closed position thereby causing the switch 1303 to activate the motor 1308 to rotate the cylinder 1322 and while the cylinder 1322 is rotating, styling the hair by pulling the tool toward the tips of the hair.

[0094] Although the present invention has been described with a degree of particularity, it is understood that the present disclosure has been made by way of example. As various changes could be made in the above description without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be illustrative and not used in a limiting sense.

CLAIMS

1. A tool suitable for hair styling comprising:

a body having a proximate end and a distal end;

a cylinder extending from the body, the cylinder being rotatable relative to the body in both a clockwise direction and a counterclockwise direction;

a motor adapted to rotate the cylinder both clockwise and counterclockwise;

a heater to heat the cylinder;

a non-rotatable styling arm supported by the body, the styling arm being movable between an open position distant from the cylinder and a closed position proximate to the cylinder for hair styling; and a detector for detecting the direction of movement of the styling arm along a user's hair, the detector being in communication with the motor for causing the motor to rotate the cylinder in a direction corresponding to the direction of movement of the styling arm along the user's hair where the detector comprises an inductor coil assembly.

2. The tool of claim 1, where the inductor coil assembly comprises:

(i) a magnetic conductor pole electrically connected to the inductor coil assembly;

(ii) a RLC tank circuit electrically connected to the inductor coil assembly; and

(iii) a microcontroller electrically connected to the RLC tank circuit for changing direction of the movement of the rotating cylinder along the user's hair.

3. The tool of claim 2, where the tool suitable for hair styling comprises an elongated body and a cylinder that rotates relative to the body in both a clockwise direction and a counterclockwise direction determined by movement of the magnetic conductor pole of the inductor coil assembly.

4. The tool of claim 3, where the inductor coil assembly comprises a rotatable member that is mechanically coupled to a shaft that is movable in and out of an air gapped inductor coil.

5. The tool of claim 4, where the shaft is made from a magnetic field inducing material.

6. The tool of claim 4, where nominal inductance of the air gapped inductor coil is between 75 *u*h to 185 *u*h depending on the shaft location with respect to the air gapped inductor coil.

7. The tool of claim 4, where the RLC tank oscillator has an oscillation frequency output by an operational amplifier between 8 KHz to 8.88 KHz.

8. A tool suitable for hair styling comprising:

a) an air gapped inductor coil detector for detecting the direction of movement of the styling arm;

b) a motor for turning a cylinder;

c) a gear box attached to the motor for adjusting the turning speed of the cylinder;

d) a spring plate inductor connected to the gearbox to change turning directions of the cylinder;

e) a bearing bracket connecting the spring plate inductor to an inductor coil assembly used to determine the direction that the user is moving the hair styling tool;

f) a magnetic conductor cover covering a magnetic conductor pole used in conjunction with the inductor coil assembly to determine the direction that the user is moving the hair styling tool,

where the contact cover is affixed to the magnetic conductor pole and to a sensor contact bracket to move the magnetic conductor pole along the inductor coil assembly; and

g) a barrel shaft affixed to the contact cover, the cylinder and an end cap to support the cylinder during hair styling or brushing.

9. The tool of claim 8, where the magnetic conductor pole comprises magnetic field inducing materials.

10. The tool of claim 9, where the magnetic conductor pole is preferably iron.

11. The tool of claim 8, where the air gapped inductor coil detector automatically identifies and selects the proper rotation direction of the cylinder for each pass through the user's hair.

12. The tool of claim 8, where the barrel shaft, the cylinder and the end cap are mechanically coupled to an iron magnetic conductor pole that is movable in and out of the air gapped inductor coil.

13. The tool of claim 8, where the nominal inductance of the air gapped inductor coil is between 75*u*h to 185*u*h depending on the location of the iron magnetic conductor pole with respect the air gapped inductor coil.

14. The tool of claim 8, where the inductor coil is operably connected to an RLC tank oscillator that changes the oscillation frequency output of an operational amplifier between 8 KHz to 8.88 KHz.

15. The tool of claim 8 further comprising a circuit for controlling the direction of the cylinder using the inductor coil assembly.

16. The tool of claim 15, where the circuit comprises at least one microcontroller used to control the motor's speed and direction during styling or brushing.

17. A method for operating a tool suitable for hair styling comprising the steps of:

a) placing at least a single strand of hair into the hair styling tool;

b) moving the hair styling tool in a direction causing a magnetic conductor pole to change position causing electricity to be conducted through an inductor coil assembly;

c) detecting the amount of electricity generated by the movement of the magnetic conductor pole in proximity to the inductor coil assembly by a circuit, where the circuit comprises:

1) an RLC tank;

2) an operational amplifier; and

3) at least one microcontroller; and

d) driving a motor in the same direction as the movement of the hair styling tool detected by the circuit.

18. A method of using a tool suitable for hair styling comprising an induction sensor system for automatically reversing direction of a hair styling tool comprising the steps of:

a) plugging the tool into an outlet;

b) a user presses an on/off button into the on position;

c) resetting a sensor;

d) determining inductor limits, L-Max and L-Min by moving a motor in two directions;

e) examining extreme frequency ranges by a microcontroller at the beginning of each operation,

where the microcontroller monitors and measures the output frequency of a RLC tank oscillator circuitry;

f) automatically placing the inductor in a center location;

g) detecting a frequency variation with respect to the center frequency as counter-clock-wise (CCW) or clock-wise (CW) rotation; and

h) stopping the motor;

i) If the user closes the handle and begins pulling hair through the tool, rotating the motor in the related sensor direction;

j) If the user releases the handle, then the motor is reset and the inductor limits for L-Max and L-Min are determined again; and

k) repeating steps a from a) through j) until the user releases the handle and is finished hair styling.

FIG. 1

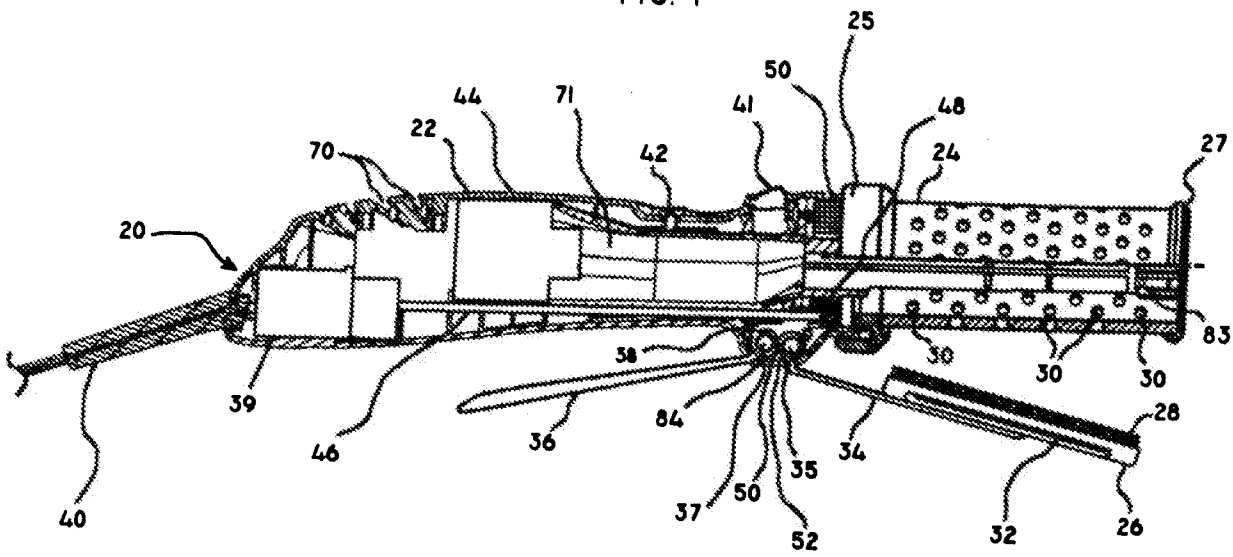

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FIG. 2

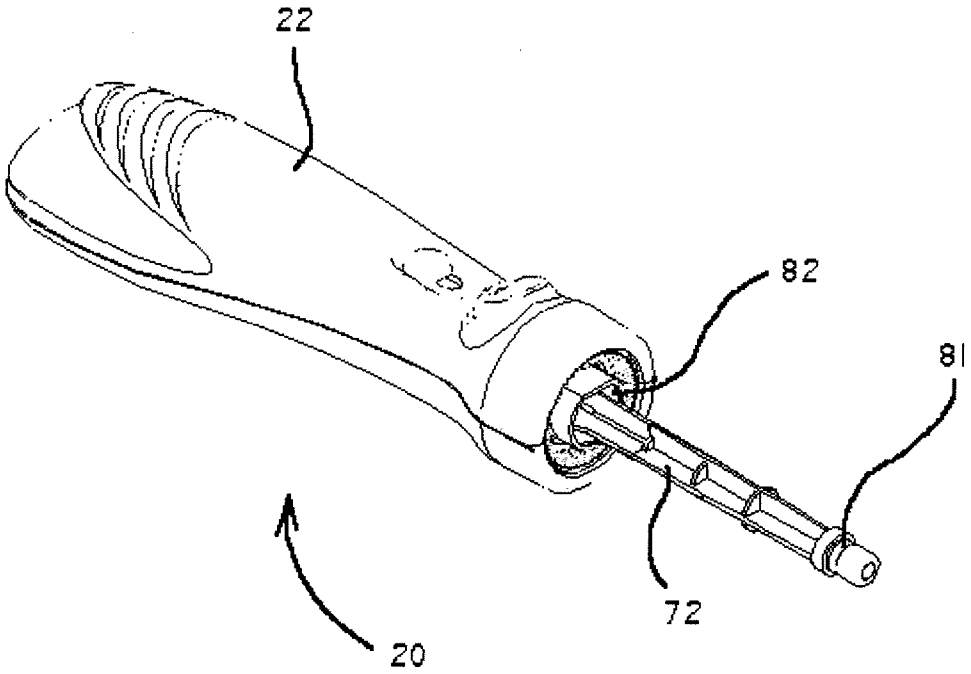


FIG. 3A

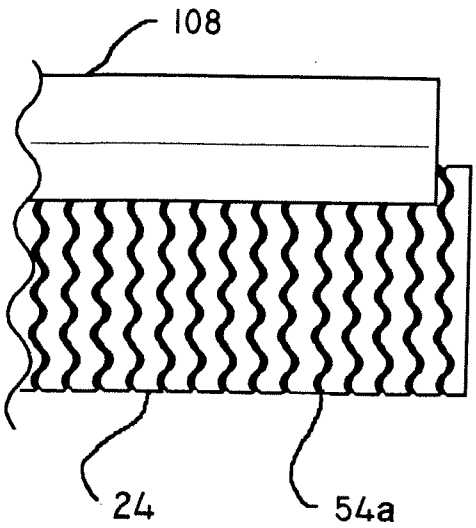


FIG. 3B

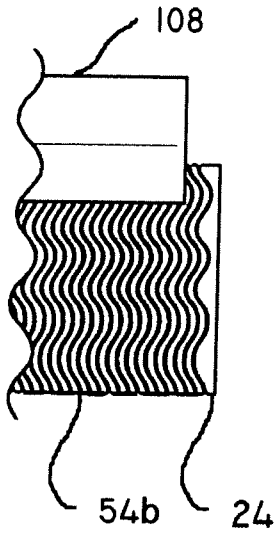


FIG. 3C

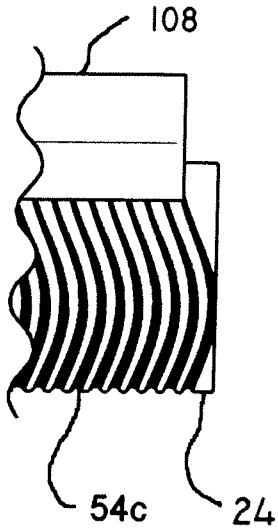


FIG. 3D

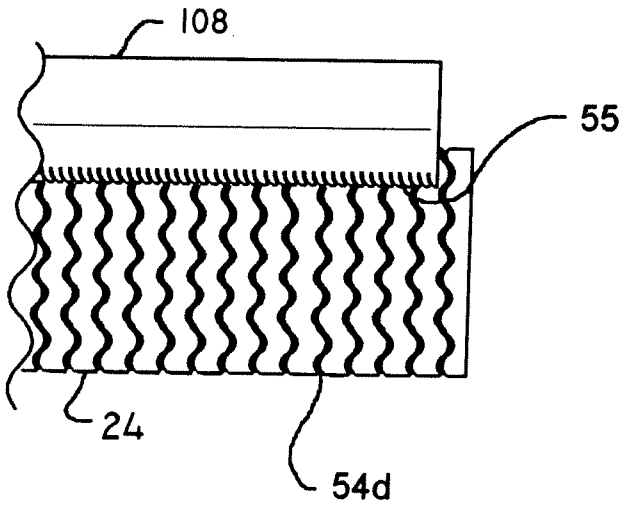


FIG. 4

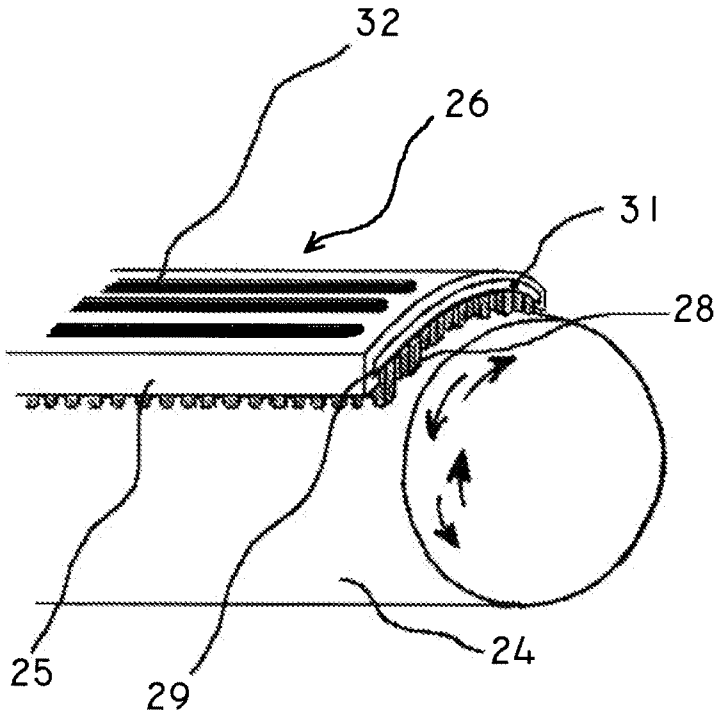


FIG. 5

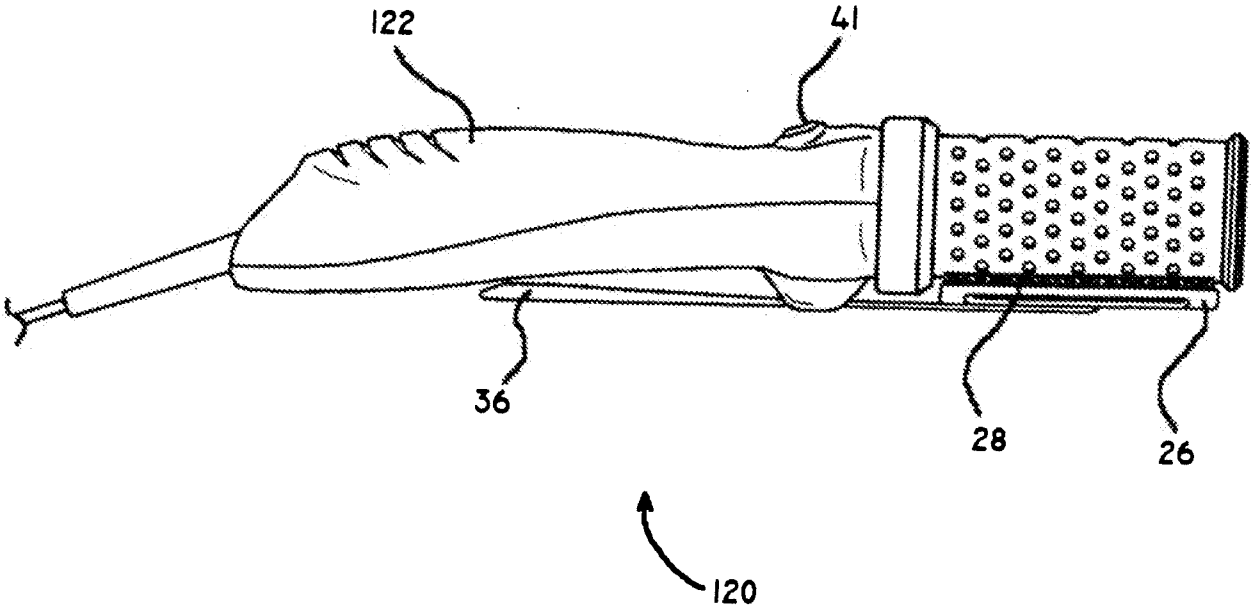


FIG. 6

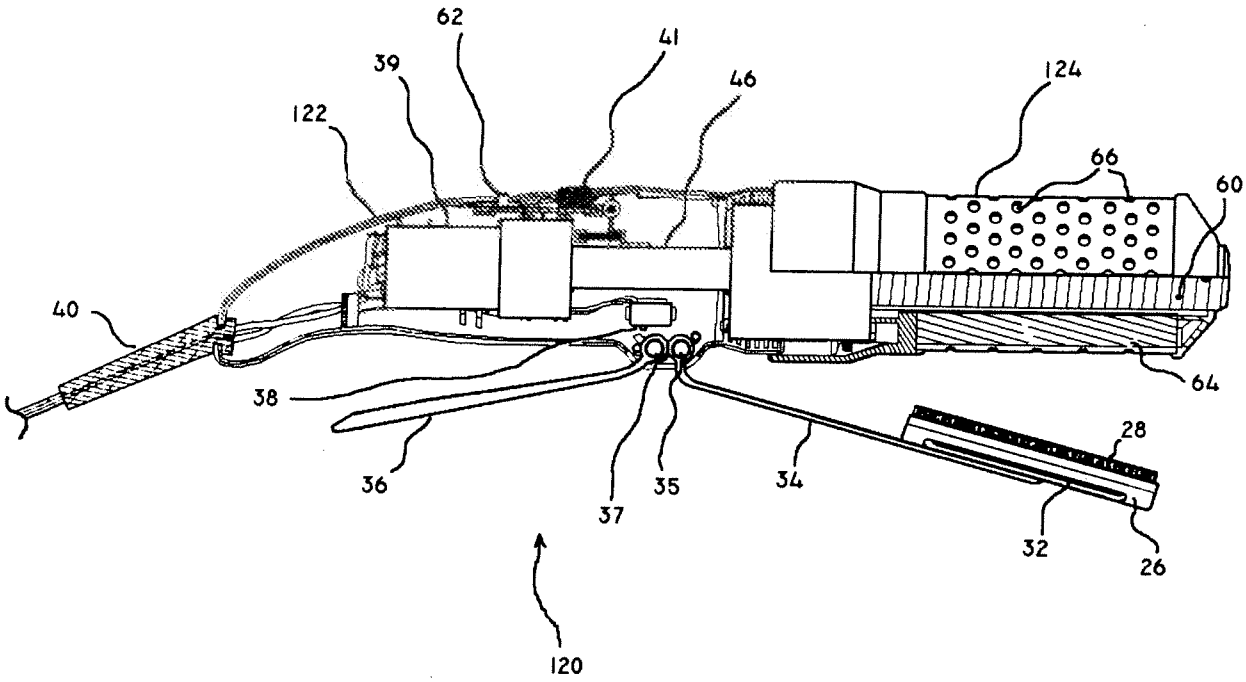


FIG. 7

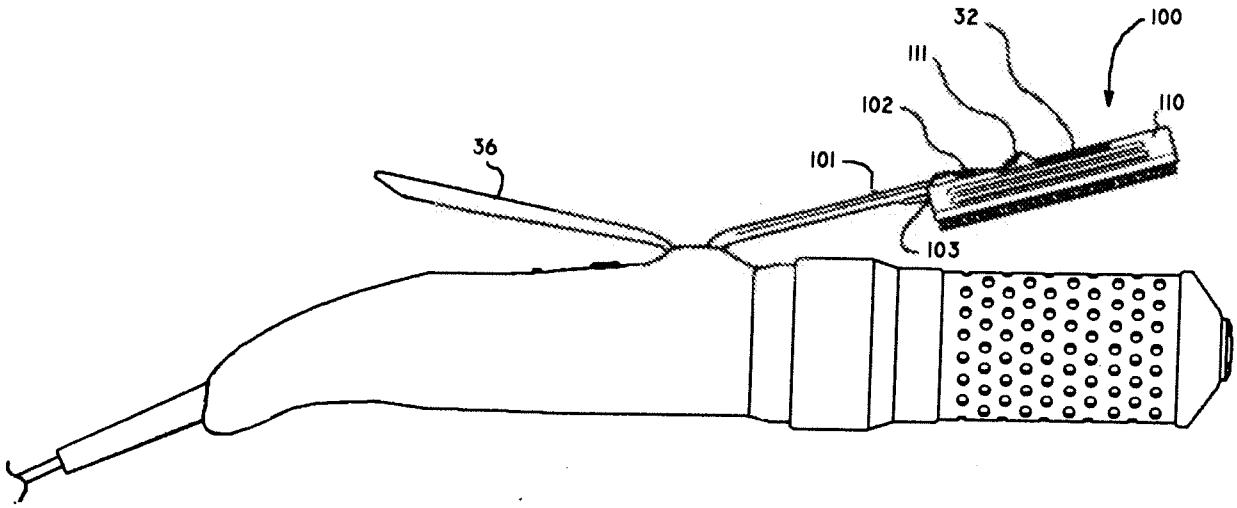


FIG. 8A

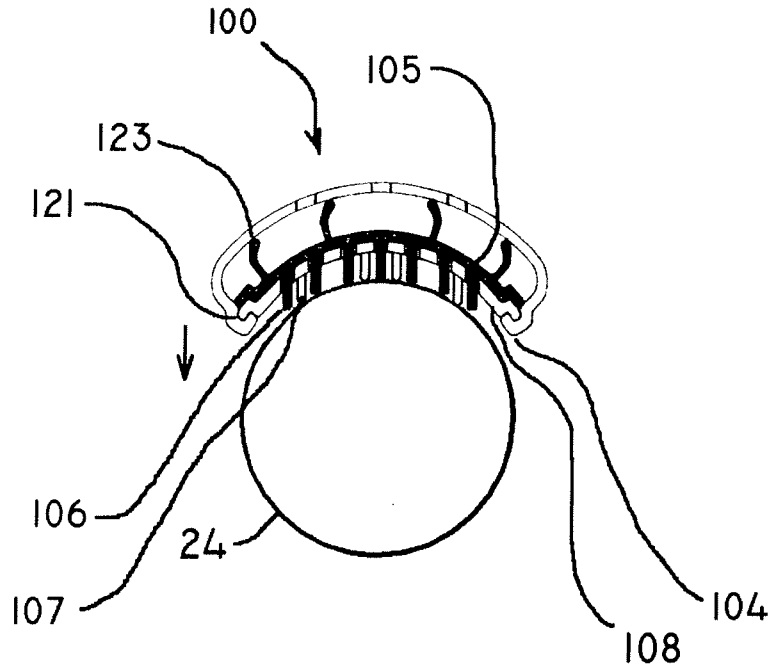


FIG. 8B

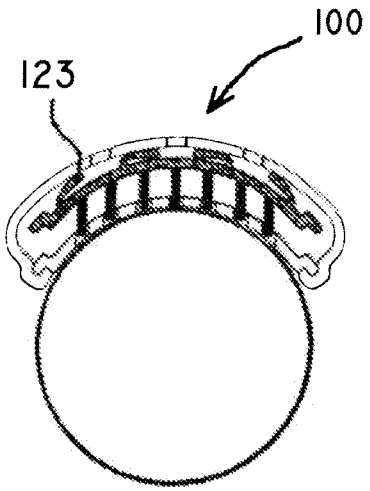


FIG. 8C

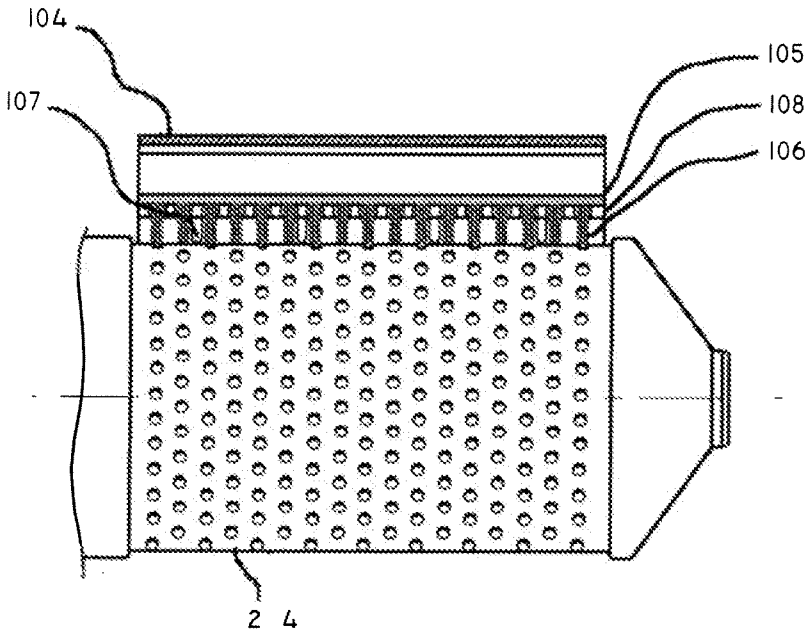


FIG. 8D

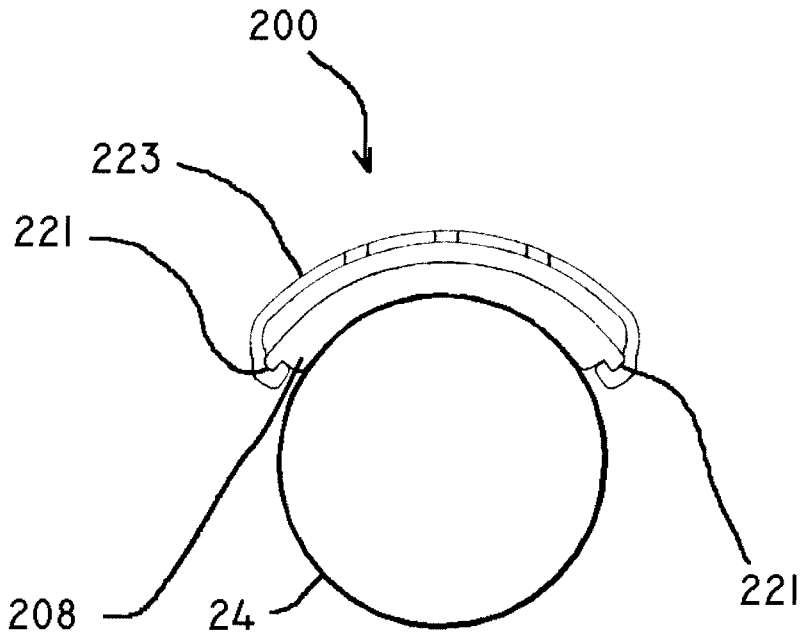


FIG. 9A

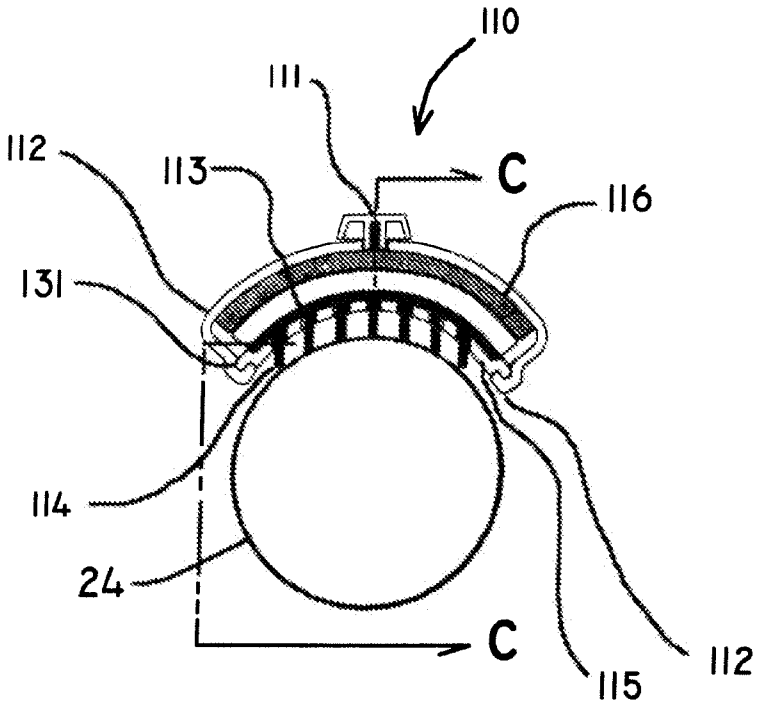


FIG. 9B

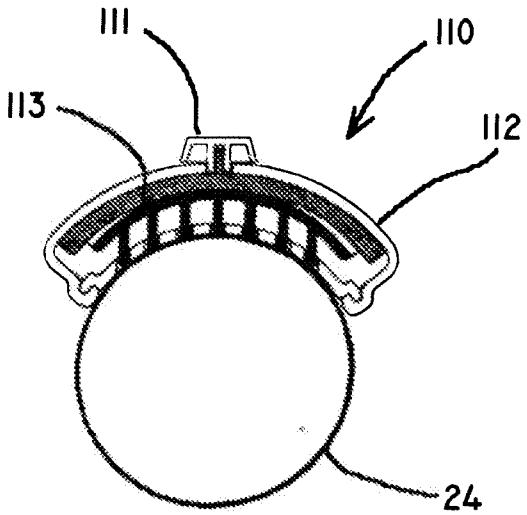


FIG. 9C

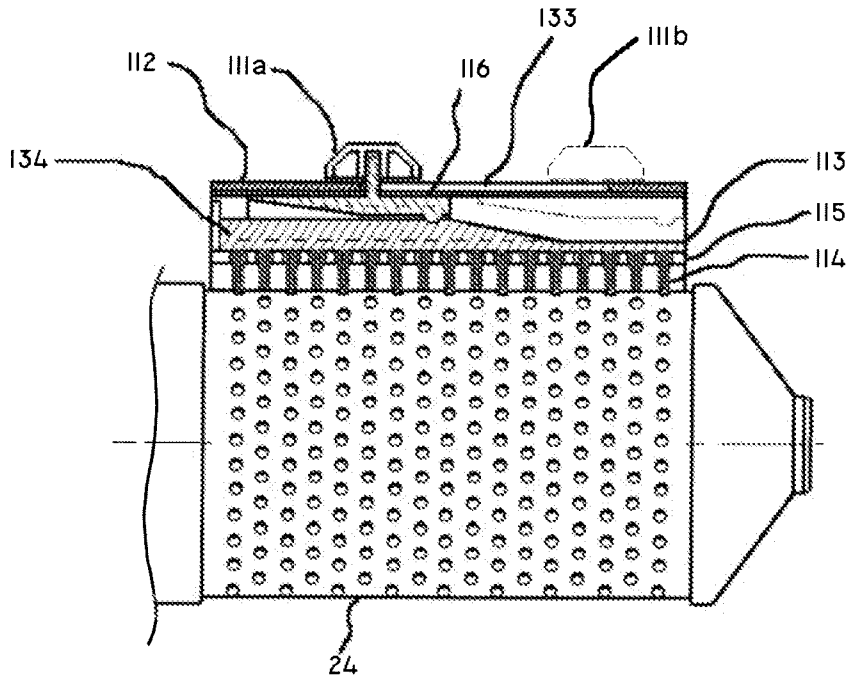


FIG. 10

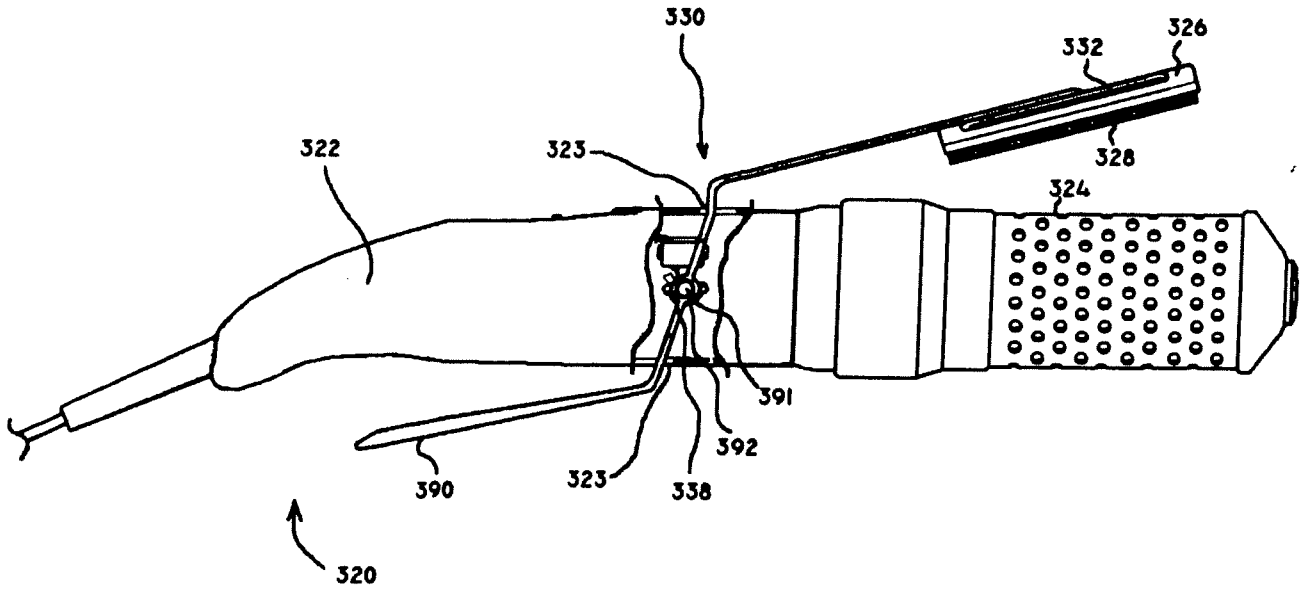


FIG. 11

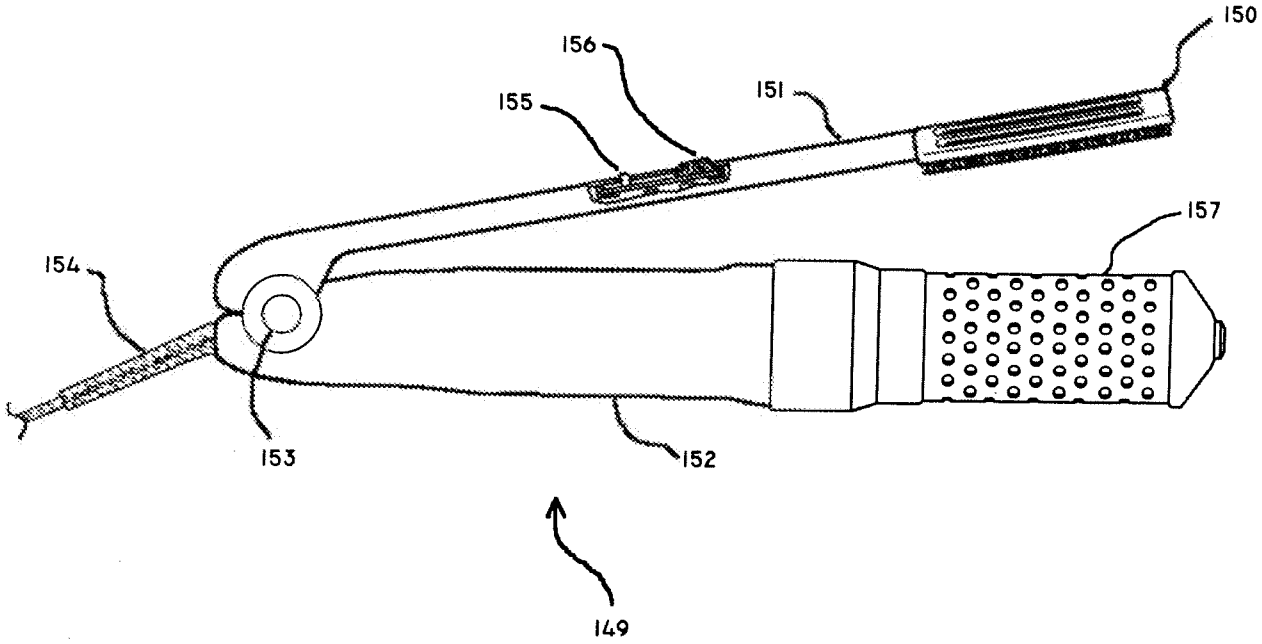
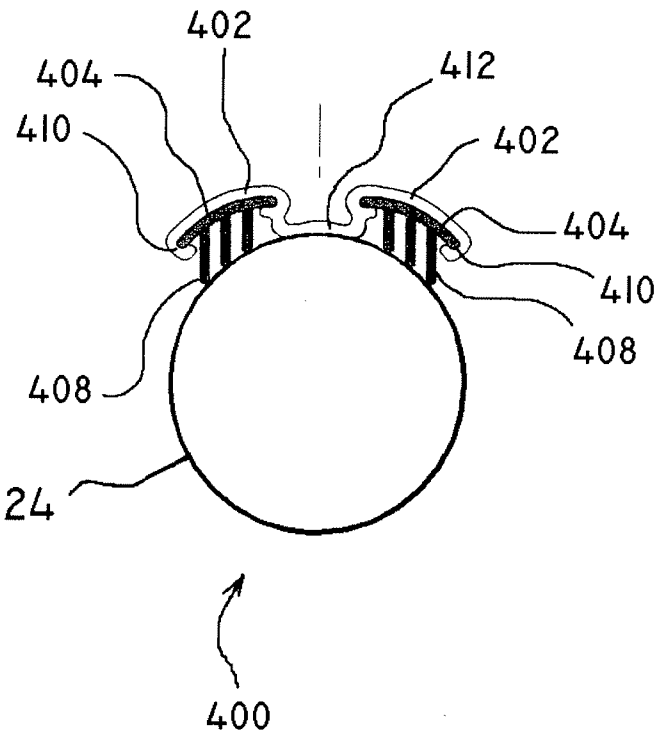


FIG. 12



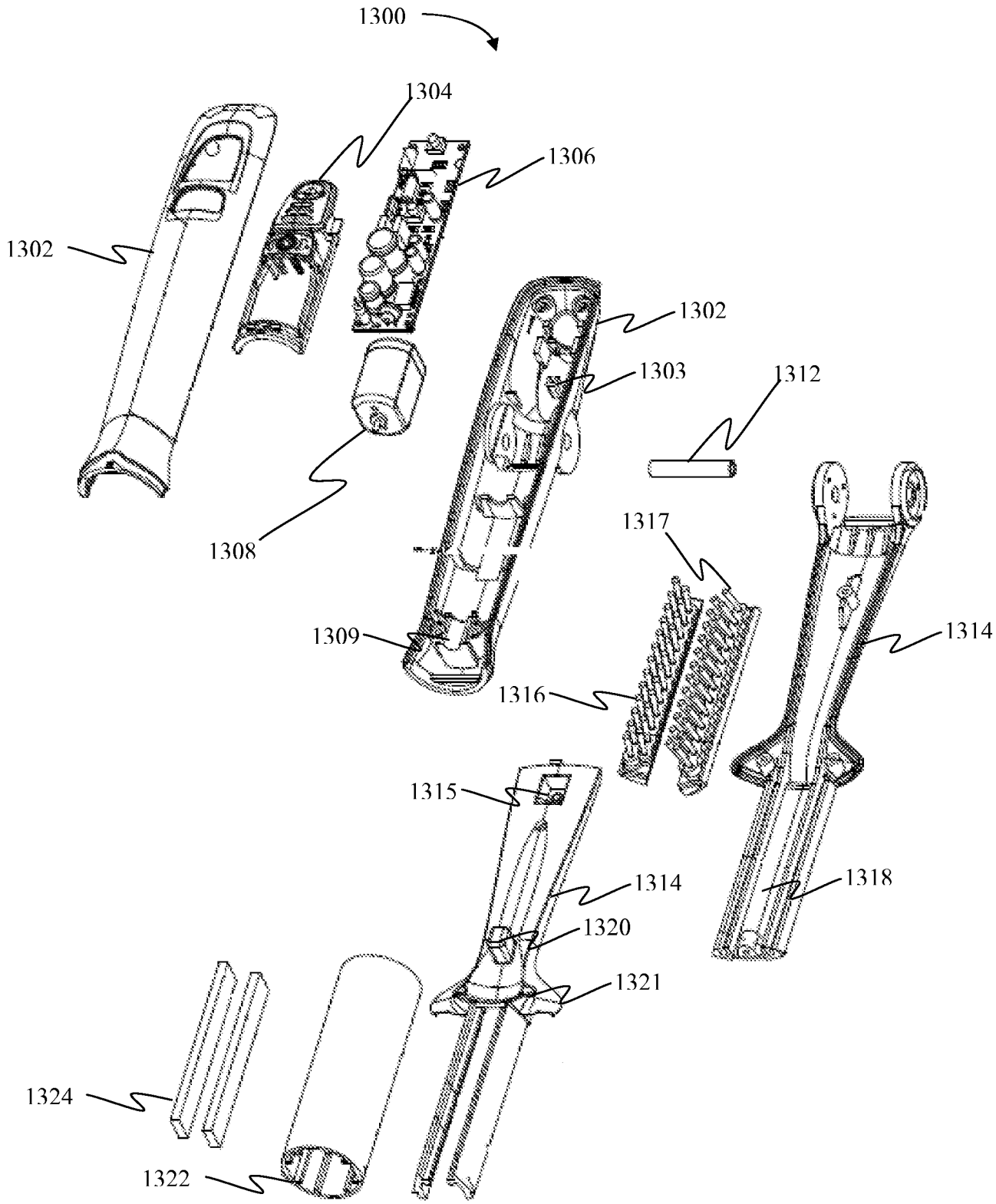

1300
1304
1306
1302
1302
1303
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1308
1317
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1322

Figure 13

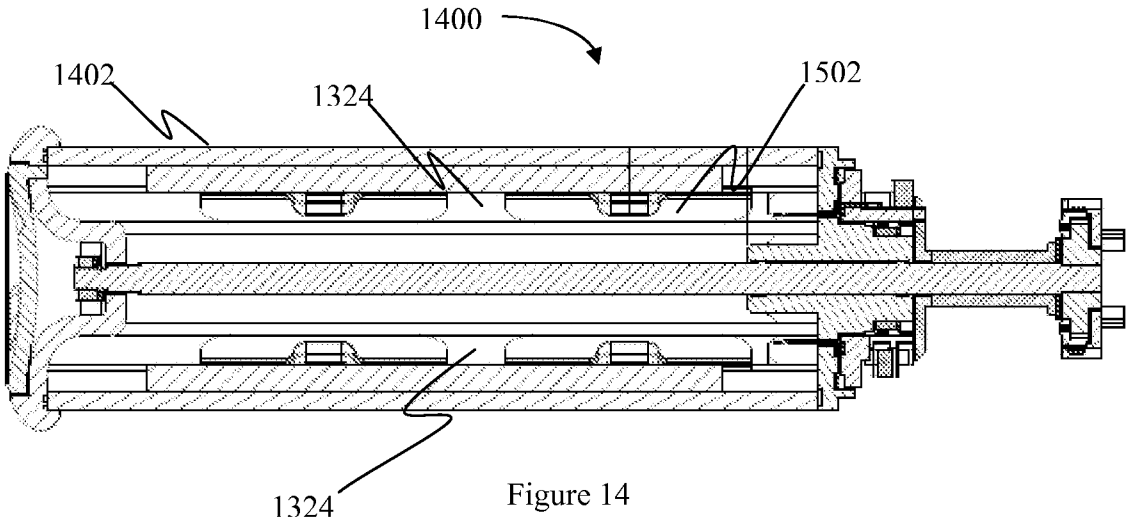


Figure 14

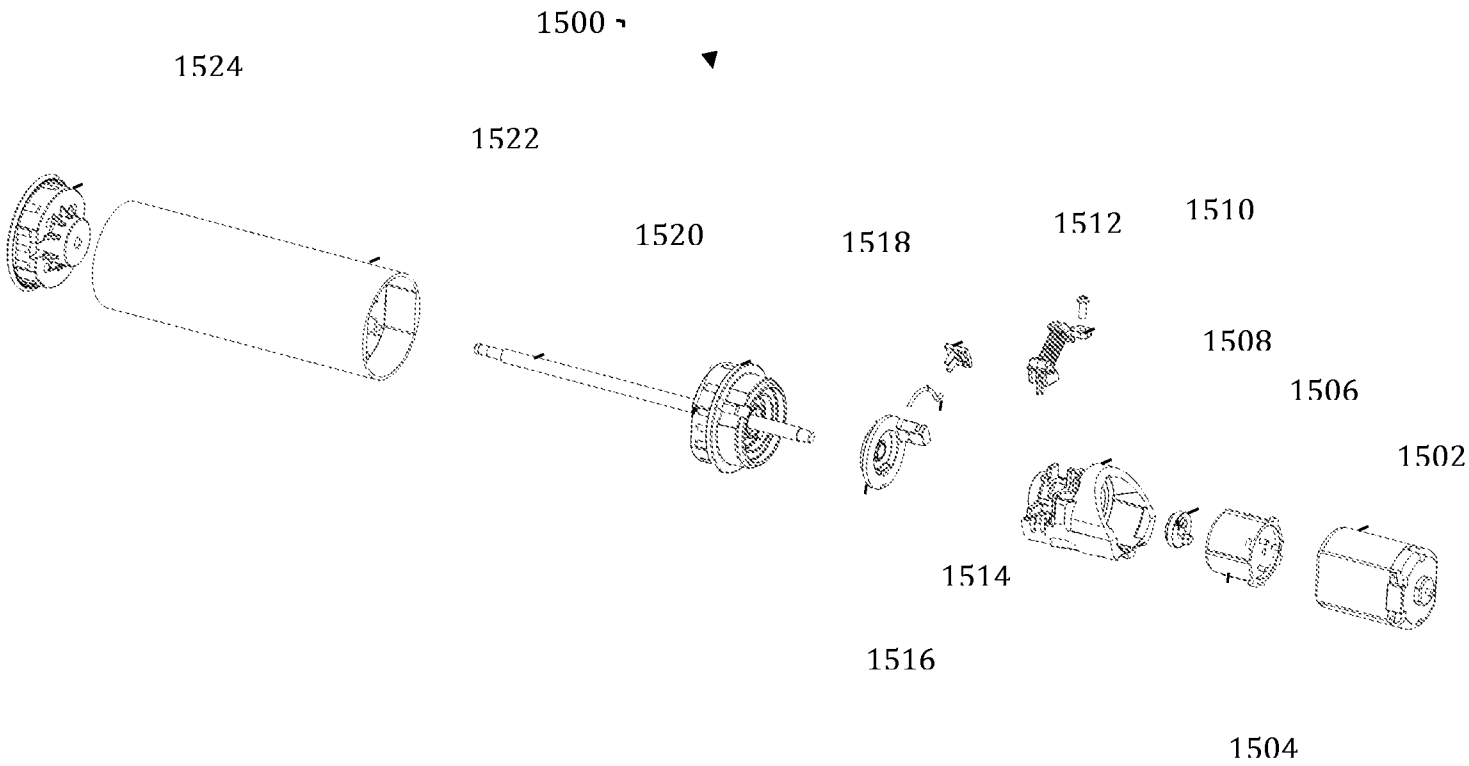

1500
1524
1522
1520
1518
1512
1510
1508
1506
1502
1514
1516
1504

FIG. 15

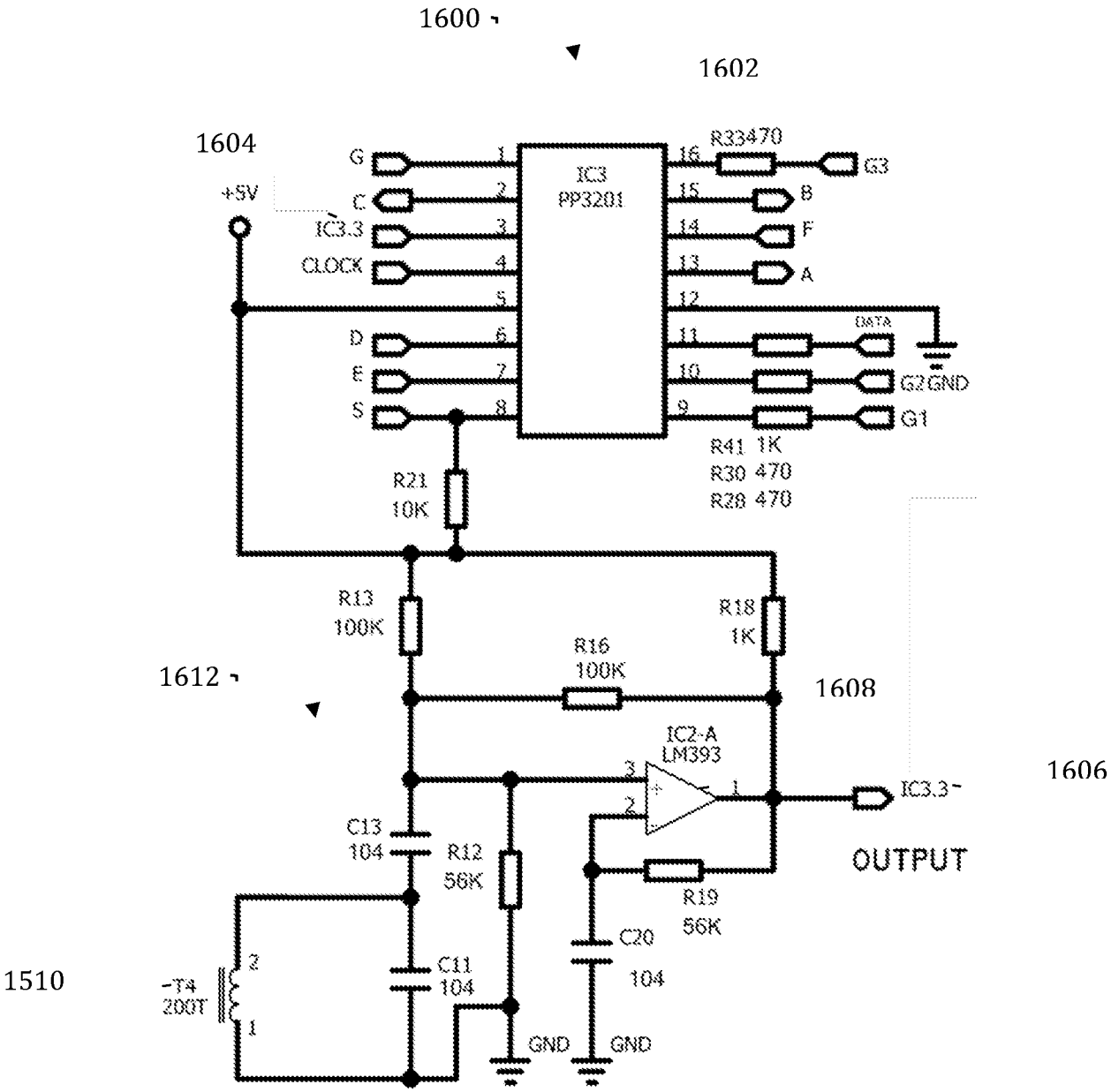

1600
1602
1604
1606
1608
1612
1510
IC3
PP3201
G
C
IC3.3
CLOCK
D
E
S
+5V
R33470
G3
B
F
A
DATA
G2 GND
G1
R41 1K
R30 470
R28 470
R21
10K
R13
100K
R16
100K
R18
1K
IC2-A
LM393
IC3.3
OUTPUT
C13
104
R12
56K
R19
56K
C20
104
C11
104
T4
200T
GND
GND

FIG. 16

1700

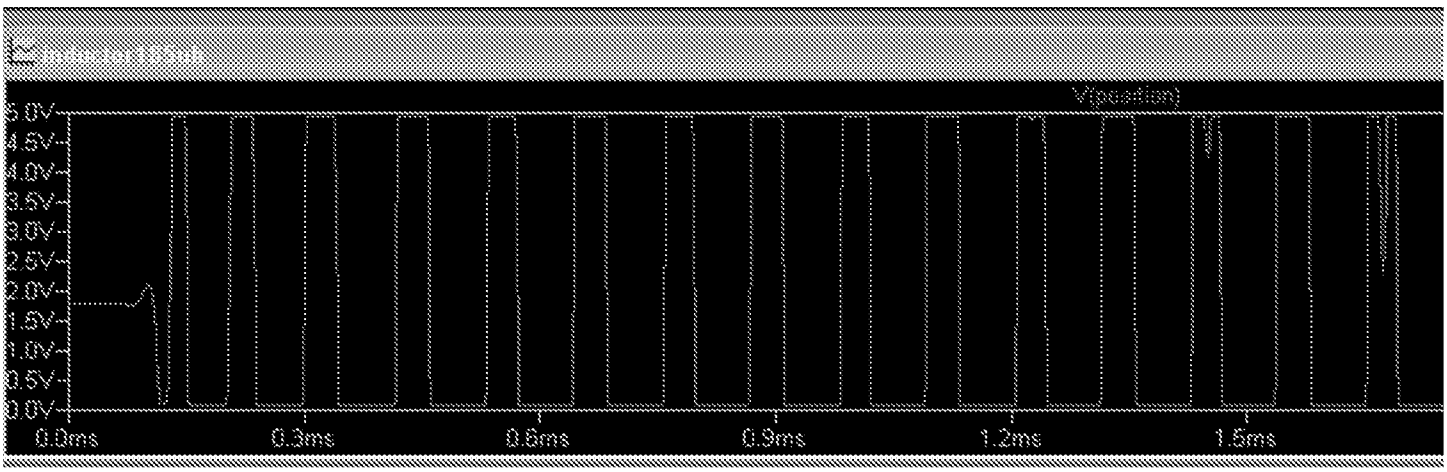


FIG. 17

1800

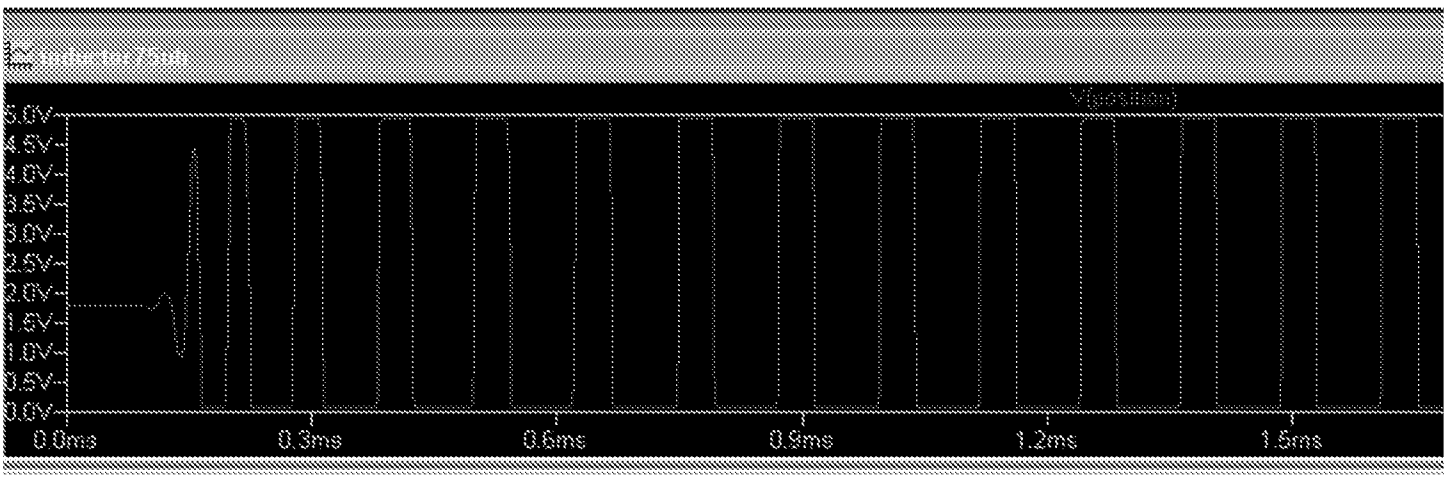


FIG. 18

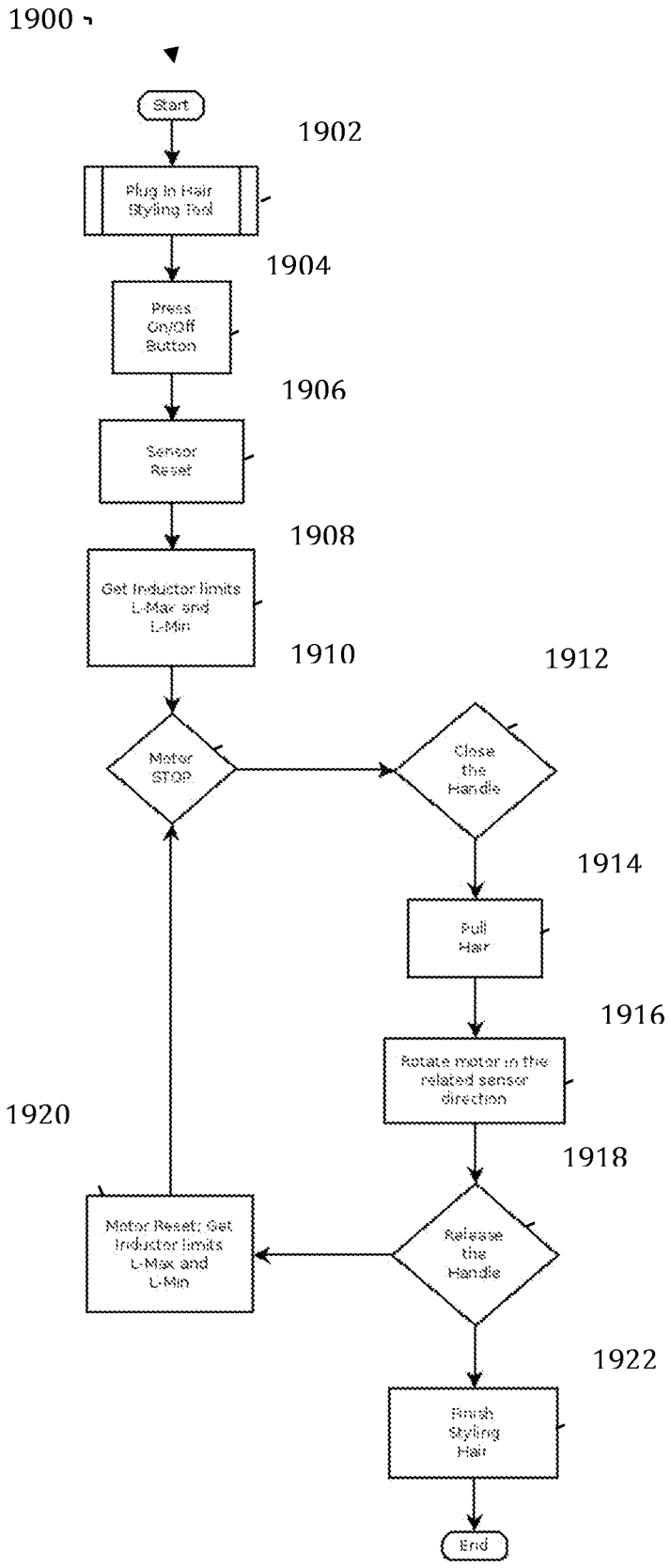

1900
Start
1902
Plug in Hair Styling Tool
1904
Press On/Off Button
1906
Sensor Reset
1908
Get Inductor limits L-Max and L-Min
1910
1912
Motor STOP
Close the Handle
1914
Pull Hair
1916
Rotate motor in the related sensor direction
1918
1920
Release the Handle
Motor Reset; Get Inductor limits L-Max and L-Min
1922
Brush Styling Hair
End

FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/043910

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A45D 2/36 (2013.01)
USPC - 132/238
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) - A45D 1/04, 1/20, 2/36, 6/02, 6/20, 7/02, 20/00 (2013.01)
USPC - 15/23, 141.2, 179; 132/211, 227, 229, 236-238, 269; 219/222, 225, 227, 240; 331/12, 13, 117R, 167

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - A45D 1/02, 1/20, 2/36, 2/367, 6/02 (2013.01)

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0043818 A1 (RAGOSTA et al) 25 February 2010 (25.02.2010) entire document	1-3, 17
Y	US 7,469,838 B2 (BROOKS et al) 30 December 2008 (30.12.2008) entire document	1-3, 17
A	EP 0 357 397 A2 (CRAIG) 07 March 1990 (07.03.1990) entire document	1-18
A	US 4,480,218 A (HAIR) 30 October 1984 (30.10.1984) entire document	1-18
A	US 5,392,018 A (COLLINS et al) 21 February 1995 (21.02.1995) entire document	1-18

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

* 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
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"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
14 October 2013	22 OCT 2013
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