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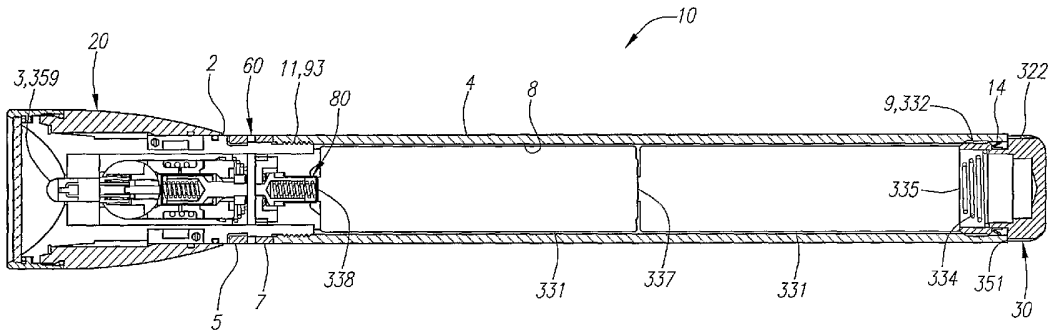
(54) Title: APPARATUS AND METHOD FOR ALIGNING A SUBSTANTIAL POINT SOURCE OF LIGHT WITH A REFLECTOR FEATURE



(57) Abstract: A combination for use in aligning a substantial point source of light with respect to an axis of a reflector is provided. The combination includes a reflector, a light source having a subtantial point source of light, and a movable light source holder. The movable holder may be moved using an actuating member. The relector has a first open end for emitting a light beam, a second end and an axis extending between the first and second reflector ends. The light source is secured to the movable holder and is disposed about the second end of the reflector. The actuating member is operatively coupled to the movable holder at an actuation interface for moving the substantial point source of light relative to the axis of the reflector and aligning the susbtantial point source of light with the reflector axis and the focal point of the reflector. Flashlights employing the combination are provided.

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SPECIFICATION

Apparatus And Method For Aligning A Substantial Point Source Of Light With A Reflector Feature

Background

The field of the present invention relates to hand held or portable lighting devices, including flashlights and flashlight components.

Various hand held or portable lighting devices, including flashlight designs, are known in the art. Flashlights typically include one or more dry cell batteries having positive and negative electrodes. In certain designs, the batteries are arranged in series in a battery compartment of a barrel or housing that can be used to hold the flashlight. An electrical circuit is frequently established from a battery electrode through conductive means which are in electrical contact with an electrode of a lamp bulb. After passing through the lamp bulb, the electric circuit continues through a second electrode of the lamp bulb in electrical contact with conductive means, which in turn are in electrical contact with the other electrode of a battery. Incandescent lamp bulbs include a bulb filament. Typically, the circuit includes a switch to open or close the circuit. Actuation of the switch to close the electric circuit enables electricity to pass through the lamp bulb and though the filament, in the case of an incandescent lamp bulb, thereby generating light.

The light generated by a filament is typically reflected by a reflector to produce a beam of light. The filament typically includes a substantial point source of light which is the hottest portion of the filament and generates the most light. The position of the substantial point source of light of the filament relative to the reflector determines the type of beam that emanates from the flashlight.

The production of light from flashlights, which include headlamps, can be degraded by the quality of the reflector used and the optical characteristics of the lens interposed in the beam path. As a result, efforts at improving flashlights have often attempted to address the quality of the optical characteristics of the reflector or the lens. For example, more highly reflective, well-defined reflectors have been found to provide a better-defined focus thereby enhancing the quality of the light beam produced. Additionally, certain advances have been achieved with respect to the lens materials. Another significant factor in the quality of light produced by a flashlight is the lamp bulb used in the flashlight. Several improvements have been made in the light emitting qualities of lamp bulbs.

Despite such efforts, there is still a need to improve the quality and intensity of the light produced by known hand held or portable lighting devices, including flashlights. The light pattern formed by the beam emanating from such light devices is frequently asymmetrical or elongated in shape which adversely impacts on the quality and intensity of the beam. These beam aberrations generally result from the fact that the flashlight lamp bulb is not properly aligned with the reflector of the assembled flashlight.

In various designs, the lamp bulb is supported within the lighting device by a holder or spacer within a battery compartment or barrel and extends into a reflector. Due to manufacturing and assembly operations and tolerances, however, after manufacture of the lighting device is fully completed, the lamp is typically misaligned with the reflector, resulting in degraded performance.

One attempt at addressing the misalignment of the lamp bulb is described in U.S. Patent No. 5,260,858, by A. Maglica, which is hereby incorporated by reference. This patent describes a flashlight that includes a switch housing that partially floats within the barrel thereby helping to center the lamp bulb relative to the reflector. Although this patent's attempt to avoid a misalignment of the lamp bulb to the reflector is an improvement over the prior art, simply aligning the lamp bulb relative to the reflector does not ensure that aberrations in the projected light beam will be eliminated. This is because light is mostly emitted from the substantial point source of light of the lamp bulb. Accordingly, the critical component of the lamp that must be aligned relative to the reflector is the substantial point source of light of the lamp bulb.

An attempt at aligning the substantial point source of light of a lamp bulb to the reflector is described in the co-pending application Serial No. 09/932,443, which is hereby incorporated by reference. This application describes a combination that includes a lamp base that secures a lamp bulb in such a way that the lamp bulb filament is aligned to a predetermined axis extending through the lamp base. The lamp base is then seated in a base receiver mounted adjacent to the reflector in a way that the predetermined axis of the lamp base is aligned to the axis of an axisymmetrical reflector. Although alignment of a lamp bulb filament to the reflector axis is significantly improved in this manner, alternate means to align the lamp bulb filament to the reflector axis are desirable.

Manually maneuvering the lamp bulb to address the misalignment problem is impractical. During operation, the temperature of an illuminating lamp bulb is too high to allow for manual adjustment. Also, the alignment of the substantial point source of light with the reflector is verified by assessing the quality of the

light beam emanating from the light device. Accordingly, any attempt to maneuver the lamp bulb from the forward end of the light device will block the light beam and prevent the user from performing a contemporaneous visual assessment of the beam.

The present invention provides an apparatus and method for adjusting and maintaining alignment of the substantial point source of light with a characteristic feature of the reflector. The present invention further provides an apparatus and method for the user to perform a contemporaneous visual assessment of the light beam as the substantial point source of light adjustment is being performed.

Another feature of the present invention relates to the switch design. Switch designs that are adapted to close an electrical path between the lamp bulb and battery, or batteries, in response to axial movement of the head along the barrel and to open the electrical path in response to axial movement in the opposite direction along the barrel are known. While such switches have generally worked well for flashlights that employ smaller batteries of the AA or AAA type, known designs are less suitable for flashlights that employ larger battery sizes, such as C or D size batteries. One reason such designs are not well suited for flashlights employing larger batteries is that the positive electrode of the battery closest to the head end of the flashlight is urged against a conductor mounted flush against the bottom of the switch. As a result, the battery or batteries or the conductor may become damaged in the event that the flashlight is shaken or dropped. The problem also becomes more acute as the number of batteries connected in series increases due to the added weight, and hence momentum, of the multiple batteries.

One attempt at addressing the problem of damage that may occur to the battery or batteries due to physical impact to a flashlight is described in U.S. Patent No. 5,804,331, by A. Maglica, which is hereby incorporated by reference. Although a protection to the battery electrodes is improved in the manner described in U.S. Patent No. 5,804,331, alternate means to protect the batteries and other components of a portable lighting device, such as a flashlight, are desirable.

The development of lighting devices having a variable focus, which produces a beam of light having variable dispersion, has also been accomplished. In flashlights, the head assembly is typically rotatably connected to the barrel of the flashlight at the end where the bulb is retained. In addition, the head assembly is adapted to be controllably translatable along the barrel such that the relative positional relationship between the reflector and the lamp bulb may be

varied, thereby varying the dispersion of the light beam emanating through the lens from the lamb bulb. While variable focus flashlights have also employed switches that are adapted to open and close in response to the axial movement of the head assembly, such flashlights have generally been limited to flashlights employing AA and AAA batteries for a variety of reasons, including some of those described above.

Summary Of The Invention

An object of the present invention is to provide new lighting devices, preferably lighting devices that ameliorate or address one or more of the foregoing problems associated with prior art lighting devices discussed above. To this end, in one aspect of the present invention, a combination for use in positioning a substantial point source of light with a reflector is provided. The substantial point source of light may be along a filament of a lamp bulb. In one embodiment, the combination includes a reflector, a light source, and a movable lamp bulb holder. The reflector has a first open end adapted to emit a light beam, a second end, and an axis extending therebetween. A movable light source holder positions the light source between the first open end and the second end of the reflector. An actuating member may be coupled to the movable light source holder for moving the point source of light relative to the axis of the reflector. A holder axis is defined about which the movable light source holder moves. The actuating member moves the light source and the substantial point source of light by maneuvering the holder axis relative to the reflector axis.

The combination may also include a securing mechanism to maintain the position of the substantial point source of light with the reflector axis after the point source of light of the filament has been aligned with the reflector axis. As a result, the combination advantageously maintains the position of the point source of light once it has been moved to a desired position.

In another aspect of the invention, a flashlight that includes a means for adjusting the position of a substantial point source of light relative to a reflector is provided. The flashlight includes a housing, a reflector, an illumination source, a movable holder, and an electrical circuit. The housing retains one or more batteries. The reflector includes a first open end to emit a light beam, a second end and an axis extending therebetween. The illumination source can comprise an incandescent lamp bulb including a filament and the filament typically includes a substantial point source of light. The movable holder holds the illumination

source extending through the second end of the reflector. The movable holder is adapted to selectively adjust the position of the illumination source relative to the reflector axis in response to an actuation force. The electrical circuit couples the illumination source to the one or more batteries..

The substantial point source of light of the illumination source may be moved in a non-linear path. Further, the flashlight may include means to maintain the position of the point source of light of the illumination source after it is properly aligned with the reflector axis. The flashlight may include an adaptable conductor means in the electrical circuit. As a result, the electrical circuit may be maintained while the point source of light is being moved.

In addition, the flashlight may include an adjustable focusing means to vary the position of the substantial point source of light with respect to the focal point in a direction parallel to the axis of the reflector. The lamp holder holds the substantial point source of light and maintains the operable connection with the battery. The actuating member may be coupled to the movable holder for moving the point source of light to a position coaxial with the reflector axis.

The flashlight may also include a curved conductor that is interposed in the electrical circuit and operably connected to an electrode of the illumination source. The curved conductor advantageously maintains the operable connection between the illumination source and the one or more batteries when the point source of light of the illumination source is moved relative to the reflector axis.

In another aspect of the invention, the flashlight includes a spring conductor means that is coupled to one or more batteries for protecting the one or more batteries from damage. The spring conductor means advantageously absorbs stresses that might otherwise damage the center electrode of the battery or other flashlight components. As a result, the flashlight is more durable and the components contained in the flashlight and the battery are better protected.

In another aspect of the present invention, a method is provided to align the substantial point source of light of a lamp bulb with the axis of a flashlight reflector. The method includes attaching the lamp bulb to a movable bulb holder adapted to position the filament of the lamp bulb within the reflector and selectively adjusting the movable bulb holder to move the substantial point source of light from a first position laterally displaced from the reflector axis to a second position aligned with the reflector axis.

The above and other features and advantages of the present invention will become apparent from the following detailed description of a preferred embodiments.

Brief Description Of The Drawings

FIG. 1 is a perspective view of a flashlight in accordance with the present invention.

FIG. 2 is a side view of the flashlight of FIG. 1.

FIG. 3 is a cross-sectional view of the flashlight of FIG. 1 as taken through the plane indicated by 3-3.

FIG. 4 is a perspective view of an embodiment of an incandescent lamp bulb as viewed from the forward direction.

FIG. 5 is a perspective view of the incandescent lamp bulb shown in FIG. 4 as viewed from the rearward direction.

FIG. 6 is an enlarged cross-sectional view of the front end of the flashlight of FIG. 1 as taken through the plane indicated by 6-6.

FIG. 7 is a cross-sectional view of a movable assembly of the flashlight of FIG. 1.

FIG. 8 is a cross-sectional view of a movable holder assembly of the flashlight of FIG. 1.

FIG. 9 is a perspective view of a front contact holder.

FIG. 10 is a perspective view of a sectioned front contact holder of FIG. 9.

FIG. 11 is a perspective view of an aft contact holder.

FIG. 12 is a perspective view of a sectioned aft contact holder of FIG. 11.

FIG. 13 is a perspective view of a positive electrode contact and a negative electrode contact.

FIG. 14 is a perspective view of a ball housing.

FIG. 15 is a perspective view of an end cap.

FIG. 16 is a cross-sectional view of a post contact.

FIG. 17 is a perspective view of a receptacle contact.

FIG. 18 is a cross-sectional view of a cam follower assembly.

FIG. 19 is a cross-sectional view of a reflector module.

FIG. 20 is a perspective view of the reflector module of FIG. 19.

FIG. 21 is a side view of a movable cam.

FIG. 22 is a perspective view of an assembled movable cam.

FIG. 23 is a side view of a cross sectioned movable cam.

FIG. 24 is an enlarged cross-sectional view of the front end of the flashlight of FIG. 1 as taken through the plane indicated by 3-3.

FIG. 25 is a perspective view of a circuit assembly.

FIG. 26 is an enlarged cross-sectional view of the front end of the flashlight of FIG. 1 as taken through the plane indicated by 26-26.

FIG. 27 is a schematic cross-sectional view of a typical reflector illustrating the reflector focal point, reflector axis and the light beam emerging from the reflector.

Detailed Description Of A Preferred Embodiments

Embodiments of the present invention will now be described with reference to the drawings. To facilitate description, any reference numeral representing an element in one figure will represent the same element in any other figure. Further, in the description of the present invention that is to follow, upper, front, forward or forward facing side of a component shall generally mean the orientation or the side of the component facing the direction toward the front end of the flashlight where the light source is disposed. Similarly, lower, aft, back, rearward or rearward facing side of a component shall generally mean the orientation or the side of the component facing the direction toward the rear of the flashlight where the tail cap is located.

Referring to FIG. 1, a lighting device in the form of flashlight 10, an embodiment of the present invention, is illustrated in perspective. Flashlight 10 incorporates various features of the present invention. These features are described in detail below and illustrated in the accompanying figures for the purpose of illustrating preferred embodiments of the invention. It is to be expressly understood, however, that the present invention is not restricted to the flashlights described herein. Rather, the present invention includes hand held or portable lighting devices that incorporate one or more of the various features of the invention. It is also to be understood that the present invention is directed to each of the inventive features of the lighting devices described below.

Referring to FIGS. 1, 2 and 3, the flashlight 10 includes a head assembly 20, a reflector module 2, a substantial point source of light 3, a barrel 4, and a tail cap assembly 30. The head assembly 20, the reflector module 2, and the substantial point source of light 3 are disposed about the forward end of the barrel 4. The tail cap assembly 30 encloses the aft end of barrel 4. Optionally, a first conducting member 5, a second conducting member 7 and a circuit assembly 60 may be disposed between the reflector module 2 and the barrel 4.

The substantial point source of light 3 may be any suitable device that generates light. For example, the substantial point source of light 3 may be a light emitting diode (LED), an arc lamp or a filament-based incandescent lamp. The

substantial point source of light 3 may also be a bi-pin or potted type lamp, or other types as known in the art.

Referring to FIGS. 3, 4 and 5, in an illustrative embodiment, the substantial point source of light 3 is a lamp 359. The lamp 359 includes a bulb portion 361 at one end that contains a light emitting filament 360. The other end of the lamp includes a glass bead 362 for sealing the bulb end. The first and second terminal electrodes 357 and 358 extend through the glass bead and into the bulb portion. In the bulb portion 361, the opposing ends of filament 360 are attached to the ends of electrodes 357 and 358. Preferably, the electrodes extend into the bulb portion substantially parallel and equidistant from the lamp axis 363.

Generally during operation of the lamp 359, there exists a substantial point source of light along the filament that emits a substantial amount of light relative to other points along filament 360. This point is the hottest portion of the filament and is intended to be located at the middle of the overall length of the wire filament extending between the ends of the electrodes. However, this substantial point source of light on the filament is oftentimes not located on the center axis of the lamp or mid-way between electrodes 357 and 358. This may be due to a number of factors. For example, the filament may be more tightly wound at one end versus the other end, thus shifting the point source of the filament closer to the end of one electrode than the end of the other electrode and closer to one side of the lamp.

Even if the filament is uniformly wound, the filament may be attached to electrodes 357, 358 so that the substantial point source is not aligned with the axis of the lamp. Furthermore, even if the substantial point source of the filament 360 is properly positioned equidistant between the ends of the electrodes 357, 358, misalignment may occur if the ends of the electrodes themselves are not exactly equally spaced from the axis 363 of the lamp or if the ends of the electrodes are not properly positioned on a common plane with the central axis 363 of the lamp. These misalignment problems are not unique to filament type lamps and also apply to other substantial point source of light devices, such as, among others, LED's and arc lamps.

Flashlight 10, among other things, includes a movable holder that facilitates moving and aligning the substantial point source of light 3 with characteristic features of a reflector to improve the performance of a flashlight. In particular, in an illustrative embodiment, the movable holder holds the substantial point source of light relative to a reflector's axis and is rotatable about an axis that is not coincident with the reflector's axis. Preferably, the movable holder is rotatable

about at least two axes of rotation. Those skilled in the art will appreciate that a movable holder that is rotatable about two axes, wherein the second axis is oriented perpendicular to the first axis, will result in a substantial point source of light displacement range that is generally two-dimensional. Flashlight 10, therefore, includes a feature of aligning the point source of light with a characteristic axis of a flashlight reflector. Flashlight 10 also includes a feature for moving the substantial point source of light along the axis of the reflector and aligning it to the focal point of the reflector. It should be noted that the present invention is not limited by the specific manner in which the substantial point source of light is moved or displaced.

Referring to FIG. 3, the housing or barrel 4 houses at least one source of energy, such as for example a battery. In the illustrative embodiment, two batteries 331 are disposed in the barrel 4 in a series arrangement. It will be appreciated by those skilled in the art, however, that barrel 4 may also be configured to include a single battery, a plurality of two or more batteries, or other suitable portable source of energy in either a series or a side-by-side parallel arrangement. Furthermore, while batteries 331 may comprise any of the known battery sizes, flashlight 10 according to the illustrative embodiment is particularly suited for C or D sized batteries. Moreover, although the present invention is not limited to the type of batteries, the batteries housed in flashlight 10 are preferably rechargeable type batteries, such as Lithium Ion, Nickel Metal Hydride or Nickel Cadmium cells.

Referring to FIG. 3, the barrel 4 includes an inner surface 8, a back threaded portion 9, and a front threaded portion 11. The back threaded portion 9 releasably engages the barrel 4 with the tail cap assembly 30. The front threaded portion 11 releasably engages with the reflector module 2. The forward face of the barrel 4 is disposed adjacent to the second conducting member 7.

The tail cap assembly 30 of the illustrative embodiment includes a tail cap 322 and conductive spring member 334. Tail cap assembly 30 may include a removable spare lamp holder disposed in a cavity that opens to the end of the tail cap that engages barrel 4. Removable spare lamp holder may include an inner hub that frictionally retains a spare lamp. Spokes from the hub may extend to an outer hub in frictional contact with the inner surface of the cavity formed in the tail cap 322 to prevent damage to the spare lamp.

Tail cap 322 preferably includes a region of external threading 332 for engaging matching back threaded portion 9 formed on the interior of the barrel 4. However, other suitable means may also be employed for attaching tail cap 322 to

barrel 4 such as, for example, spring clips. A sealing element 14 may be provided at the interface between the tail cap 322 and the barrel 4 to provide a watertight seal. In a preferred embodiment, the sealing element 14 is a one-way valve that is oriented so as to prevent flow from outside into the interior of the flashlight 10, while simultaneously allowing overpressure within the flashlight to escape or vent to the atmosphere. However, as those skilled in the art will appreciate, the sealing element 14 may be other suitable sealing devices such as an O-ring.

The external threading 332 of the tail cap 322 that mates with the barrel 4 may be provided with a flattened top so as to create a spiral passage through the mating threads between the barrel 4 and the tail cap 322. Additionally, radial spines may be formed in a mating face 351 of the tail cap 322 to ensure that the end of barrel 4 does not provide a gas tight seal against the adjacent flange, thereby impeding the flow of overpressure gases from the interior of the flashlight.

The design and use of one-way valves in flashlights is more fully described in U.S. Patent No. 5,113,326 to Anthony Maglica, which is hereby incorporated by reference.

Referring to FIG. 3, when the tail cap assembly 30 is installed onto the barrel 4, the spring member 334 forms an electrical path between the case electrode 335 of the rear battery 331 and the tail cap 322. An electrical path is further formed between the tail cap 322 and the barrel 4 through, for example, the face 351 and/or the mating threads.

The spring member 334 also urges the batteries 331 forward towards the front of the flashlight 10. As a result, the center electrode 337 of the rear battery 331 is in electrical contact with the case electrode of the forward battery 331, and the center electrode 338 of the forward battery 331 is urged into contact with a spring biased lower contact assembly 80 disposed about the forward end of the flashlight 10.

As shown in FIG. 6, the reflector module 2 is mounted in a fixed relationship to the forward end of the barrel 4. The reflector module 2 generally contains a movable assembly 40, a lower insulator 25 and the circuit assembly 60.

FIG. 7 illustrates the movable assembly 40 in isolation. The movable assembly 40 embodies several aspects of the present invention. Among other things, the movable assembly 40 facilitates aligning the substantial point source of light 3 with the axis or the focal point of the reflector. The movable assembly 40 also includes features that facilitate the point source of light to displace while maintaining electrical contact with a source of energy to allow the user to visually

critique the quality of the light beam emanating from the flashlight during the filament alignment process.

The movable assembly 40 includes an end cap 16, sleeve retainer 18, a holder housing 22, an upper spring member 24, a cam follower assembly 50, an upper contact assembly 70, and a movable holder assembly 90.

Referring to FIG. 8, the movable holder assembly 90, among other things, holds the lamp 359 and is movable relative to a flashlight reflector. The movable holder assembly 90 may take the form of other configurations that may receive a light source and move in response to actuating pressure. Also, although the illustrative embodiment shown in FIG. 8 is an assembly, the movable holder assembly 90 may be an integral structure having the necessary features. In the illustrative embodiment, the movable holder assembly 90 includes a forward contact holder 26, an aft contact holder 12, a positive electrode contact 28, a negative electrode contact 29, and a ball housing 31.

FIG. 9 illustrates a perspective view of the forward contact holder 26. FIG. 10 illustrates a perspective view of a cross section of the forward contact holder 26. The forward contact holder 26 includes a set of cavities that are sized to contain a portion of the positive electrode contact 28 and the negative electrode contact 29. The forward contact holder 26 includes a pair of apertures 32, a pair of contact cavities 34, a pair of contact slots 35, an alignment groove 6, an outer diameter 36, and a shoulder 38. The apertures 32 are through holes that extend from the front of the forward contact holder 26 and each communicates with one of the pair of contact cavities 34. In the illustrative embodiment, the contact cavities 34 are rectangular cavities that extend to the aft end of the forward contact holder 26. In a preferred embodiment, the forward contact holder 26 is made from a non-conductor, such as plastic.

Referring to FIG. 8, the aft contact holder 12 is disposed adjacent to the aft end of the forward contact holder 26. FIG. 11 illustrates a perspective view of the aft contact holder 12. FIG. 12 illustrates a perspective view of a cross section of the aft contact holder 12. The aft contact holder 12 includes a pair of aft contact cavities 56, a pair of relief slots 27, a back profile 39, an alignment tab 42, an aft shoulder 74, and an aft outer diameter 76. The alignment tab 42 is sized to correspond with the alignment groove 6 of the forward contact holder 26 and align the respective cavities of the forward and aft contact holders. The back contour 39 is preferably a segment of a sphere. The aft contact cavities 56 are sized and arranged to extend the contact cavities 34 of the forward contact holder 26. The aft outer diameter 76 corresponds to the outer diameter 36 of the forward contact

holder 26. In a preferred embodiment, the aft contact holder 12 is made from a non-conductor, such as plastic.

Referring to FIGS. 8 and 13 the positive electrode contact 28 is disposed in a cavity defined by one of the contact cavities 34 and aft contact cavity 56 of the forward and aft contact holders 26, 12, respectively. The positive electrode contact 28 includes a neck 44, a contact extension 45, a contact base 46 and a tab 47. The neck 44 is configured to frictionally receive the electrode 357 of the lamp 359. The contact extension 45 is sized to extend the positive electrode contact 28 to the aft of the aft contact holder 12. The contact base 46 is generally circular and is configured to conform to the back contour 39 of the contact holder 26. The tab 47 of the positive electrode contact 28 is folded into the other aft contact cavity 56.

Still referring to FIGS. 8 and 13, the negative electrode contact 29 is disposed in a second cavity defined by one of the contact cavities 34 and relief slot 27 of the forward contact holder 26, and the aft contact cavity 56 of the aft contact holder 12. The negative electrode contact 29 includes a neck 48 and a curved arm 49. The neck 48 is configured to frictionally receive the lamp electrode 358. The negative electrode contact 29 is formed to extend out of the contact cavity 34, through the relief slot 27, and into the cavity slot 35 wherein the curved arm 49 may project beyond the outer diameter 36 of the forward contact holder 26.

In a preferred embodiment, the positive electrode contact 28 and the negative electrode contact 29 are made from a sheet of a conductor material that is formed to an hour glass shape having a neck 44, 48 as illustrated in FIG. 13. The neck 44, 48 of the electrode contacts illustrates one way of frictionally receiving an electrode to establish an electrical connection thereto, other suitable methods of establishing an electrical connection is well known to those skilled in the art. To facilitate the shaping/forming of the sheet of conductor material, relief cuts in the conductor sheet may be employed. In a preferred embodiment, the electrode contacts are made from a sheet of copper.

Referring to FIG. 8, the extended outer diameter defined by outer diameter 36 and aft outer diameter 76 of the forward contact holder 26 and the aft contact holder 12, respectively, interfaces with a bore 51 of the ball housing 31.

Referring to FIG. 14, the ball housing 31 includes the bore 51, an outer profile 52, a back face 54, and a pair of sockets 58. In the illustrative embodiment, the bore 51 is substantially perpendicular to the back face 54. The outer profile 52 is spherical and extends from the back face 54 symmetrically

relative to the bore 51. Each of the pair of sockets 58 extend substantially perpendicular from the axis of the bore 51 and through the spherical outer profile 52. In a preferred embodiment, the ball housing 31 is a conductor such as, for example, aluminum.

The socket 58 of the ball housing 31 is an actuation interface that is adapted to receive an actuating member to move the movable holder assembly 90. In the illustrative embodiment, the socket 58 has a hexagonal form.

Referring to FIG. 8, the extended outer diameter defined by the outer diameters 36, 76 of the forward and aft contact holders 26, 12 is secured in the bore 51 of the ball housing 31 by an interference fit. To enhance the interference fit a key 75 disposed about the outer diameter 76 of the aft contact holder 12 may be included, as shown in FIG. 11. The ball housing 31 may have a corresponding mating slot 37 as shown in FIG. 14. It should be appreciated by those ordinarily skilled in the art that other suitable fastening methods, such as use of adhesives, pins, screws, clips, or bands may also be employed.

Also, as shown in FIG. 8, because the curved arm 49 of the negative electrode contact 29 is configured to project beyond the outer diameter 36 of the front contact holder 26 in the radial direction, the curved arm 49 frictionally engages with the bore 51 of the ball housing 31 when the ball housing 31 is assembled with the contact holders 26, 12. In this way, the illustrative embodiment discloses one way of providing an electrical connection between the negative electrode contact 29 and the ball housing 31.

Still referring to FIG. 8, the back face 54 of the ball housing 31 bears against the shoulder 74 of the aft contact holder 12. Preferably, the ball housing 31 and the aft contact holder 12 are configured such that when assembled, the spherical segment outer profile 52 of the ball housing 31 and the spherical segment back profile 39 of the aft contact holder 12 substantially form a common and continuous spherical surface.

The lamp 359 is received by the movable holder assembly 90 through apertures 32. The lamp electrodes 357, 358 extend through the apertures 32 and frictionally engage with the necks 44, 48 of the positive electrode contact 28 and the negative electrode contact 29, respectively. This illustrative embodiment discloses one way of holding and making electrical connections to a lamp 359. It should be evident to those skilled in the art that other configurations may be employed to receive the lamp 359 and make electrical connections to the lamp electrodes 357, 358.

Referring to FIG. 7, the movable holder assembly 90 is shown in the holder housing 22 of the movable assembly 40 in relation to the end cap 16, the sleeve retainer 18, the upper spring member 24 and the upper contact assembly 70. In the illustrative embodiment, a profiled contour of the holder housing 22, the sleeve retainer 18 and the upper contact assembly 70 together define an envelope in which the movable holder assembly 90 moves.

Referring to FIG. 7, the holder housing 22 is generally a hollow cylindrical structure that includes a clearance hole 67, a profiled contour 69, a pair of access holes 72, a cam follower receiver 73 and a snap-in groove 68. The clearance hole 67 is disposed on the forward end of the holder housing 22 and extends to the profiled contour 69. The clearance hole 67 is sized to provide clearance for the outer diameter 36 of the movable holder assembly 90 and the lamp 359 and to accommodate the range of motion of the movable holder assembly 90. The profiled contour 69 generally blends with the inside diameter of the holder housing 22 and corresponds to the outer profile 52 of the ball housing.

In the illustrative embodiment, the cam follower receiver 73 of the holder housing 22 is a threaded port. The pair of access holes 72 are generally disposed 180° apart and each extends through the wall of the holder housing 22. The snap-in groove 68 is disposed towards the aft of the holder housing 22 and includes a forward side that is tapered and a back side that is generally perpendicular to the axis of the holder housing 22. In a preferred embodiment, the holder housing 22 is a conductor such as, for example, aluminum.

Still referring to FIG. 7, the sleeve retainer 18 includes a cylindrical aft section 62, a flange 63 and a through hole 64. The forward side of the flange 63 includes a mating profile 65 that generally conforms to the back contour 39 of the movable holder assembly 90. In the illustrative embodiment, the mating profile 65 is a spherical segment. In a preferred embodiment, the sleeve retainer 18 is a non-conductor such as, for example, plastic.

Referring to FIGS. 7 and 15, the end cap 16 is generally a hollow cylindrical structure that includes three flexible segments 202 and three stiffened segments 203 alternately arranged about its aft end. In the embodiment illustrated, each of the segments 202, 203 are defined by six relief slots 204 equally spaced in the circumferential direction. On each of the three flexible segments 202 is an outer tab 206. Each outer tab 206 includes a forward end taper 208 and a back face 212. The back face 212 is generally perpendicular to the axis of the end cap 16. Connected to each of the stiffened segments 203 is an inner support 214. The inner support 214 includes a hub 215 with three spokes 217. Each spoke extends

to one of the three stiffened segments 203. The hub 215 includes a support taper 216 on the forward facing side and an inner diameter 218.

The end cap 16 has an outer diameter that corresponds to the inner diameter of the holder housing 22. Because of the relief slots 204, the flexible segment 202 may flex sufficiently inward when the end cap 16 is assembled with the holder housing 22. Each outer tab 206 fits into the snap-in groove 68 of the holder housing 22 and is sized such that the back face 212 bears against the aft face of the snap-in groove 68. In a preferred embodiment, the end cap is a non-conductor such as, for example, plastic.

Referring to FIG. 7, the upper contact assembly 70 is a spring biased conductor that provides an energy path to the movable holder assembly 90. The upper contact assembly 70 includes a contact post 77, a contact receptacle 78 and a contact spring 79.

Referring to FIG. 16, the contact post 77 includes a contact end 116, a blind hole 117, an outer taper 222 and a front outer diameter 224. In having a blind hole 117, the contact post 77 is similar to a receptacle. The blind hole 117 is sized to receive the contact spring member 79. In a preferred embodiment, the contact spring member 79 extends out of the blind hole 117 and bears against the contact receptacle 78.

Referring to FIG. 17, the contact receptacle 78 is an open-ended receptacle including an end contact 112 and an inside diameter 114. In the preferred embodiment, the end contact 112 has a spherical profile to match the contour of the contact base 46 that conforms to the back contour 39 of the movable holder assembly 90.

Referring to FIG. 7, to assemble the upper contact assembly 70, the contact receptacle 78 is fitted over the contact post 77 with the contact spring member 79 contained therebetween. The front outer diameter 224 of the contact post 77 and the inside diameter 114 of the contact receptacle 78 are sized so that the components may relatively slide axially without significant side-to-side movement. Because the upper contact assembly 70 provides an electrical path to the movable holder assembly 90 and to the substantial point source of light in the form of a lamp 359, the contact post 77, contact receptacle 78 and the contact spring member 79 are preferably a conductor, such as for example aluminum or copper.

To assemble the movable assembly 40, the movable holder assembly 90 is installed such that its outer profile 52 of the ball housing 31 bears against the profiled contour 69 of the holder housing 22. The movable holder assembly

sockets 58 are aligned with the holder housing access holes 72. The sleeve retainer 18 is installed to have its mating profile 65 bear against the back contour 39 of the movable holder assembly 90. The upper spring member 24 is disposed over the sleeve retainer's cylindrical aft section 62 and against the aft side of the sleeve retainer flange 63. The upper contact assembly 70 is slidably positioned in the sleeve retainer's through hole 64 to make an electrical connection with the contact base 46 of the positive electrode contact 28. The end cap 16 is installed to secure and contain the components. The cam follower assembly 50 may be secured to the cam follower receiver 73 on the holder housing 22. An insulator ring 53 may also be secured to the aft end of the contact post 77.

Arranged this way, the upper spring member 24 is contained between the sleeve retainer 18 and the end cap 16. The housing holder snap-in groove 68 prevents the end cap 16 from moving aft once the outer tabs 206 have snapped into the snap-in groove 68. The aft travel of the contact post 77 is limited because the contact post's taper 222 bears against the support taper 216 of the end cap 16. The upper spring member 24 and the contact spring 70 serve to maintain the desired component relationship. Accordingly, the movable assembly 40 is described wherein the assembly of its internal components is accomplished by snap-fit.

The inventive features of the embodiment described herein are not limited by the specific mode of assembly, and other suitable fastening schemes may be utilized. For example, press-fitting, crimping, or using adhesives may be employed to secure or assemble the end cap 16 to the holder housing 22. However, among other things, the combination of components assembled by snap-fitting as described above provides component assembly that eases manufacturing and reduces cost because assemblies may be completed without the need for holding tight tolerances as demanded by press fit or interference fit, and without the need for special tooling as demanded by a crimping operation.

Referring to FIG. 18, the cam follower assembly 50 includes a shoulder screw 97, a cam follower 127 and a bushing 87. The shoulder screw 97 includes a circumferential groove 118 disposed on its head. The cam follower 127 is generally a sleeve with a counterbore on one end and a chamfer 131 on the second end. The bushing 87 is generally a hollow cylinder with an upper lip 99 having a reduced wall thickness at one end of the cylinder. To assemble, the counterbore of the cam follower 127 is positioned adjacent to the flange of the head of the shoulder screw 97. With the cam follower 127 in place, the bushing 87 is secured to the shoulder screw 97 by crimping the upper lip 99 into the

circumferential groove 118. The chamfer 131 of the cam follower 127 facilitates in the crimping step by guiding the upper lip 99 into the groove 118. By properly sizing the height of the cam follower 127, the cam follower 127 and the bushing 87 are free to rotate about the shoulder screw 97 after the bushing 87 is installed. The free rotation of the details advantageously facilitates smooth advancement of the cam follower 127 and/or the busing 87 against a cam or a guide and reduces wear to the adjacent parts. Also, because the bushing 87 retains the cam follower in place, the handling and installation of the cam follower assembly 50 is simplified. Other suitable cam follower configuration may also be utilized in conjunction with the various inventive aspects as described herein. For example, the cam follower assembly 50 may be a simple shoulder screw.

Referring to FIG. 6, the movable assembly 40 is shown installed in the flashlight 10 and disposed in the reflector module 2. The reflector module 2 includes many features. Generally, the reflector module 2 includes a reflector on its forward end, a housing portion to contain the movable assembly 40 about its mid-section, and a support structure to contain optional electronics on its aft end.

Referring to FIGS. 19 and 20, the reflector module 2 includes a reflector 82 on its forward end. The reflector 82 has a reflective surface that is axisymmetrical about an axis 43 and includes a first open end 83 for emitting a beam of light at one end and a second end 85. The axis 43 may be defined by the first open end 83 and the second end 85. A flange 84 is also disposed on the forward end of the reflector module 2. In the illustrative embodiment, the second end 85 is an opening that facilitates a light source to be disposed within the reflector 82. Preferably, the reflector 82 has a reflective surface that is substantially parabolic. A parabolic configuration includes a focal property wherein light emanating from the focus or the focal point is redirected into a collimated light beam. Other suitable reflector configurations, for example elliptical, may also be employed.

Referring to FIG. 27, some features of an axisymmetrical reflector are shown. The reflector axis 43, is the axis of the reflector. The focus or the focal point 71 of the reflector lies on the reflector axis 43.

FIG. 27 also illustrates the action of the light being redirected by a reflector to generate a collimated light beam. When the substantial point source of light is aligned to the focal point of a reflector, the most collimated light beam the reflector is able to produce will be generated. When the substantial point source of light is not aligned with the axis of the reflector, unwanted light dispersion occurs resulting in a light beam that is asymmetrical or elongated in shape. To substantially reduce this unwanted light dispersion and minimize the asymmetrical

or comet-tail effect on the shape of the light beam, aligning the substantial point source of light with the reflector axis and the focal point is desired.

Referring to FIGS. 19 and 20, the mid-section of the reflector module 2 includes an inside diameter 86, an outer diameter undercut 88, and an axial slot 94. The inside diameter 86 and the outer diameter undercut 88 are substantially co-axial with each other and with the axis 43 of the reflector 82. The inside diameter 86 of the reflector module 2 corresponds to the outer diameter of the holder housing 22 of the movable assembly 40 such that relative co-axial displacement movement may be realized without significant side-to-side movement. The axial slot 94 is a through slot that is disposed substantially parallel to the axis 43 of the reflector module 2. The width of the axial slot 94 is sized to receive the cam follower assembly 50 thereby limiting any significant relative displacement between the reflector module 2 and the movable assembly 40 in the circumferential direction.

Referring to FIG. 6, when the movable assembly 40 is positioned in the inside diameter 86 of the reflector module 2 and the cam follower assembly 50 is positioned in the axial slot 94, the socket 58 of the ball housing 31 is also aligned with and accessible through the slot 94. The reflector module 2 is also sized so that the lamp 359 held by the movable assembly 40 is positioned between the first open end 83 and the second end of the reflector 82.

Still referring to FIG. 6, the outer diameter undercut 88 of the reflector module 2 is sized to receive a movable cam 96. Referring to FIGS. 6, 21 and 22, the movable cam 96 includes a cam 101, an access hole 103, a detent 105, and lock tabs 107. The cam 101 is generally a barrel cam in the form of a parallel slot that extends circumferentially around the movable cam 96. The movable cam 96 is sized such that when installed, the cam follower 127 of the cam follower assembly 50 engages with the cam 101. The movable cam 96 is also sized such that it is confined within the forward and aft ends of the outer diameter undercut 88 while being free to rotate thereabout. Accordingly, the cam 101 is able to define the axial rise, fall and dwell of the movable assembly 40. The access hole 103 facilitates installing or removing the cam follower assembly 50.

Referring to FIG. 21, the detent 105 is disposed about the forwardmost side of the cam 101. As will be described in more detail below, the detent 105 in cooperation with other features of the present invention facilitates providing a tactile response feature to the user to indicate that, for example, that the flashlight 10 is in the OFF position.

Preferably, the movable cam 96 is a two-piece construction that may be fitted over the outer diameter undercut 88 of the reflector module 2 and the cam follower assembly 50. The two pieces of the movable cam 96 may be secured by suitable methods known in the art. Referring to FIG. 23, in a preferred embodiment, the two pieces of the movable cam 96 are held together by snap-in plugs 124 and mating holes 126. The snap-in plug 124 includes a flexible tab with a head 134 that is sized greater than the split shaft 135. Each mating hole 126 has a counterbore shoulder 138. Configured this way, when the snap-in plug 124 is inserted into the mating hole 96, the head snaps and secures the movable cam together against the counterbore shoulder of the mating hole 126.

Referring to FIG. 22, the lock tabs 107 are disposed on the outer diameter of the movable cam 96 and extend in a direction parallel to the axis of the flashlight 10. In a preferred embodiment, four lock tabs 107 are equally spaced on the outer diameter of the movable cam 96.

Arranging the movable assembly 40, the reflector module 2 and the movable cam 96 as described, rotating the movable cam 96 relative to the movable assembly 40 will cause the movable assembly 40 to axially displace along the inside diameter 86 of the reflector module 2. In this way, the lamp 359 may be caused to translate along the reflector axis 43.

Referring to FIGS. 19 and 20, the aft end of the reflector module 2 includes a mid-flange 106 and aft curved segments 92. In the illustrative embodiment, two aft curved segments 92 define the inside diameter 86 towards the aft end of the reflector module 2. Each aft curved segment 92 includes threads 93 on the free end. The aft curved segments 92 also define gaps 111 therebetween. The threads 93 are configured to engage with the front threaded portion 11 of the barrel 4 to fix the reflector module 2 thereto as shown in FIG. 24. While the embodiment shown illustrates external threads on the reflector module 2 and internal threads on the barrel 4, this arrangement could be reversed.

Referring to FIG. 24, an insulator 109, the first recharging member 5, the circuit assembly 60 and the second recharging member 7 are interposed between the mid-flange 106 and the front face of the barrel 4. A spring 108 is interposed between the movable assembly 40 and the circuit assembly 60. In the illustrative embodiment, the insulator 109 is generally a ring having an L-shaped cross section that bears against the mid-flange 106. The first recharging member 5 is also a ring and is positioned adjacent to the insulator 109.

The circuit assembly 60 preferably contains electronics to, among other things, control the energy flowing to the lamp 359 or regulate the recharging of the

rechargeable batteries 331. The circuit assembly 60 may include a processor for performing the desired operations and functions. The circuit assembly 60 is interposed between the first and second recharging members 5, 7. The circuit assembly 60 includes a plurality of contact areas to selectively and electrically couple to the first recharging member 5, the second recharging member 7, the upper contact assembly 70, the lower contact assembly 80 and the spring 108. Referring to FIG. 25, contact areas 137a - 137c disposed on the forward side of the circuit assembly 60 are shown. Contact area 137a is sized and positioned to couple with the first recharging member 5, contact area 137b is sized and positioned to couple with the spring 108, and contact area 137c is sized and positioned to couple with the upper contact assembly 70. On the aft side of the circuit assembly 60 (not shown), are contact area 137d sized and positioned to couple with the second recharging member 7, and contact area 137e sized and positioned to couple with the lower contact assembly 80. Clearance slots 115 allow the circuit assembly 60 to fit through the aft curved segments 92 of the reflector module 2.

Referring to FIG. 24, also disposed about the aft end of the reflector module 2 is the spring biased lower contact assembly 80 and the lower insulator 25. Similar to the upper contact assembly 70, the lower contact assembly 80 includes a contact post 77a, a contact receptacle 78a, and a contact spring member 79a; wherein each component is appropriately sized to fit into the lower insulator 25. In addition, the contact post 77a includes a flange 59 that extend beyond the outer diameter of the generally cylindrical portion of the contact post 77a. The contact receptacle 78a also includes a flange depending from the open end of the receptacle.

Referring to FIG. 24, the lower insulator 25 is configured to receive the lower contact assembly 80 and to be secured about the aft end of the reflector module 2. The lower insulator 25 includes a central bore 33, a counterbore shoulder 115, a back face 121, a recess 122 and flexible arms 132. The lower insulator 25 also includes outer features that facilitate its assembly and installation to the aft end of the reflector module 2.

The contact receptacle 78a is slidably disposed in the central bore 33 of the lower insulator 25. The lower insulator's flexible arms 132 allow the contact post's flange 59 to be contained within the counterbore of the lower insulator 25. The flange of the contact receptacle 78a, disposed adjacent to the counterbore shoulder 115, limits the axial displacement of the contact receptacle 78a in the aft

direction. The contact post 77a, being biased forward by the contact spring member 79a, couples with the contact area 137e of the circuit assembly 60.

Preferably, the axial length of the contact receptacle 78a is sized so that the end contact 112a is adjacent to or slightly forward of the back face 121 and remains within the envelope defined by the recess 122 of the lower housing 25. In the illustrated embodiment, the recess 122 is a frustoconical cavity with the base facing to the back of the flashlight 10. The recess 122 is dimensioned to be deeper than the height of the battery's center electrode 338 that extends beyond the battery casing.

Arranged this way, when the battery is urged forward against the back face 121 of the lower housing 25, the center electrode 338 of the battery engages with the end contact 112a of the contact receptacle and lifts its flange off the lower insulator's counterbore shoulder 115. Concurrently, the contact spring member 79a urges the contact receptacle 78a in the rearward direction against the battery's center electrode to achieve a spring biased electrical connection with the battery 331. In this way, the lower contact assembly 80 provides a simple configuration that enhances the electrical coupling between components even when the flashlight is jarred or dropped, which may cause the battery or batteries 331 to suddenly displace axially within the barrel 4. Further, because the contact spring member 79a may absorb impact stresses due to, for example mishandling, the battery's center electrode and the flashlight components, for example the circuit assembly 60, are better protected.

Also, because the depth of the recess 122 is greater than the distance the center electrode 338 extends beyond the end of the battery case, if a battery or batteries 331 are inserted backwards into the barrel 4 so that their case electrodes are directed forward, no coupling with the lower contact assembly 80 is formed. When the batteries are inserted correctly, the center electrode of the fowardmost battery is urged into contact with and compresses the lower contact assembly 80. Such an arrangement immediately notifies the user of improper battery installation.

Referring to FIG. 6, the head assembly 20 is disposed on the forward end of the flashlight 10, and is rotationally mounted to the flange 84 of the reflector module 2. The head assembly 20 comprises of a face cap 142, lens 144, a sleeve 146 and a sealing ring 148.

The face cap includes a flange 152, which extends radially towards the axis of the face cap, a groove 153 and aft threads 154. In the illustrative embodiment, the lens 144 is disposed in the groove 153 of the face cap and is positioned

against the sealing ring 148. Preferably, the lens 144 is fitted into the groove 153 by snap-fit, as commonly known in the art. The flange 152 of the face cap is positioned forward of the flange 84 of the reflector module 2. The aft threads 154 is adapted to engage with corresponding threads of the sleeve 146.

The sleeve 146 protects the inner components of the flashlight from contamination by covering the axial slot 94 and the socket 58 of the ball housing 31. The sleeve 146 is generally a hollow cylinder with a tapered outer surface. The sleeve 146 includes threads about its forward end to engage with the face cap threads 154. The forward end of the sleeve 146 is positioned on the aft side of the flange 84 of the reflector module 2. The corresponding diameters between the face cap 142 and the flange 84 of the reflector module 2 are also sized and controlled for a clearance fit. Configured and arranged this way, the face cap 142 and the sleeve 146 define a clearance envelope surrounding the reflector module flange 84 and the head assembly 20 may rotate about the axis of flashlight 10 relative to the reflector module 2. Optionally, a spacer 156 may be installed to fill any excess axial clearance. In a preferred embodiment, the spacer 156 is made of nylon.

Referring to FIG. 26, the sleeve 146 also includes a plurality of lock slots 151 that corresponds to the lock tabs 107 of the movable cam 96. By having the movable lock tabs 107 mate with the sleeve's lock slots 151, the movable cam 96 may be caused to rotate about the axis of the flashlight 10 when the head assembly 20 is rotated thereabout.

Referring to FIG. 6, because the movable assembly 40 is limited from rotating within the inside diameter 86 of the reflector module 2 by the cooperation of the cam follower assembly 50 and the axial slot 94, and because the movable cam 96 is free to rotate about its axis while being limited to displace axially by its cooperation with the outer diameter undercut 88, rotating the head assembly 20 causes the rotation of the movable cam 96, which in turn causes the movable assembly 40 to travel axially within the inside diameter 86 of the reflector module 2. Because the reflector axis 43 is substantially co-axial with the axis of the inside diameter 86 of the reflector module 2, the light source that is secured to the forward end of the movable assembly 40 is able to travel along the reflector axis 43 by the rotation of the head assembly 20. In this way, the position of the lamp 359 held in the movable holder assembly 90 can be adjusted along the axis 43 of the reflector 82. Varying the axial position of the lamp 359, and its substantial point source of light with respect to the reflector advantageously varies the dispersion of light produced by the flashlight 10.

The combination described above is one embodiment for moving the substantial point source of light along or parallel to the axis 43 of the reflector 82. Although other combinations may be suitable for this purpose, having the reflector 82 integral to the feature that controls the fidelity of the light source's axial displacement, i.e., the inside diameter 86, advantageously improves manufacturability and reduces cost. Also, having the reflector fixed to the barrel and to other features of the flashlight reduces the number of components needed and advantageously eases manufacturing.

Also, although the embodiment described above uses a cam that rotates with the head assembly to effectuate axial translation of the light source, the present invention is not limited by the configuration and arrangement of the cam. The light source may be axially translated by other suitable means, such as for example, having a cam fixed to the barrel and coupling the movable holder to the head assembly.

The flashlight 10 described above is also one embodiment that is suitable for moving the substantial point source of light in a direction other than parallel to or along the reflector axis 43. Referring to FIG. 6, the movable holder assembly 90 holds the lamp 359 within the reflector 82. To move the lamp 359 or the substantial point source of light 3, the user first disengages the sleeve 146 from the head assembly 20 and slides it in the rearward direction to expose the axial slot 94 and to gain access to the socket 58 of the ball housing. The user may then couple an actuating member (not shown) to the socket 58. In a preferred embodiment, the actuating member is a standard hex key that is coupled to the socket 58 having a hexagonal form. Preferably, the actuating member also includes a handle to ease the user's handling of the actuating member. Moreover, the actuating member is preferably configured so that it may be stowed in the flashlight 10.

As described above, the movable holder assembly 90 is secured in place by spring forces provided through the sleeve retainer 18 and the upper contact assembly 70. In the illustrative embodiment, the lamp 359 is moved by, for example, rotating the actuating member with sufficient pressure to overcome the spring forces and causing the movable holder assembly 90 to roll within the spherical envelope defined in part by the holder housing 22 and the sleeve retainer 18. Rotating the hex key causes the lamp bulb to rotate about an actuation axis 61 that is not coincident to the reflector axis 43, as defined by the socket 58. In this regard, the socket 58 is an actuation interface of the movable

holder assembly 90 that facilitates the substantial point source of light to move relative to the reflector axis 43.

Also, the movable holder assembly 90 may move the lamp 359 and its filament 360 in a second direction when the actuating member in a lever motion as indicated by arrow A in FIG. 6. By moving the actuating member in this manner, the movable holder assembly 90 rolls within the spherical envelope about a second actuation axis substantially 90° from the first actuation axis 61. In this way, the lamp 359 held by the holder assembly 90 has two degrees of freedom and, accordingly, the substantial point source of light the lamp may be moved over a defined area, which in the illustrative embodiment, is a spherical contour substantially perpendicular or lateral to the reflector axis 43. In this way, the substantial point source of light may be aligned with the axis 43 of the reflector.

It should be noted that the movement of the movable holder assembly 90 is not limited by two axes of rotation as described above. The spherical form of the movable holder assembly 90 and the envelope containing the movable holder assembly 90 advantageously provides a full range of motion, similar to a ball joint, and the actuating member may be maneuvered in any direction.

The spring force(s) exerted by the upper spring member 24 through the sleeve retainer 18 and/or the upper contact assembly 70 serve as an alignment locking mechanism by providing sufficient forward force to maintain the position of the lamp 359 before and after the lamp is moved to align the substantial point source of light with the axis of the reflector. Although other methods to maintain the position of the lamp after alignment may be employed, spring force, preferably in a form of a coil spring, provides a simple and effective configuration to achieve the desired result.

In the embodiment described above, the substantial point source of light is caused to move by maneuvering the axis defined by the socket 58 of the movable holder assembly 90. While a removable actuating member is described herein, the actuating member may be integral to the movable holder assembly 90.

Therefore, one embodiment of a movable holder that is able to move a substantial point source of light in substantially the lateral direction relative to the reflector axis, and that is able to move the substantial point source of light along the axis of the reflector axis has been described. By having such an adjustment capability, the movable holder of the present invention facilitates aligning the substantial point source of light with the focal point of the reflector. Even after the substantial point source of light is aligned with the focal point along the reflector's axis, the movable holder of the present invention facilitates moving the point

source away from the focal point along the reflector's axis and varying the dispersion of light emanating from the point source. Because of the alignment locking mechanism described above, the substantial point source's alignment to the reflector axis is maintained and the point source may be re-aligned with the focal point by translating it back along the reflector axis.

The movable assembly 40 and the movable cam 96 are one distinct combination for moving and aligning the substantial point source of light relative to the reflector axis or the focal point of the reflector. By providing such a combination, the performance of the flashlight is advantageously improved. However, it is expressly noted that the present invention is not limited to any specific combination or arrangement for moving a substantial point source of light relative to the reflector axis.

In another aspect of the present invention, the spring loaded upper contact assembly 70 engages with the contact base 46 that conforms to the spherical back contour 39 of the aft contact holder 12. Advantageously, such a relationship between the contacts provides an electrical connection between the two components even where there is movement or rotation of the movable holder assembly 90 because the spring loaded upper contact assembly 70 follows the curvature of the contact base 46.

In the illustrative embodiment in FIG. 6, the displacement range of the substantial point source of light may be limited by the size of the reflector module's axial slot 94, the holder housing's access holes 72 or clearance hole 67, or the reflector's second end 85. Preferably, the access features are sized so as to avoid the light source from contacting any component and causing damage while achieving the desired range of light source displacement. The present invention is not limited to any specific manner in which the substantial point source of light moves or the manner in which the displacement range of the point source is limited or controlled.

Also, the actuation interface of the movable holder assembly 90 may be any suitable combination that may facilitate the movable holder assembly (and the lamp held thereon) to move. For example, the movable holder assembly 90 may be configured without a socket 58 so that the spherical outer profile 52 of the ball housing 31 is made as the actuation interface. The access to the spherical outer profile 52 may be achieved by, for example, appropriately sizing the adjacent structures to facilitate the user's finger or thumb to access and engage with the outer profile 52. To enhance the engagement, the outer profile 52 may be knurled or roughened to increase the friction with the user's hand or finger. In this

alternate movable holder configuration, the user can move the lamp by handling the spherical outer profile 52 to move the ball housing 31 within the spherical envelope defined in part by the holder housing 22 and sleeve retainer 18.

Further, the actuation interface of the movable holder may be an external feature. For example, an extension may protrude from the ball housing 31 that has an external hexagonal form. In such a configuration, the actuating member may be a socket or other female-type coupling to engage with the external feature of the extension. If the extension is sufficiently sized, the user may be able to maneuver the movable holder directly without the use of an actuating member.

There are other ways to move the point source of light. For example, the movable lamp holder may be configured with an aft extension that protrudes through two actuator rings. By arranging the two actuator rings to move in a direction perpendicular to the axis of the flashlight, and by arranging the first and second actuator rings to translate in a direction perpendicular to each other, a two-dimensional light source displacement range can be achieved. Similarly, a single actuating ring that is translatable in two directions will also yield a two-dimensional light source displacement range.

Moreover, the embodiment described above tend to move the substantial point source of light in an arcuate or non-linear path. The present invention is not limited to the displacement path of the substantial point source of light. Linear translation of the point source of light in a perpendicular direction relative to the reflector axis may also be employed to align the point source of light. Those skilled in the art will appreciate that coupling two actuating members, disposed 90° apart and perpendicular to the reflector axis, to a movable holder will allow the substantial point source of light to be translated in any direction along a plane perpendicular to the reflector axis.

The present invention also contemplates any suitable means to move the substantial point source of light to align the light source to the reflector axis. Although only mechanical means to move the substantial point source of light has been described herein, the present invention is not limited to moving the substantial point source of light relative to the reflector solely by mechanical means. For example, electrical or electro-mechanical devices may be used to move the lamp and its filament. The control of such devices may be provided by, for example, a microprocessor disposed on the circuit assembly 60. Accordingly, the present invention is not limited to a mechanical or a mechanically controlled means of moving the substantial point source of light.

Therefore, an apparatus for moving and aligning a substantial point source of light to a reflector axis has been disclosed. Combined with features that facilitates adjusting the position of the point source of light parallel or along the axis of the reflector as described above, the flashlight 10 discloses one configuration that can align the substantial point source of light of a light source to the focal point or the axis of a reflector.

Advantageously, the apparatus described herein moves the substantial point source of light while maintaining flow of electrical energy to the source of light. It is preferable to have the flashlight turned on while the alignment steps are performed so that the user is able to visually confirm the quality of the light beam while moving the movable holder.

Moreover, although the particular order is not essential, the user may: (1) turn on the flashlight; (2) actuate the movable holder and move the substantial point source of light to substantially reduce the asymmetrical or comet-tail effect of the light beam until a substantially symmetrical light beam is observed - which signifies that the substantial point source of light is substantially aligned with the axis of the reflector; and (3) rotate the head assembly to axially translate the point source of light along the reflector axis until the brightest beam is observed - which signifies that the substantial point source of light is substantially aligned with the focal point of the reflector.

With the configuration and the steps above described, a light beam that maximizes the focal properties of a reflector, such as a parabolic reflector, may be achieved. In doing so, unwanted dispersion of light caused by a misaligned point source of light may be substantially reduced. Also, efficient use of battery energy is realized because higher intensity light beam is generated using the same energy. Accordingly, the flashlight according to the present invention operates at a superior optical performance level than previously known flashlights.

In a preferred implementation of the illustrative embodiment, the tail cap 322, the barrel 4, the reflector module 2, the sleeve 146, and the face cap 144, generally forming the external surfaces of the flashlight 10 are manufactured from aircraft quality, heat treated aluminum, which are anodized for corrosion resistance. All interior electrical contact surfaces are preferably appropriately formed or machined to provide efficient electrical conduction. All insulating or non-conducting components are preferably made from polyester plastic or other suitable material for insulation and heat resistance. The reflector 82 is preferably provided with a computer-generated parabolic reflecting surface that is metallized

to ensure high precision optics. Optionally, the reflector 82 may include a electroformed nickel substrate for heat resistance.

The electrical circuit of flashlight 10 will now be described. Referring to FIG. 6, the electrical circuit of flashlight 10 is shown in the closed or ON position. The electrical circuit closes when the movable assembly 40 is sufficiently translated in the aft direction so that the upper contact assembly 70 electrically couples with the circuit assembly 60. Referring to FIGS. 3, 6 and 24, when the electrical circuit is closed, electrical energy is conducted from the rear battery through its center contact which is in connection with the case electrode of the battery disposed forward thereof. Electrical energy is then conducted from the forward battery through its center electrode to the lower contact assembly 80 which is coupled to the circuit assembly 60. The electrical energy then selectively conducts through the electronics of the circuit assembly 60 and to the upper contact assembly 70, which in turn is coupled to the contact base 46 of the positive electrode contact 28. After passing through the filament of the lamp 359, the electrical energy emerges through the lamp electrode 358 which is coupled to the negative electrode contact 29. The curved arm 49 of the negative electrode contact 29 is electrically coupled to the bore 51 of the ball housing 31, which is coupled to the holder housing 22, which in turn is coupled to the spring 108 that is electrically coupled to the contact area 137b of the circuit assembly 60. The electrical energy is conducted to the second recharging ring 7 which is electrically coupled to the forward edge of the barrel 4. The barrel 4 is electrically coupled to the tail cap 322. Finally, the spring member 334 of the tail cap assembly 20 forms an electrical path between the tail cap 322 and the case electrode of the rear battery to complete the electrical circuit. In this manner, an electrical circuit is formed to provide electrical energy to illuminate a light source.

Referring to FIG. 26, to open the electrical circuit or turn OFF the flashlight 10, the user rotates the head assembly 20 to translate the movable assembly 40 sufficiently forward so that the upper contact assembly 70 separates from the contact area 137a of the circuit assembly 60.

The tactile response feature of the present invention will now be described. Referring to FIG. 6, the spring 108 interposed between the movable assembly 40 and the circuit assembly 60 serves, in part, to electrically couple the movable assembly 40 to the circuit assembly 60. The spring 108 also serves to forward bias the movable assembly 40 and, as a result, forward biases the cam follower assembly 50 against the front side of the cam 101. As shown in FIG. 21, the detent 105 is disposed about the forwardmost side of the cam 101. Accordingly,

as the user rotates the head assembly 20 and translates the movable assembly away from the circuit assembly 60 to turn OFF the flashlight 10, the cam follower assembly 50 eventually moves into the detent at a point where the movable assembly 40 is farthest from the circuit assembly 60. Because the cam 101 is otherwise a smooth transitional surface, the user is able to sense the cam follower assembly 50 as it moves into the detent. In this way, a tactile response is provided to the user that the flashlight is held in the OFF position.

Similarly, a detent may be disposed on the cam 101 at a position wherein the electrical circuit is closed. In this instance, the tactile response will indicate to the user that the flashlight is held in the ON position.

Although a rotating type switch that opens and closes the electrical circuit by separating the circuit at the interface between the upper contact assembly 70 and the circuit assembly 60 has been described, the electrical circuit may be closed or opened at other locations.

Moreover, although a rotating type switch has been described, the various aspects of the invention as described herein is not limited by the type of switching scheme employed. Other suitable switch device, such as a push-button switch or an electronic switch may be employed.

The flashlight 10 is preferably a rechargeable flashlight. As described above, the flashlight 10 includes conducting members 5, 7 that are electrically coupled to the circuit assembly 60. Accordingly, a recharging device or a recharger electrically coupled to the conducting members 5, 7 would also be electrically coupled to the circuit assembly 60 and the rechargeable batteries. In this way, the portable source of light may be recharged without removing it from the barrel 4.

Further, although a certain lamp bulb is illustrated in the figures, any suitable substantial point source of light device may be used with the teaching according to the present invention. The means to secure and to make electrical connections to other suitable substantial point source of light devices should be known to those skilled in the art. Also, the teaching according to the present invention may be used with an arc lamp, LED, or other light emitting devices to improve the quality of light produced therefrom.

Various embodiments of improved high quality flashlights and their respective components have been presented in the foregoing disclosure. While preferred embodiments of the herein invention have been described, numerous modifications, alterations, alternate embodiments, and alternate materials may be contemplated by those skilled in the art and may be utilized in accomplishing the

various aspects of the present invention. For example, while the front end assembly includes an aspect for moving the substantial point source of light as well as an aspect for turning the flashlight on and off, use of the point source of light aspect of the present invention may be employed together or independently from any other aspects disclosed herein. It is envisioned that all such alternate embodiments are considered to be within the scope of the present invention as described by the appended claims.

What is claimed is:

1. A combination for use in moving a light source relative to a reflector, the combination comprising:

a reflector including a first open end adapted to emit a light beam, a second end, and a reflector axis extending between said first open end and said second end;

a light source;

a movable light source holder including an actuation interface, wherein said movable holder holds said light source in a position between said first open end and said second end of said reflector and is adapted to move said light source laterally in response to an actuation force applied to said actuation interface.

2. A combination of claim 1, wherein said actuation interface is a socket.

3. A combination of claim 2, wherein said socket defines a first actuation axis, wherein said movable light source holder moves about said first actuation axis, wherein said first actuation axis is not coincident with the reflector axis.

4. A combination of claim 2, wherein said socket defines a first axis, wherein said movable light source holder is caused to move by maneuvering said first axis relative to the reflector axis.

5. A combination of claim 1 further including an actuating member coupled to said actuation interface and adapted to transmit the actuation force to the actuation interface.

6. A combination of claim 5, wherein said actuating member is a lever removably coupled to the actuation interface of said movable lamp bulb holder.

7. A combination of claim 1 further including means for maintaining the position of said light source with respect to said reflector axis after said light source is moved relative to said reflector axis.

8. A combination of claim 1, wherein said light source includes two electrodes with a filament extending between said two electrodes.

9. A combination of claim 1, wherein said movable light source holder includes a substantially spherical housing.

10. A combination of claim 1 further comprising a securing mechanism to maintain the position of said movable light source holder after said light source has been moved relative to said reflector axis.

11. A flashlight comprising:

a housing for retaining one or more batteries, said housing having a first end and a second end;

a reflector, fixed to said first end of said housing, including a first open end adapted to emit a light beam, a second end and a reflector axis extending therebetween;

an illumination source;

a movable holder including an actuation interface, wherein said movable holder holds said illumination source in a position between said first open end and said second end of said reflector and is adapted to selectively adjust the position of said illumination source relative to said reflector axis in response to an actuation force applied to said actuation interface; and

an electrical circuit coupling said illumination source to said one or more batteries.

12. A flashlight of 11, wherein said movable holder moves about a first actuation axis, wherein said first actuation axis is not coincident with said reflector axis.

13. A flashlight of claim 12, wherein said movable holder is movable about a second actuation axis, wherein said second actuation axis is not coincident with said actuation axis or said reflector axis.

14. A flashlight of claim 11 further including an actuating member coupled to said actuation interface for moving said movable holder.

15. A flashlight of claim 11 further including a head removably mounted to said reflector, said head having a removable sleeve, wherein said sleeve covers said actuation interface when secured to said reflector, and wherein said

sleeve uncovers and facilitates access to said actuation interface when separated from said reflector.

16. A flashlight of claim 15 further including a switch for completing and interrupting said electrical circuit, wherein said switch completes and interrupts said electrical circuit in response to rotation of said head.

17. A flashlight of claim 11 further including a conducting member interposed between said housing and said head, wherein said conducting member is externally accessible and electrically coupled to said electrical circuit.

18. A flashlight of claim 11 further including a conducting member for recharging said one or more batteries without removing said one or more batteries from said housing, wherein said conducting member is electrically coupled to said electrical circuit.

19. A flashlight of claim 11 further including a variable length conductor, which axially contracts or expands in response to pressure from said one or more batteries, interposed between and electrically coupling said illumination source and one or more batteries, wherein said variable length conductor is configured to selectively electrically couple or de-couple said illumination source and said one or more batteries.

20. A flashlight of claim 11, wherein said movable holder includes a substantially spherical housing.

21. A flashlight of claim 20, wherein said spherical housing moves within a spherical envelope.

22. A flashlight of claim 11 further including means for aligning said source of light with a focal point of said reflector.

23. A flashlight of claim 11, wherein said movable holder is controllably translatable in a direction along said reflector axis to vary the relative axial position of said illumination source with respect to the focal point of said reflector.

24. A flashlight of claim 11, wherein said illumination source includes a pair of electrodes and a filament extending between said electrodes.

25. A flashlight of claim 24, wherein said movable holder further comprises means for maintaining said electrodes in electrical communication with said one or more batteries when said movable holder is moved.

26. A flashlight of claim 11 wherein said movable holder further includes a curved conductor interposed in said electrical circuit and operably connected to said illumination source, said curved conductor adapted to maintain electrical contact between said illumination source and said one or more batteries while moving said illumination source relative to said axis of the reflector.

27. A flashlight of claim 26, wherein said curved conductor includes a first contact and a second contact electrically connected to said first contact, said first contact adapted to couple with said illumination source, said second contact includes a curved area for maintaining an electrical contact location relative to an adjacent electrically connecting conductor.

28. A flashlight of claim 11, wherein said movable holder moves said illumination source in a non-linear path.

29. A flashlight of claim 11, further comprising a holding spring biased against said movable holder for maintaining a position of said illumination source with respect to said reflector axis in the absence of an actuation force.

30. A flashlight of claim 11 further including means for maintaining the position of said illumination source with respect to said reflector axis after said illumination source is positioned relative to said reflector axis.

31. A flashlight of claim 11 further including a spring conductor means operably coupled to a center electrode of said one or more batteries for protecting said one or more batteries from damage.

32. A lighting device comprising:

a housing for receiving a source of energy;

a substantial point source of light coupled to said source of energy;

a reflector including an axis and an open end for reflecting light generated by said substantial point source of light, said open end adapted for emitting a beam of light;

a movable holder to hold said substantial point source of light; and,

means for moving said movable holder to align said substantial point source of light with said axis of said reflector.

33. A lighting device of claim 32, wherein said reflector is fixed to an end of said housing.

34. A lighting device of claim 32 further including means for aligning said substantial point source of light with a focal point of said reflector.

35. A lighting device of claim 32 further including a switch for controlling energy from said portable source of energy to said substantial point source of light.

36. A lighting device of claim 35 wherein said switch is adapted to close or open in response to translation of said holder.

37. A lighting device of claim 36, wherein said switch includes a tactile response feature to indicate that the switch is open.

38. A lighting device of claim 32 further including means for translating said substantial point source of light along said reflector axis.

39. A lighting device of claim 32 further including a securing mechanism to maintain the position of said movable holder after said substantial point source of light has been substantially aligned with the focal point of said reflector.

40. A device of claim 32, further comprising a cam to control the movement of said movable holder.

41. A lighting device of claim 32, wherein said substantial point source of light is positioned on a filament extending between a pair of electrodes.

42. A lighting device of claim 32 further including an adaptable conductor means interposed between said source of energy and said substantial point source of light, said adaptable conductor means adapted to maintain electrical contact between said substantial point source of light and said source of energy while aligning said substantial point source of light with said axis of said reflector.

43. A lighting device of claim 32 further including means for maintaining the position of said substantial point source of light with respect to said reflector axis after said substantial point source of light is aligned with said reflector axis.

44. A lighting device of claim 32 further including a spring conductor means operably coupled to a center electrode of said source of energy for protecting said source of energy from damage.

45. A method of aligning a substantial point source of light emanating from a filament of a lamp bulb with a flashlight reflector axis, the method comprising:

attaching the lamp bulb to a movable bulb holder adapted to position the filament of the lamp bulb within the reflector adjacent to an end of the reflector opposite a light beam emitting end; and

selectively adjusting the movable bulb holder to move the substantial point source of light of the filament of the lamp bulb from a first position laterally displaced from the reflector axis to a second position aligned with the reflector axis.

46. A method of claim 45, wherein the step of selectively adjusting results in the filament moving laterally relative to the reflector axis.

47. A method of claim 45, wherein the movable bulb holder includes an actuation interface and the step of moving the step of selectively adjusting includes applying an actuation force to the actuation interface to maneuver the movable bulb holder.

48. A method of claim 47, wherein the actuation force is applied to the actuation interface via an actuating member coupled with the actuation interface.

49. A method of claim 45, wherein the step of selectively adjusting moves the substantial point source of light of the filament along a non-linear path from the first position to the second position.

50. A method of claim 46 further including the step of confirming alignment of the substantial point source of light of the filament to the reflector axis by visually observing the quality of the light beam emanating from the reflector.

51. A method of claim 50, wherein the step of confirming alignment of the substantial point source of light of the filament includes visually observing the symmetry of the light beam emanating from the reflector.

52. A method of claim 45 further including a step of varying the position of the reflector relative to the filament to align the substantial point source of light of the filament with a focal point of the reflector.

53. A method of claim 52 further including the step of confirming alignment of the substantial point source of light of the filament with the focal point of the reflector by visually observing the quality of the light beam emanating from the reflector.

54. A method of claim 52, wherein the step of confirming alignment of the substantial point source of light of the filament with the focal point includes visually observing the light intensity of the light beam emanating from the reflector.

55. A flashlight comprising:

means for housing a portable source of electrical energy;

a bulb means including electrodes operably connected to said portable source of electrical energy through an electrical circuit and a filament extending between said electrodes for generating light;

means for translating a substantially axisymmetrical reflector for forming a beam of light generated by said filament, said reflector including a first open end adapted to emit said beam of light, a second end adapted to receive said lamp bulb extending toward said first open end, an axis extending from said second end to said first open end and a focal point located on said axis;

a movable means for holding and moving said lamp bulb; and

an actuating means operatively coupled to said movable means for moving said filament relative to said reflector axis.

56. A combination for use in moving a light source relative to a reflector, the combination comprising:

a reflector including a first open end adapted to emit a light beam, a second end, and a reflector axis extending between said first open end and said second end;

a light source;

a movable light source holder including an actuation interface, wherein said movable holder holds said light source in a position between said first open end and said second end of said reflector and is adapted to permit selective movement of said light source in response to an actuation force applied to said actuation interface from a first position laterally displaced from the reflector axis to a second position aligned with said reflector axis.

57. A flashlight including the combination according to claim 56.

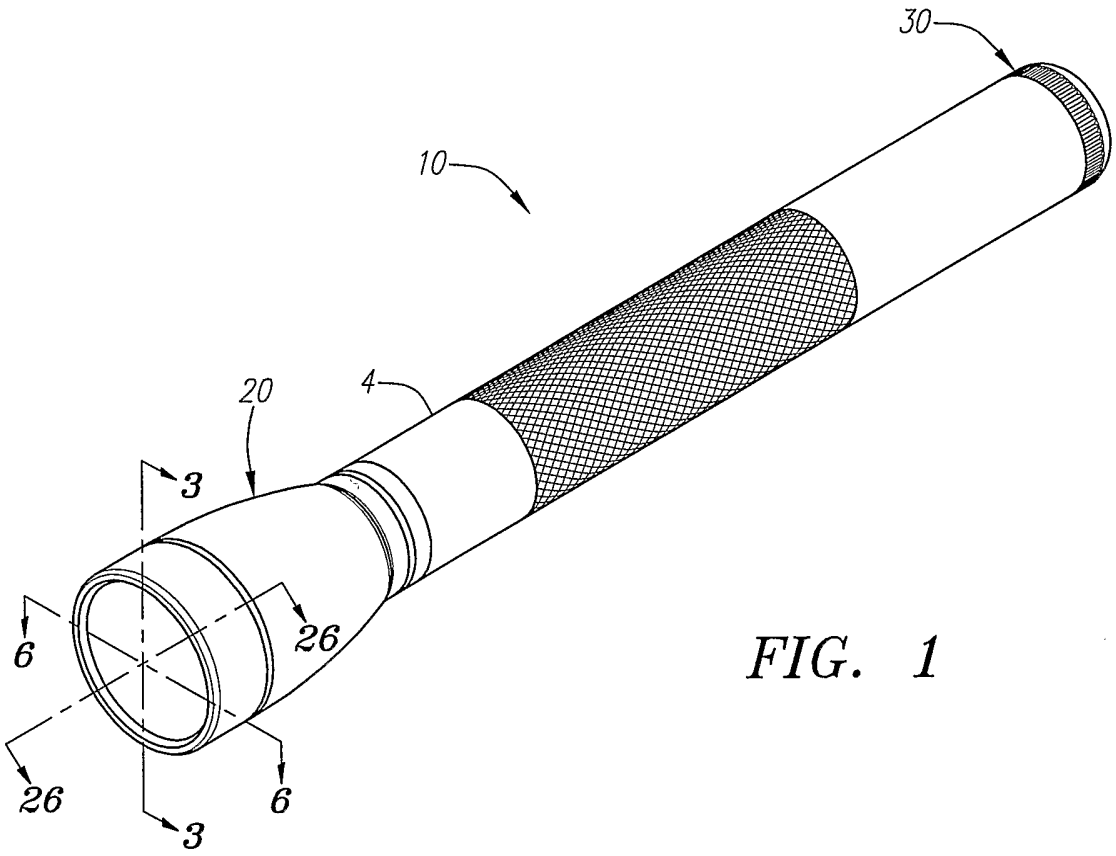

FIG. 1

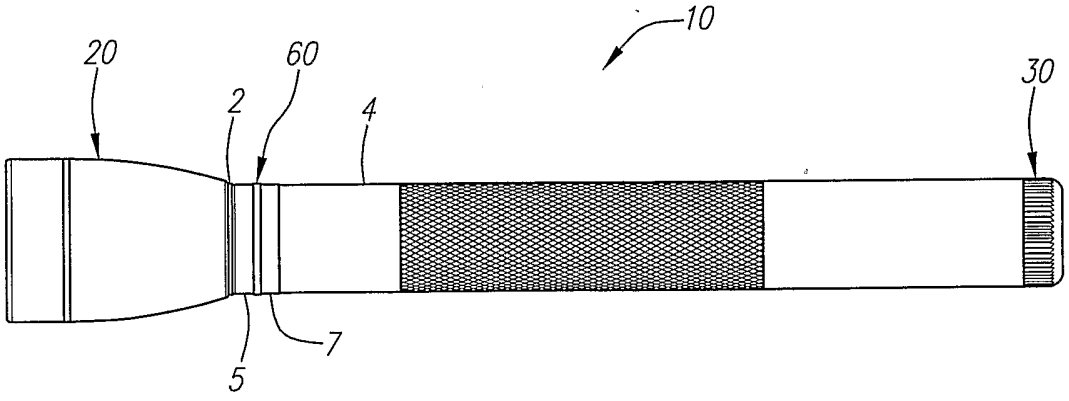

FIG. 2

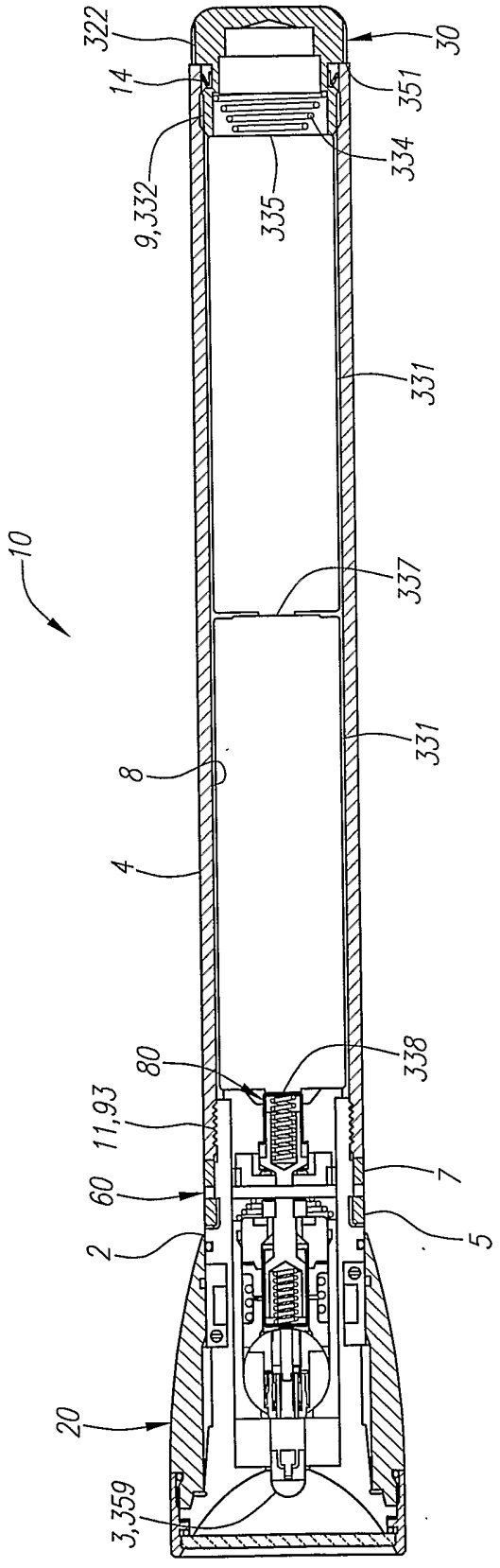
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FIG. 3

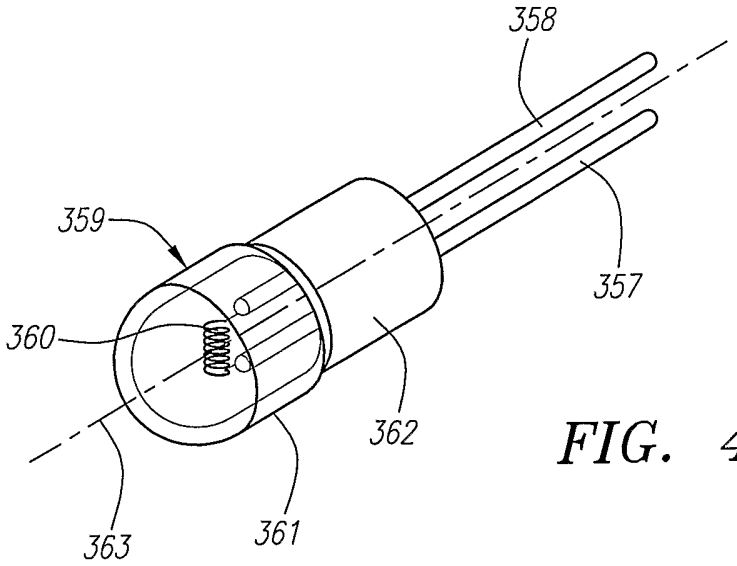

FIG. 4

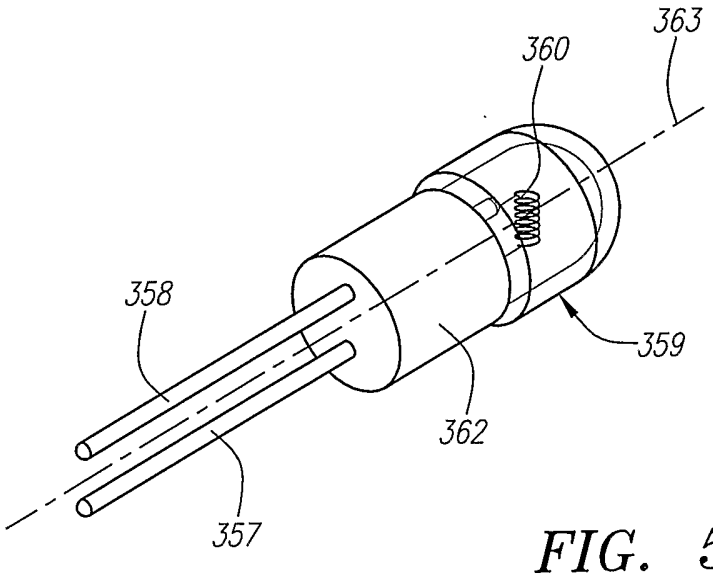

FIG. 5

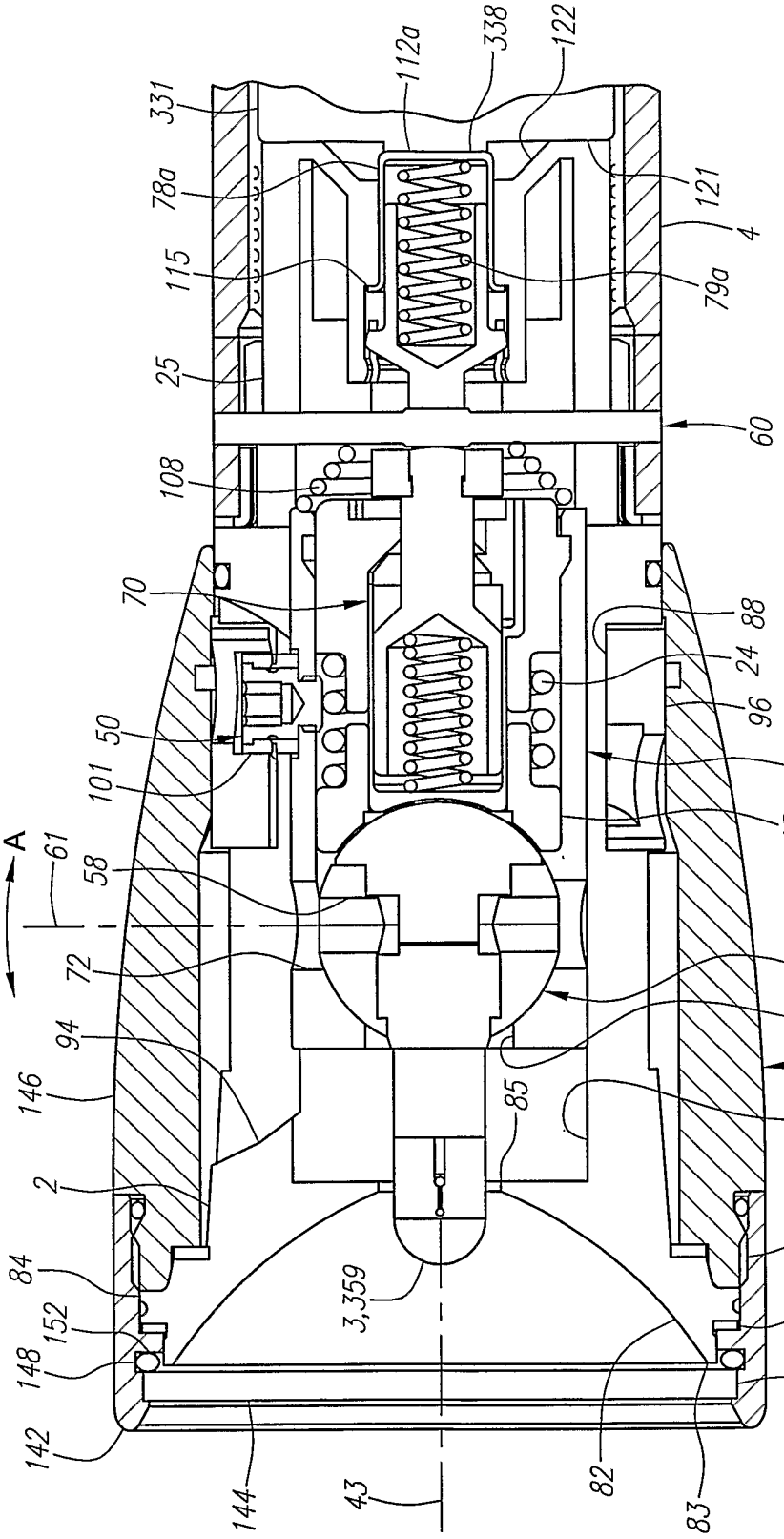
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FIG. 6

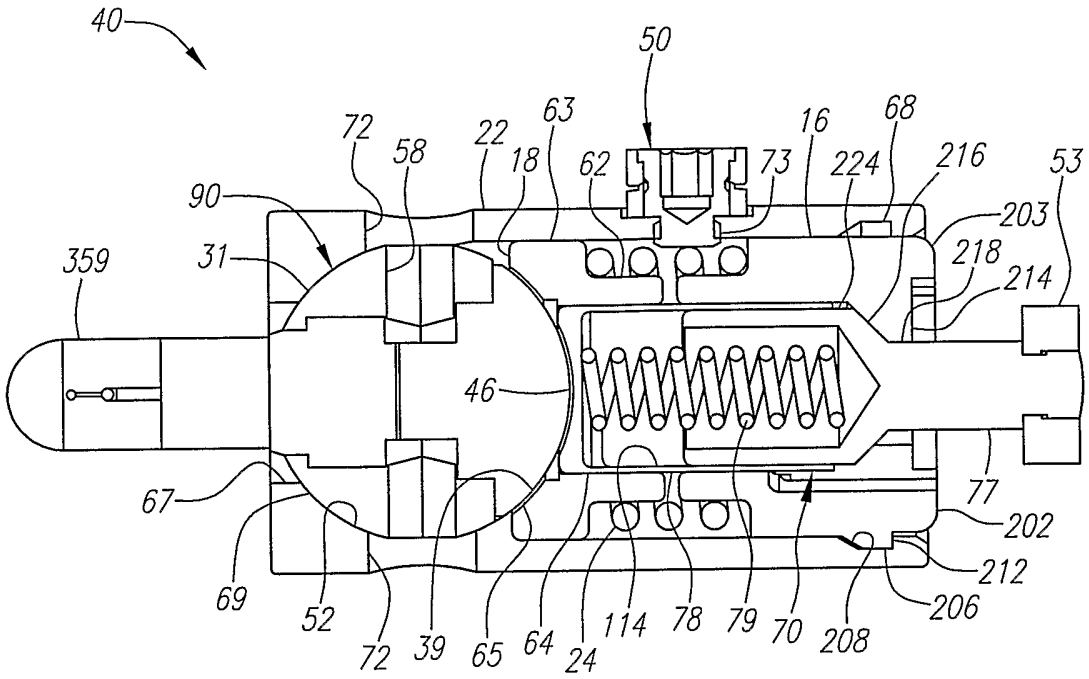
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FIG. 7

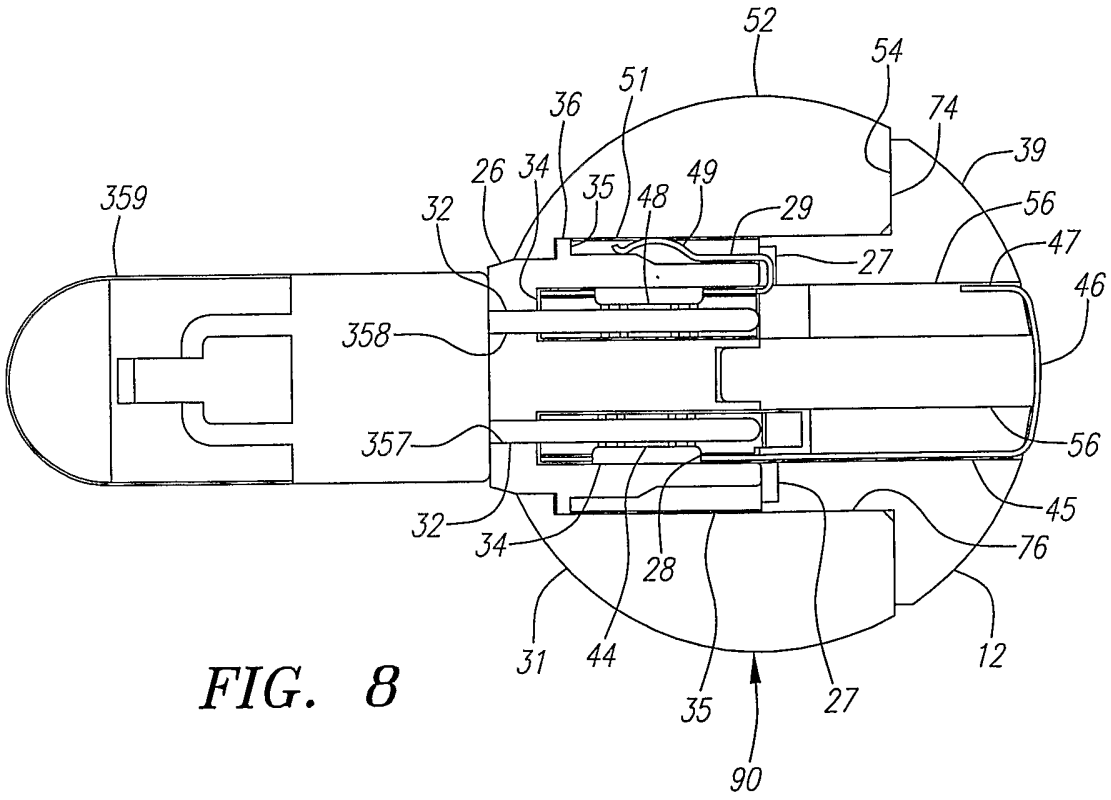
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FIG. 8

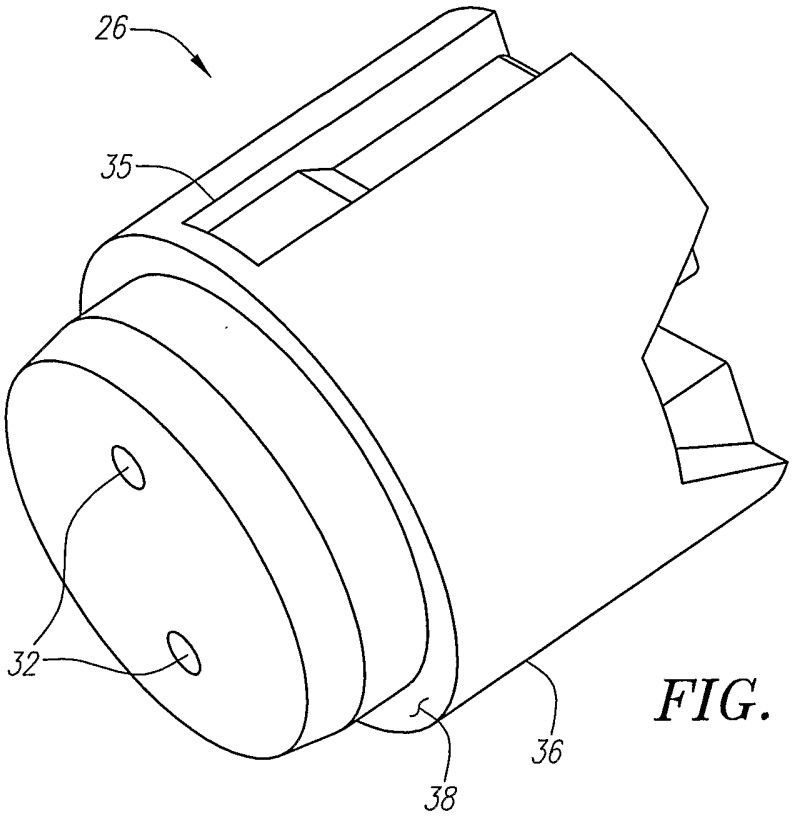

FIG. 9

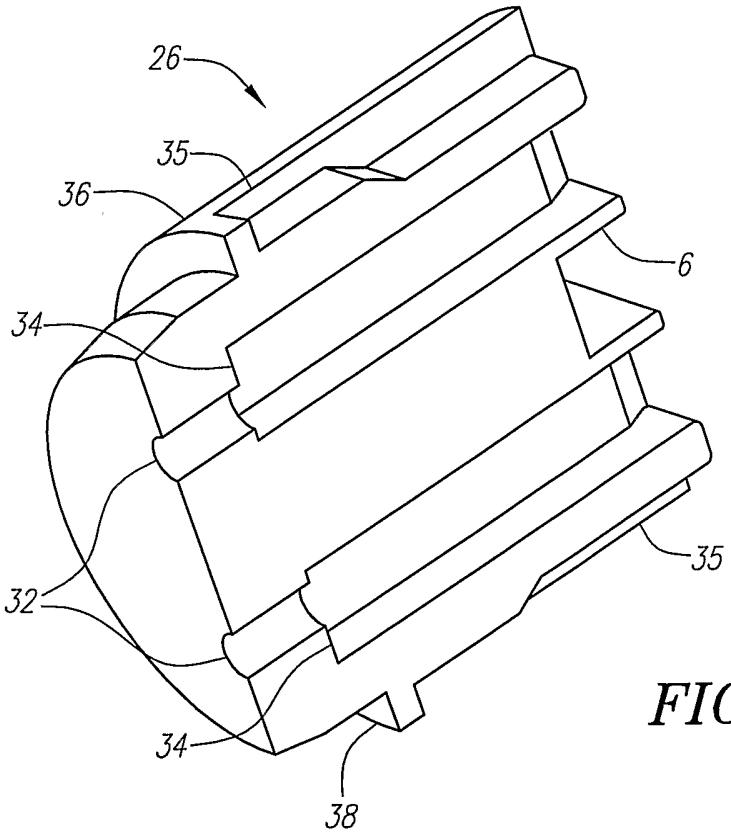

FIG. 10

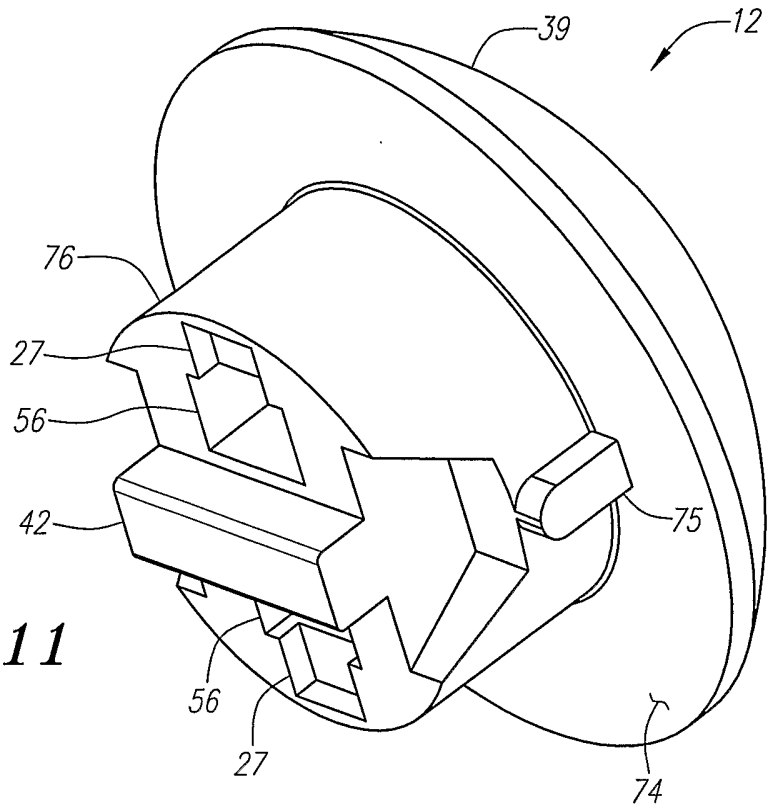

FIG. 11

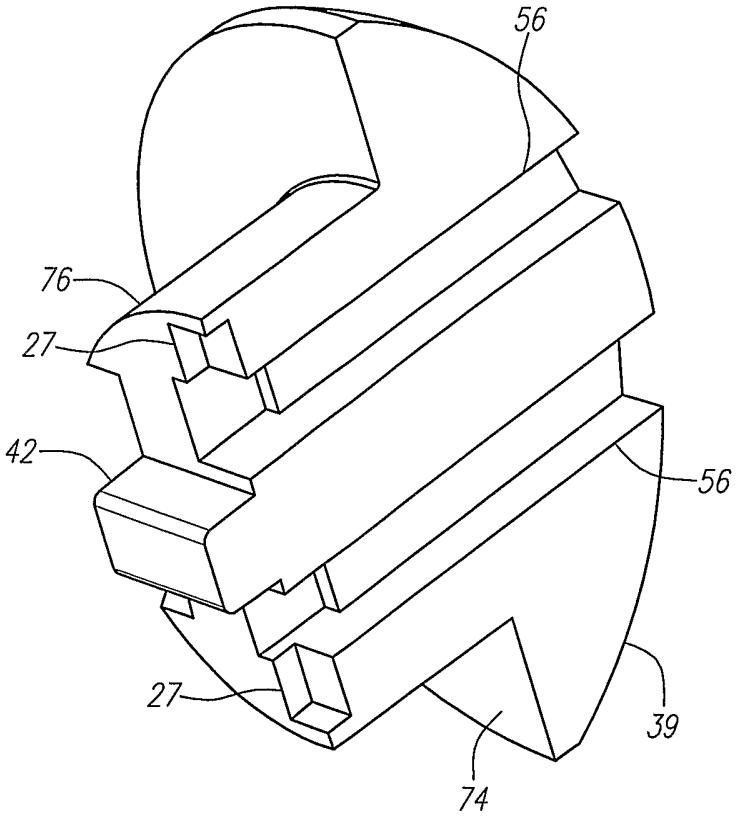

FIG. 12

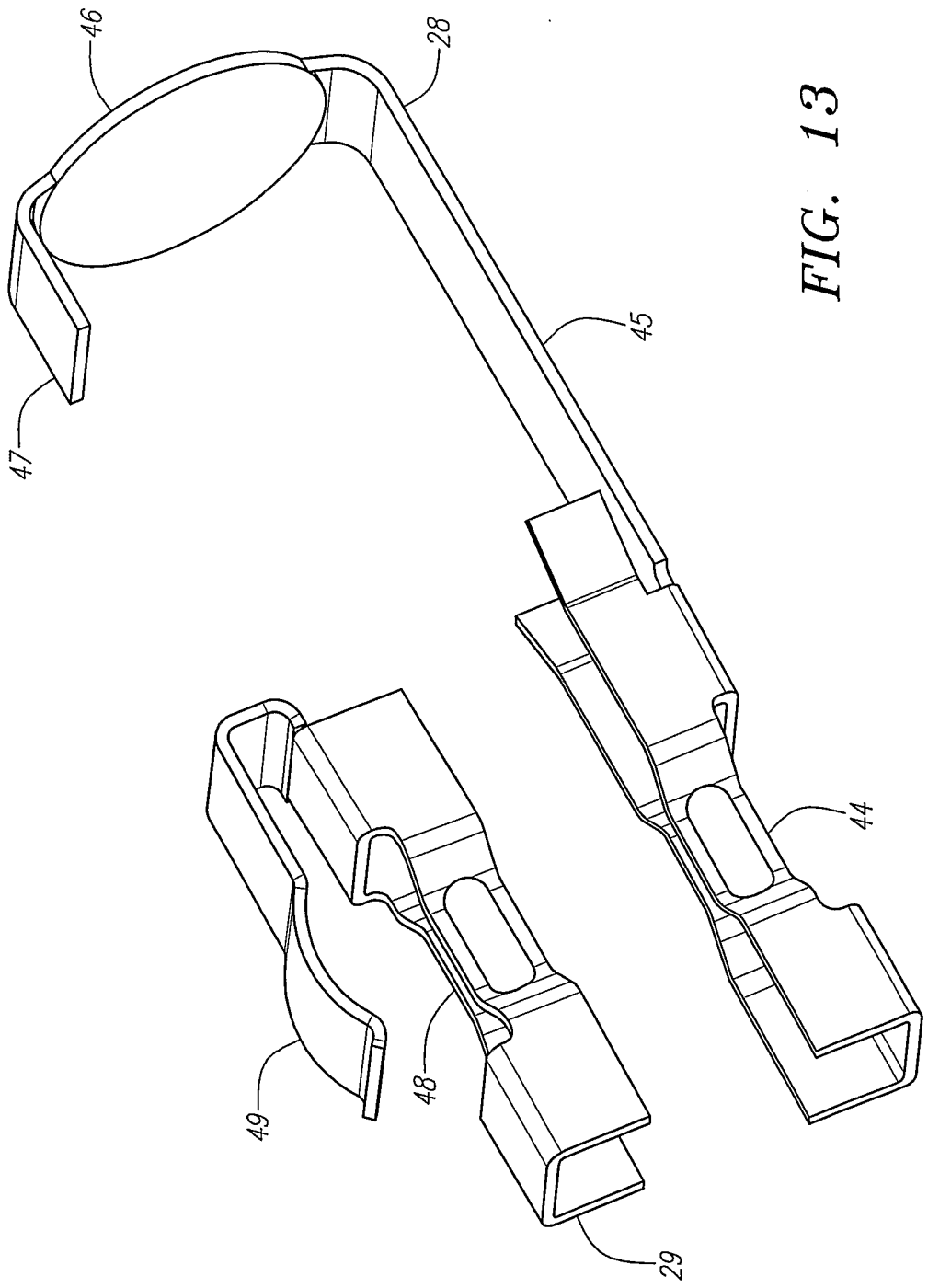

FIG. 13

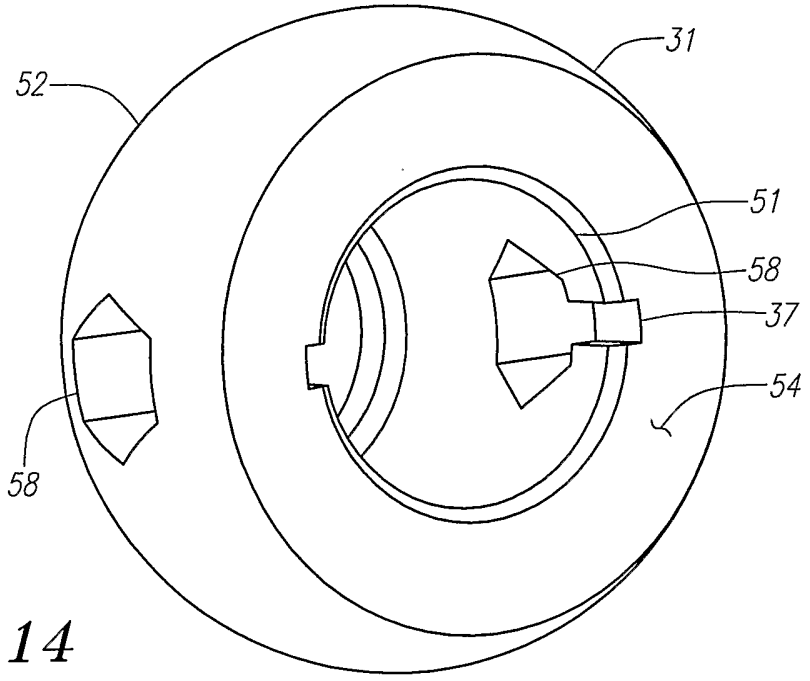
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FIG. 14

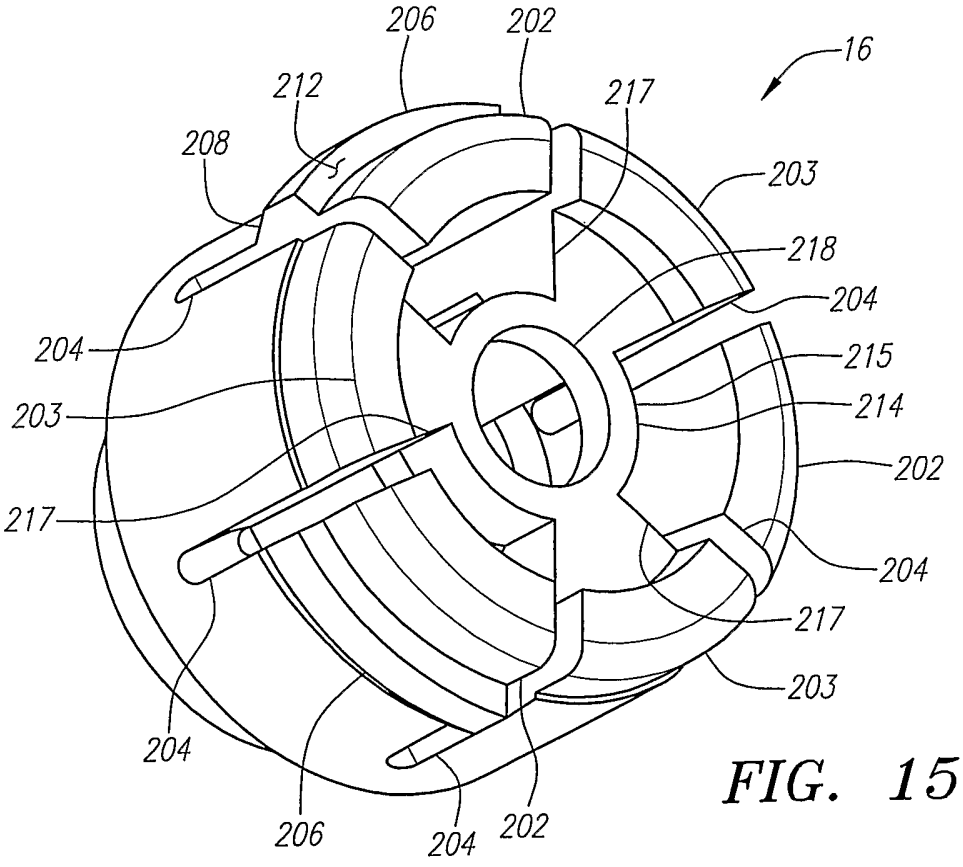
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FIG. 15

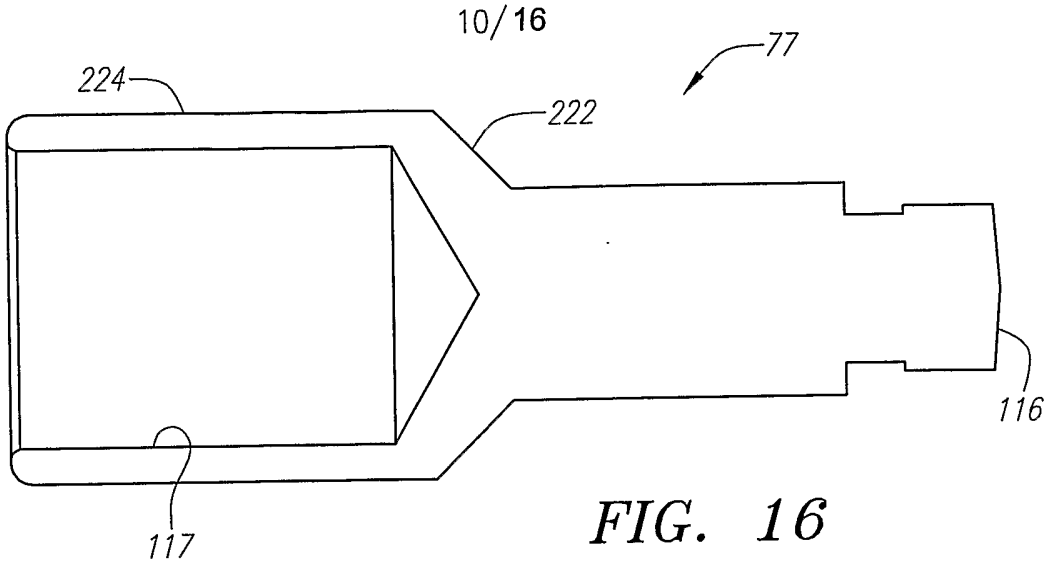

FIG. 16

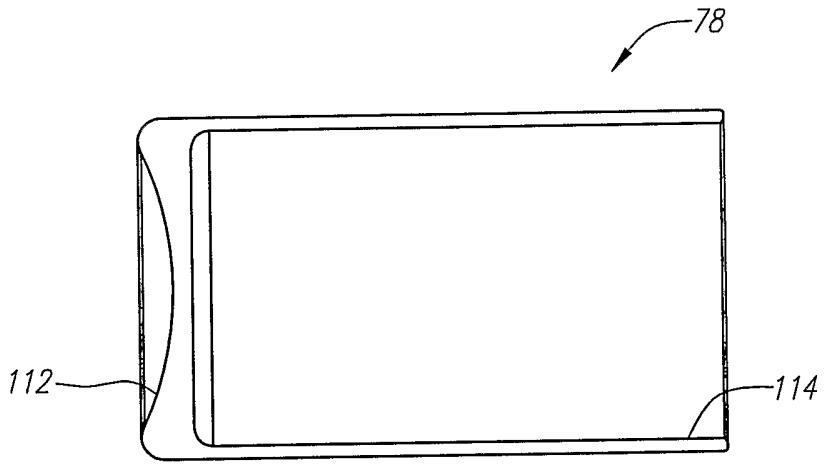

FIG. 17

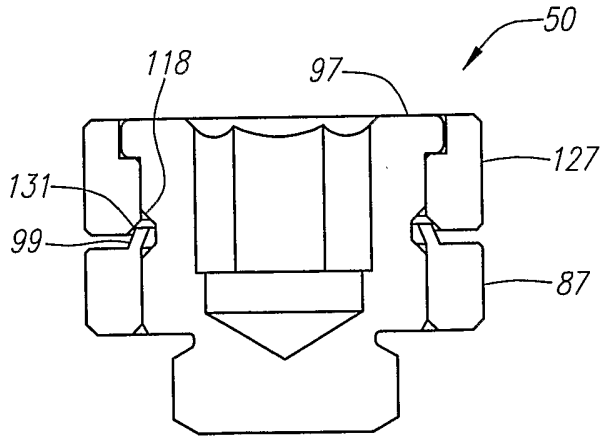

FIG. 18

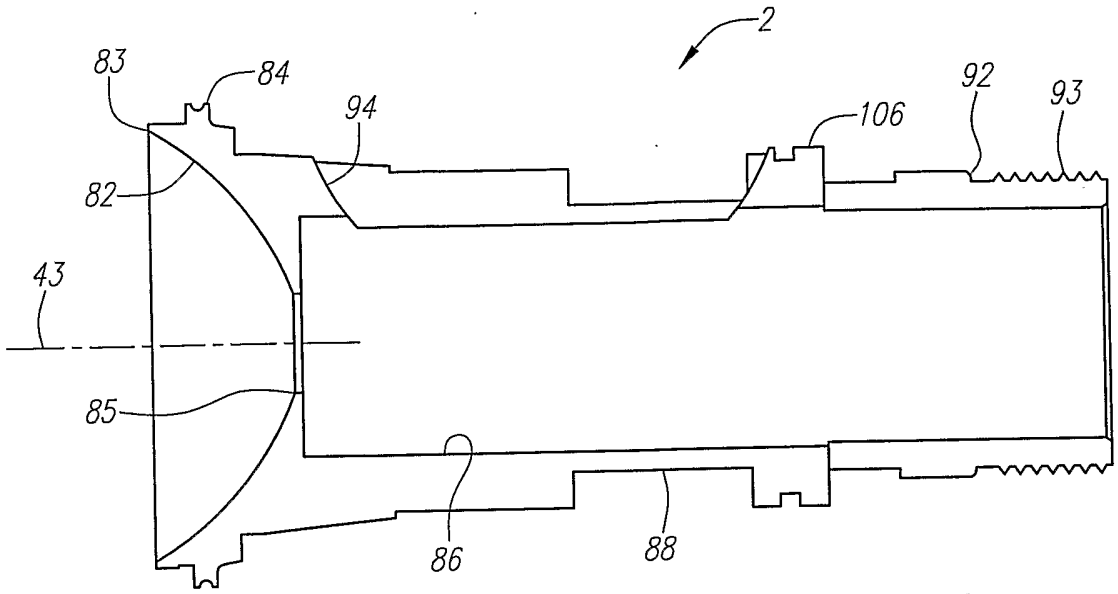

FIG. 19

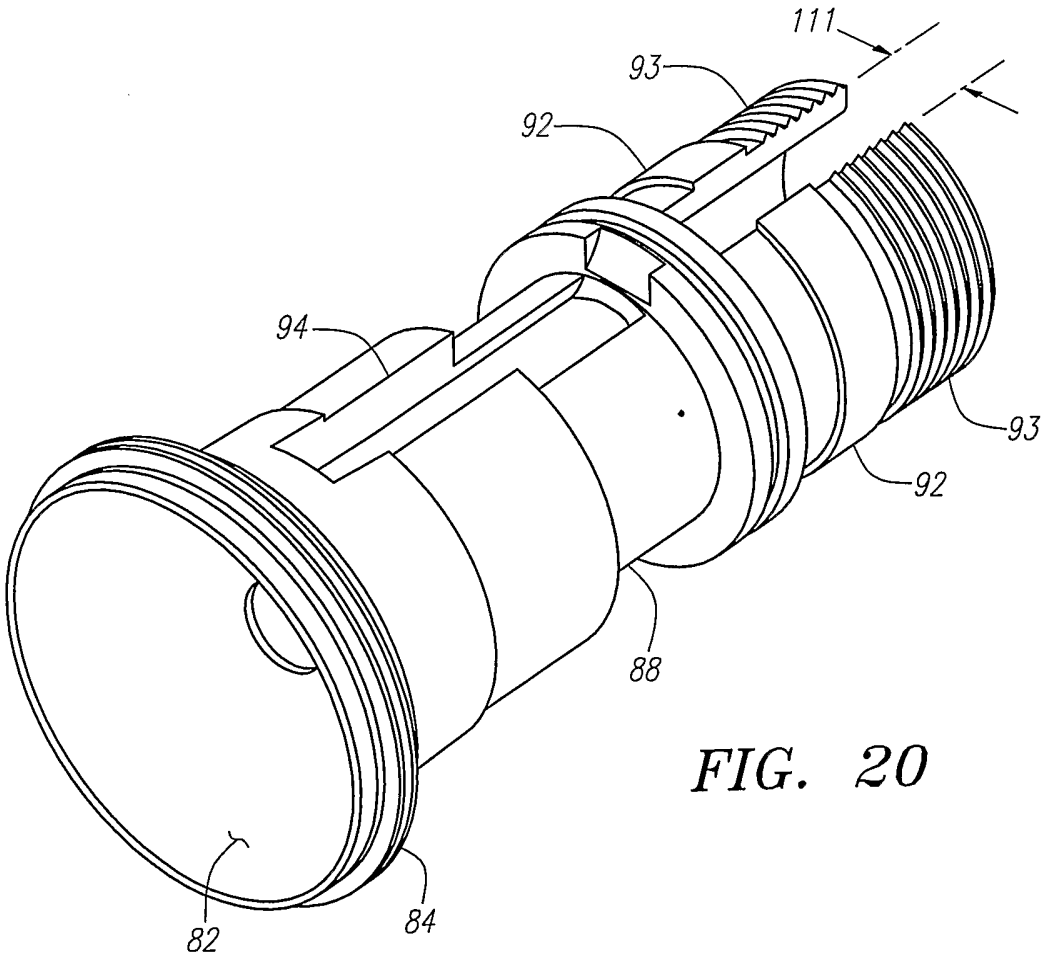

FIG. 20

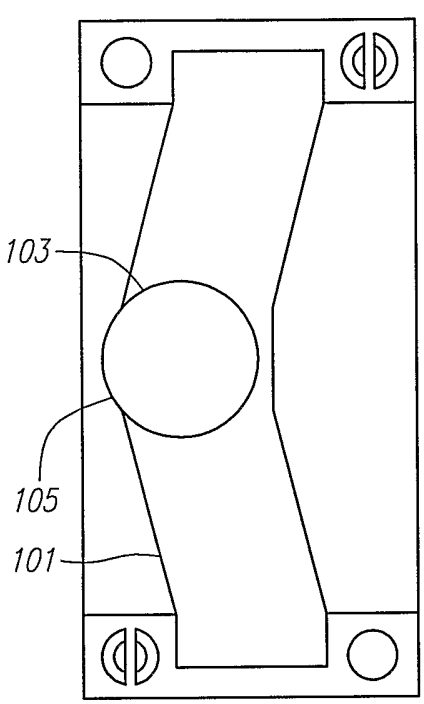

FIG. 21

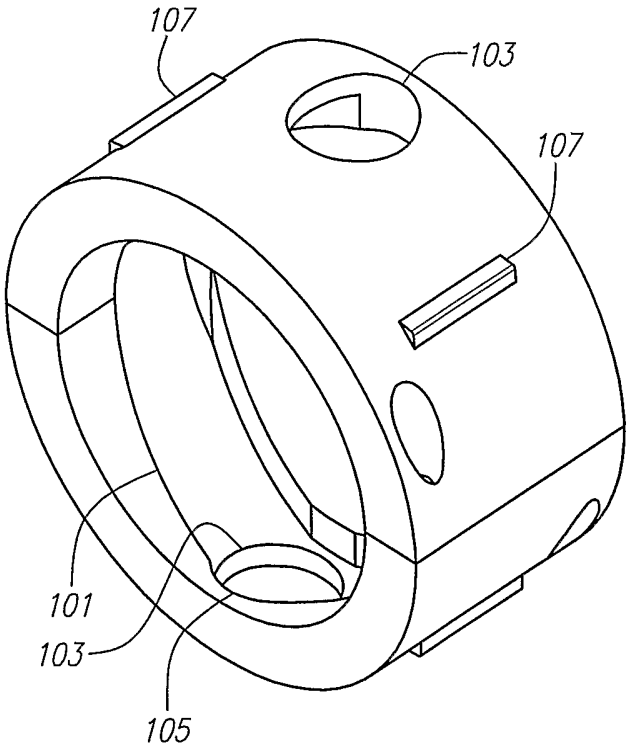

FIG. 22

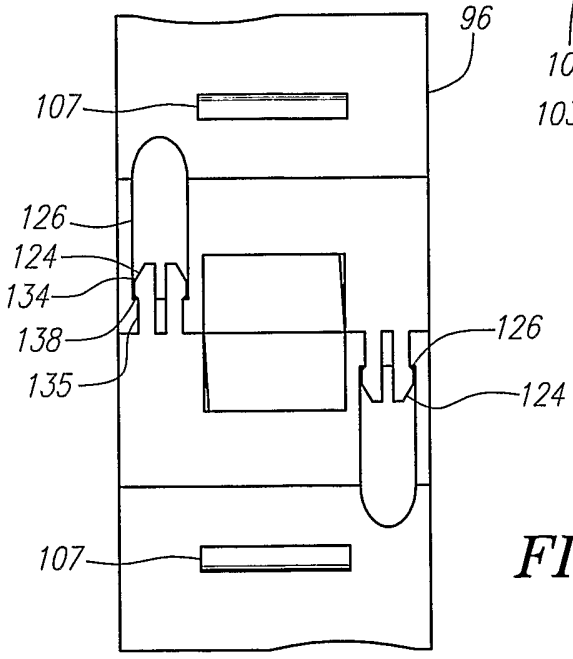

FIG. 23

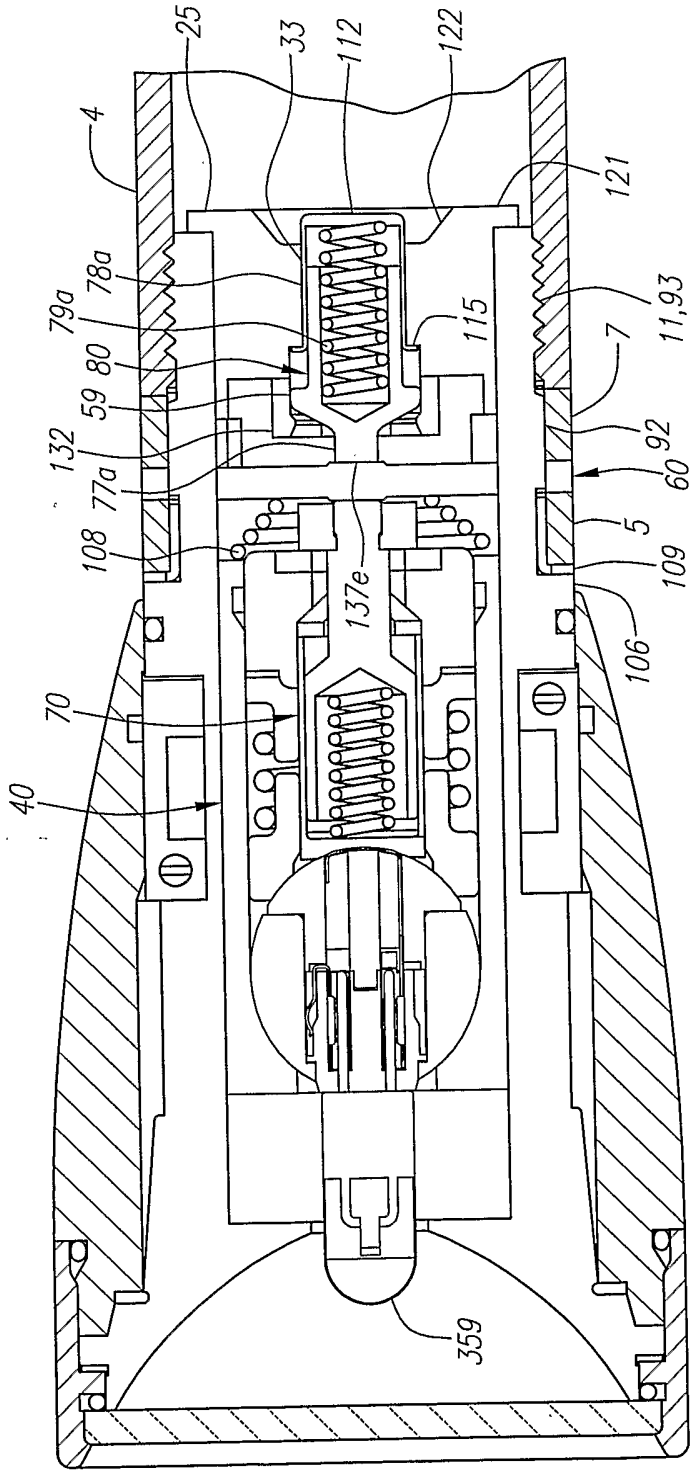
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FIG. 24

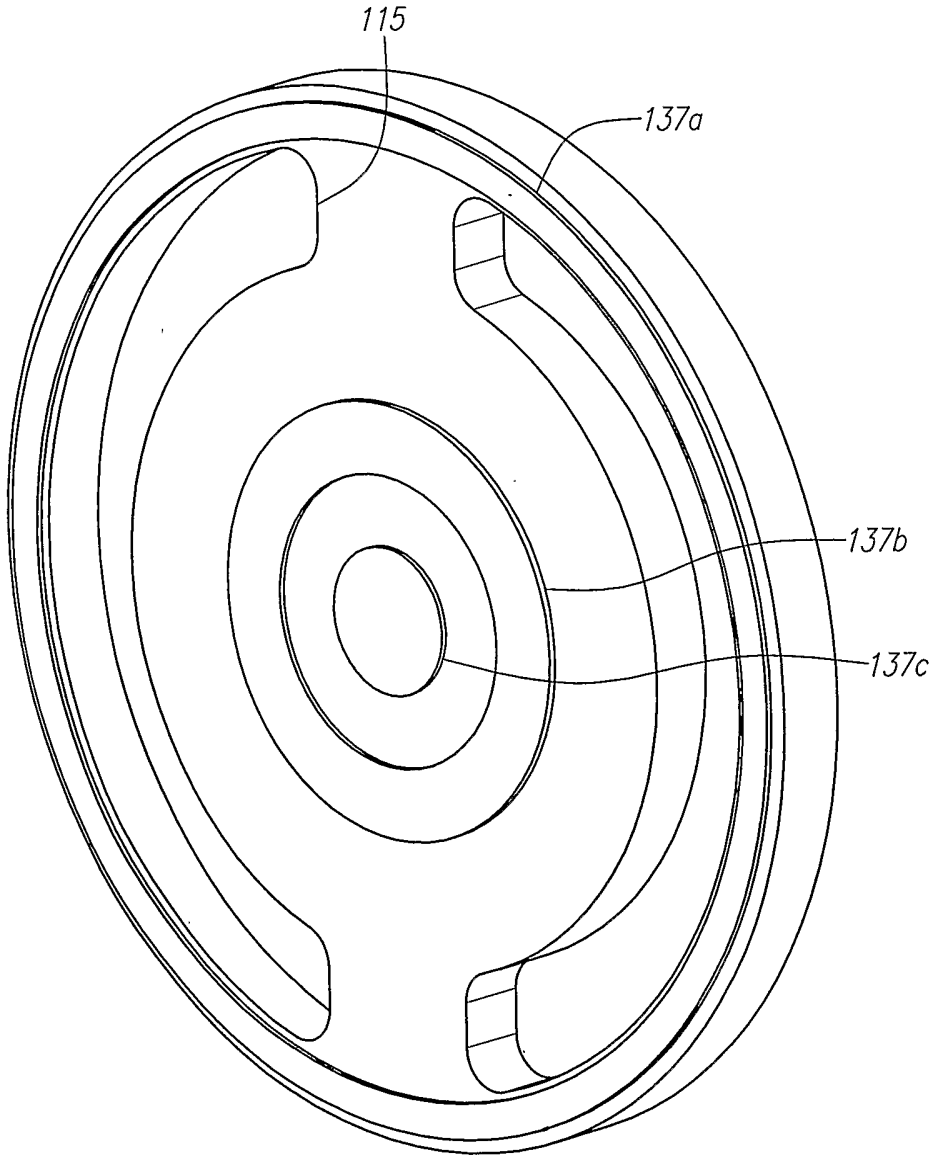

FIG. 25

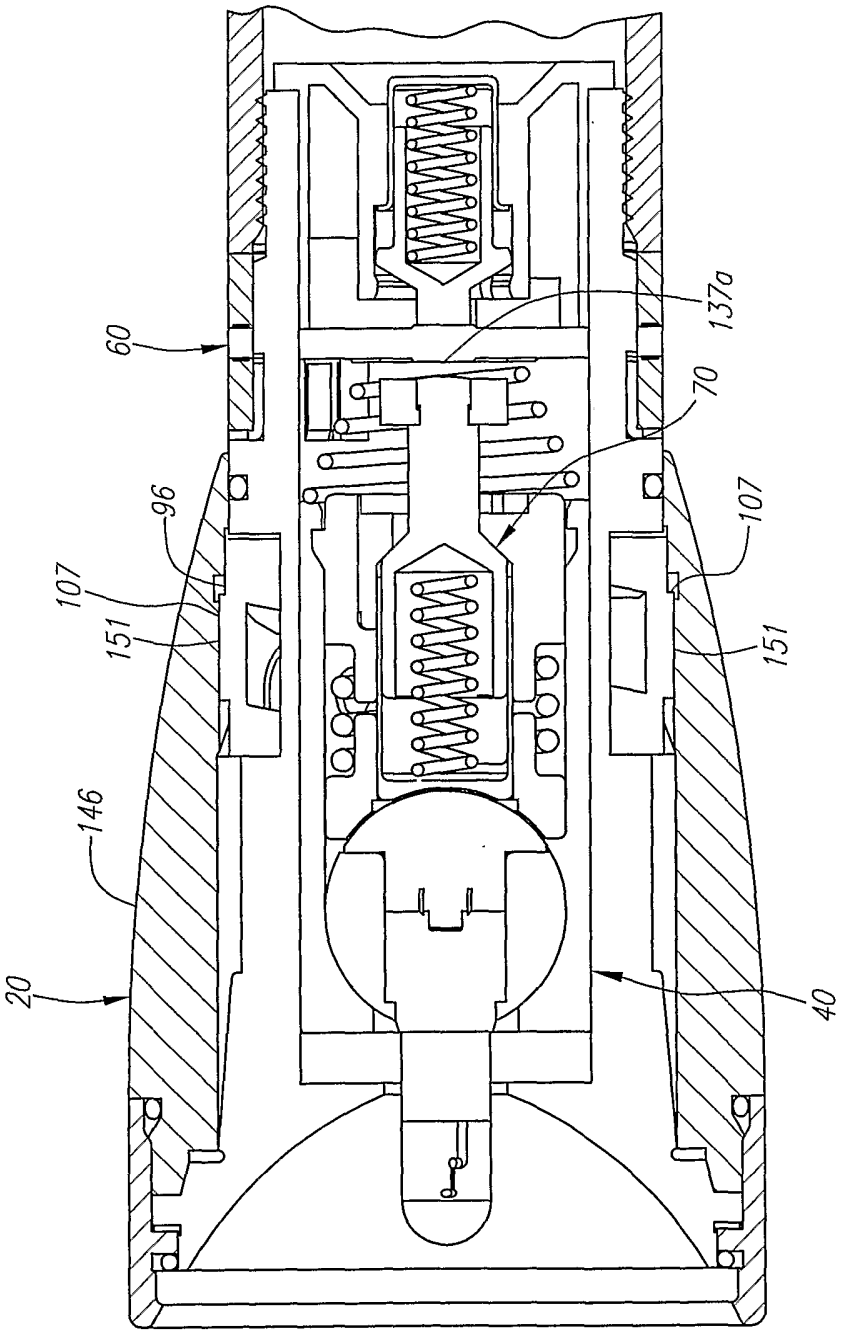

FIG. 26

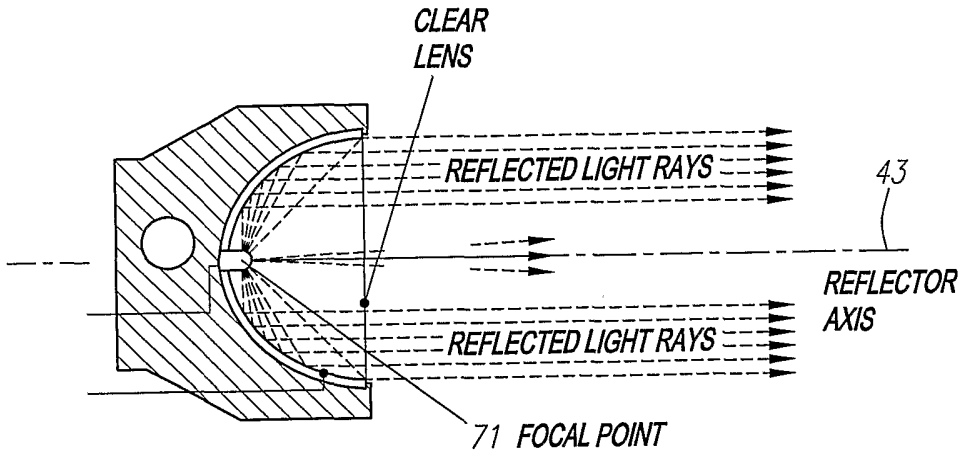
CLEAR
LENS
REFLECTED LIGHT RAYS
43
REFLECTOR
AXIS
REFLECTED LIGHT RAYS
71 FOCAL POINT

FIG. 27