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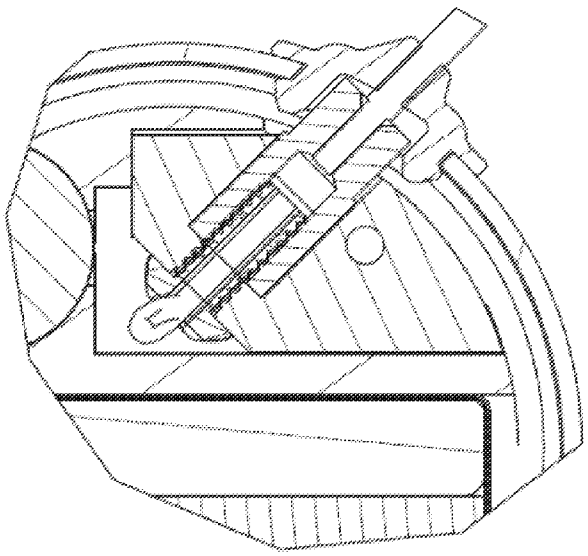

(57) Abstract: A compact connector system for electrical connections, including power, signal and antenna connections. A threaded male connector comprising a head portion and an externally threaded shaft portion that defines a longitudinal axis includes a bore that runs parallel to the longitudinal axis. A conductor is joined to the interior surface of the bore, for example by soldering. A threaded female connector connects to the external threads of the threaded male connector to complete the circuit. The system can also include a dielectric block that defines a cavity for mounting the threaded male and female connectors thereto.

ANTENNA BLOCK ASSEMBLY WITH HOLLOW CONNECTOR

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Patent Application No. 61/548,622, filed October 18, 2011, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates to antenna mounts and methods of construction. More particularly, the present invention relates to an antenna block assembly with a screw assembly utilizing a hollow shaft mated to a conductor.

BACKGROUND

Miniature electrical connectors are favored in compact systems requiring durability in a compact design. One example where such connectors find utility is in the area of "throwable" robots. Throwable robots are utilized in reconnaissance operations where the robot, housing a camera and other sensors, is tossed to a remote location and data transmitted to a remote receiving unit. Certain throwable robots are designed for weights less than 2 kg, and dimensions commensurate with hand throwing operation. Accordingly, a compact design is favored in all aspects, including power and antenna connectors.

The use of threaded male connectors as a connecting link for antenna systems is known in the art. Typically, the head of the fastener is modified with recesses on the surface to accept an antenna wire, which is then soldered onto the head of the fastener. The threaded end of the fastener is routed through a dielectric block, and can be connected to a complementary female connector to complete the antenna circuit.

While the head of the fastener can more or less retain its original shape after the soldering operation, an excess of solder can result in small solder protrusions that extend beyond the profile of the fastener head. Such protrusions can result in unwanted grounding of the antenna, particularly where the connecting link is in tight quarters proximate grounded objects. Furthermore, the conductive path passing through the fastener is not shielded, which can result in degraded antenna performance.

A threaded male connector link that maintains the original profile of the threaded male connector while providing a shielded link to the antenna would be welcome.

SUMMARY OF THE INVENTION

Various embodiments of the invention maintain the original profile of the fastener head by eliminating the requirement of applying solder to the faster head. Also, a shielded conductor, such as a coaxial cable, can be utilized to maintain better integrity of the antenna signal.

In one embodiment of the invention, a conductor (e.g. a signal wire) is routed through a passage that passes through a shaft of a fastener. The conductor is joined to the threaded end of the fastener to form an electrical connection between the fastener and the conductor. The joining of the conductor to the inside of the connector helps prevent the conductor and fastener assembly from shorting to adjoining assemblies that can occur when soldering a conductor is instead soldered to a head of the screw.

In one embodiment, the conductor is an externally threaded screw or bolt having a head at one end and a tip at an opposing end, the screw or bolt including a hollow passageway forming a cylindrical interior surface along the central axis of the screw. A conductor can be inserted into the threaded screw or bolt such that a portion of the insulator surrounding the conductor is disposed within the hollow passageway. The exposed end of the conductor can be soldered to the interior surface near the tip of the screw or bolt such that an electrical connection is formed between the conductor and the threaded screw. The assembled conductor and threaded screw can be installed in a mounting block thereby reducing the risk of the conductor forming a short circuit with other components associated with the mounting block.

In one embodiment, a robotic control system comprises a hand held transceiver and a throw robot configured for wireless communication with the hand held transceiver, the throw robot including a connector system. The connector system comprises a dielectric mounting block including structure defining a stepped passage therethrough, the stepped passage defining a mounting cavity having an interior surface that defines a major inner diameter, the stepped passage further defining an aperture having an interior surface that defines a minor inner diameter, the major diameter being greater than the minor diameter. A threaded male connector is disposed in the stepped passage, the threaded male connector including a head portion at a proximal end and a shaft portion that extends to a distal end, the head portion and the shaft portion being concentric about a longitudinal axis, the shaft portion including external threads formed thereon, the head portion being

arranged to cap the aperture of the dielectric mounting block, the threaded portion extending into the mounting cavity of the dielectric mounting block, the threaded male connector defining a through bore that is parallel to the longitudinal axis. The threaded male connector can be formed from a standard fastener. A conductor is disposed in the through bore of the threaded male connector, the conductor being electrically coupled to an interior surface of the through bore of the threaded male connector. A threaded female connector is adapted to fit within the mounting cavity, the threaded female connector defining a through bore that includes internal threads that engage the external threads of the threaded male connector. The connector system provides an electrical path that passes through the conductor, the threaded male connector and the threaded female connector. In one embodiment, the interior surface of the aperture includes threads formed thereon for coupling with the threaded male connector. The conductor can be electrically coupled to the interior surface of the through bore of the threaded male connector by a solder joint, and/or at the distal end of the shaft.

The connector system can also include an electrically insulating sleeve that surrounds the conductor along a portion of the length of the conductor. An electrical shield that surrounds the conductor and the electrically insulating sleeve along the portion of the length of the conductor. A distal end of the through passage of the threaded female connector can also include an unthreaded bore portion for crimping to an external conductor, such as an antenna. The threaded female connector can be comprised of brass.

In another embodiment, a method of providing an electrical connection includes providing a dielectric mounting block that includes structure defining a stepped passage therethrough, the stepped passage defining a mounting cavity having an interior surface that defines a major inner diameter, the stepped passage further defining an aperture having an interior surface that defines a minor inner diameter, the major diameter being greater than the minor diameter. A threaded male connector is also provided, the threaded male connector including a head portion at a proximal end and a shaft portion that extends to a distal end, the head portion and the shaft portion being concentric about a longitudinal axis, the shaft portion including external threads formed thereon, the threaded male connector defining a through bore that extends parallel to the longitudinal axis. A threaded female connector adapted to fit within the mounting cavity is also provided, the threaded female connector defining a through passage that includes internal threads that engage the external threads of the threaded male connector. The conductor is electrically

coupled to an interior surface of the through bore of the threaded male connector. The threaded male connector is inserted into the stepped passage so that the head portion caps the aperture of the dielectric mounting block and the threaded portion extends into the mounting cavity of the dielectric mounting block. The the threaded female connector is inserted into the mounting cavity of the dielectric mounting block and coupled with the internal threads of the threaded female connector with the external threads of the threaded male connector while the threaded portion of the threaded male connector is extended into the mounting cavity of the dielectric mounting block. An external conductor can be coupled to a distal end of the threaded female connector. The step of electrically coupling the external conductor to the distal end of the threaded female connector can include crimping the threaded female connector to the external conductor. The interior surface of the aperture of the dielectric mounting block provided in the step of providing the dielectric mounting block can also include interior threads for coupling with the external threads of the threaded male connector, the method further comprising threadably engaging the external threads of the threaded male connector with the interior threads of the aperture of the dielectric mounting block. The conductor can also be soldered to the interior surface of the through bore of the threaded male connector in the step of electrically coupling.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the present invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

FIG. 1 is a front view of a throwable robot utilizing an embodiment of the invention;

FIG. 2 is a sectional view of the throwable robot of FIG. 1;

FIG. 3 is an enlarged, partial view of the section view of FIG. 2;

FIG. 4 is a perspective view of a dielectric block assembly according to an embodiment of the invention;

FIG. 5 is a rear view of the block assembly of FIG. 4;

FIG. 6A is a front view of the block assembly of FIG. 4;

FIG. 6B is a front view of the block assembly of FIG. 4 at a vantage that is substantially normal to a threaded male connector;

FIG. 7 is a sectional view of a dielectric mounting block of FIG. 4;

FIG. 8 is a cut away view depicting the threaded male connector installed in the block assembly of FIG. 4;

FIG. 9 is the cut away view of FIG. 8 with a threaded female connector coupled to the threaded male connector; and

FIG. 10 is an exploded view of the block assembly of FIG. 4.

While the present invention is amendable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the present invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to FIGS. 1 and 2, a throwable robotic device 20 is depicted in an embodiment of the invention. The robotic device 20 includes a housing 22 supported between two wheels 24. A pair of antennae 26 extend from the housing 22. Each of the antennae 26 are mounted to a dielectric block assembly 28 that is secured within the housing 22. The throwable robotic device 20 is configured to communicate with a hand held transceiver 29.

Referring to FIGS. 3-9, a connector system 30 of the block assembly 28 is depicted in an embodiment of the invention. The block assembly 28 includes a stepped passage 32 passing through a dielectric block 33 along a central axis 34. The stepped passage 32 defines a mounting cavity 36 and an aperture 38 (FIG. 7). The mounting cavity 36 includes an interior surface 42 that defines a major inner diameter 44. The aperture 38 includes an interior surface 46 that defines a minor inner diameter 48. The minor inner diameter 48 of the aperture 38 is of smaller dimension than the major inner diameter 44 of the mounting cavity 36. In one embodiment, the interior surface 46 of the aperture 38 includes threads 50 formed thereon (FIG. 7).

In the depicted embodiment, a threaded male connector 52 is disposed in the stepped passage 32. The threaded male connector 52 includes a head portion 54 at a proximal end 56 and a shaft portion 58 that extends to a distal end 62, the shaft portion 58 having external threads 60 formed thereon. The head portion 54 and the shaft portion 58 can be concentric about a longitudinal axis 64. The threaded male connector 52 also defines a through bore 66 that passes through the threaded male connector 52 parallel to the longitudinal axis 64, the through bore 66 having an interior surface 68. The head portion 54 can include wrench flats 70 (FIG. 5) to facilitate rotation of the threaded male connector 52. In various embodiments, the through bore 66 is concentric with the longitudinal axis 64 to form a central bore, as depicted in the various figures. In one embodiment, the threaded male connector 52 is formed from a standard fastener, such as a bolt or screw. Thus, the head portion 54 can be a hex configuration, for example a #4-40 x ¼" machine screw with a central bore of approximately 3/16" diameter.

A conductor 72 is disposed in the through bore 66 of the threaded male connector 56. The conductor 72 is secured to the interior surface 68 of the through bore 66 to provide an electrical coupling thereto. In one embodiment, the electrical coupling is provided by a solder joint 71. In one embodiment, the conductor 72 is secured to the interior surface 68 of the through bore 66 proximate the distal end 62 of the threaded male connector 52. In one embodiment, the conductor 72 is the central conductor of a coaxial cable, having an electrically insulating sleeve 73 surrounding the conductor and an electrical shield (e.g., a woven metallic braid) surrounding the insulating sleeve. The conductor 72 can also be terminated with a mating plug 75. The mating plug 75 can be any of a variety of connectors configured to mate, for example, with a transmitting or receiving circuit.

The block assembly 28 also includes a threaded female connector 74 disposed in the mounting cavity 36 and coupled to the threaded male connector 52. The threaded female connector 74 includes a through bore 76 having internal threads 78 formed at least at a proximal end 82 thereon that mate with the external threads 60 of said threaded male connector 52. A distal end 84 of the threaded female connector 74 can be of a straight bore 86 (i.e., unthreaded) to facilitate mating with an external conductor 88, for example, by crimping.

Thus, the connector system 30 provides an electrical path that passes through the conductor 72, the threaded male connector 52, the threaded female connector 74 and the external conductor 82.

In assembly, the major inner diameter 44 can be dimensioned to provide an annular space 92 between the threaded male connector 52 and the interior surface 42 of the mounting cavity 36. The threaded female connector 74 and the annular space 92 are dimensioned so that the threaded female connector 74 fits within the annular space 92 when threaded onto the threaded male connector 52.

A heat shrink sheath 94 can affixed around the electrically insulating sleeve 73 of the conductor 72 to provide a secure fit between the insulating sleeve 73 and the through bore 66 of the conductor 72. In one embodiment, the threaded male connector 52 is threadably engaged with threads 50 formed on the interior surface 46 of the aperture 38. Locktite, or another thread sealant, can be used to secure the threaded male connector 52 to the block assembly 28.

In one embodiment of the present invention the conductor 72 is inserted into the through bore 66 such that an exposed end of the conductor 72 is proximate to the distal end 62 of the threaded male connector 52. The exposed end of the center conductor is joined (e.g. soldered) to the tip of the connector before the connector is installed in the mounting cavity 36 of the block assembly 28.

The threaded female connector 74 can be joined to the external conductor 88 by, for example, a crimping or a soldering operation, or by other joining techniques available to the skilled artisan. In one embodiment, the threaded female connector 74 is then threaded onto the threaded male connector 52 to complete the electrical connection.

The embodiments above are intended to be illustrative and not limiting. Although aspects of the present invention have been described with reference to particular embodiments, those skilled in the art will recognize that changes can be made in form and detail without departing from the spirit and scope of the invention, as defined by the claims.

Persons of ordinary skill in the relevant arts will recognize that the invention may comprise fewer features than illustrated in any individual embodiment described above. The embodiments described herein are not meant to be an exhaustive presentation of the ways in which the various features of the invention may be combined. Accordingly, the

embodiments are not mutually exclusive combinations of features; rather, the invention may comprise a combination of different individual features selected from different individual embodiments, as understood by persons of ordinary skill in the art.

For purposes of interpreting the claims for the present invention, it is expressly intended that the provisions of Section 112, sixth paragraph of 35 U.S.C. are not to be invoked unless the specific terms "means for" or "step for" are recited in the subject claim.

CLAIMS

What is claimed is:

1. A robotic control system, comprising:

a hand held transceiver;

a throw robot configured for wireless communication with said hand held transceiver, said throw robot including a connector system, the connector system comprising:

a dielectric mounting block including structure defining a stepped passage therethrough, said stepped passage defining a mounting cavity having an interior surface that defines a major inner diameter, said stepped passage further defining an aperture having an interior surface that defines a minor inner diameter, said major diameter being greater than said minor diameter;

a threaded male connector disposed in said stepped passage, said threaded male connector including a head portion at a proximal end and a shaft portion that extends to a distal end, said head portion and said shaft portion being concentric about a longitudinal axis, said shaft portion including external threads formed thereon, said head portion being arranged to cap said aperture of said dielectric mounting block, said threaded portion extending into said mounting cavity of said dielectric mounting block, said threaded male connector defining a through bore that is parallel to said longitudinal axis;

a conductor disposed in said through bore of said threaded male connector, said conductor being electrically coupled to an interior surface of said through bore of said threaded male connector; and

a threaded female connector adapted to fit within said mounting cavity, said threaded female connector defining a through bore that includes internal threads that engage said external threads of said threaded male connector,

wherein said connector system provides an electrical path that passes through said conductor, said threaded male connector and said threaded female connector.

2. The control system of claim 1, wherein said interior surface of said aperture includes threads formed thereon for coupling with said threaded male connector.

3. The control system of claims 1 or 2, wherein said conductor is electrically coupled to said interior surface of said through bore of said threaded male connector by a solder joint.

4. The control system of claims 1, 2 or 3, wherein said conductor is electrically coupled to said interior surface of said through bore of said threaded male connector at said distal end of said shaft.

5. The control system of claim 4, further comprising an electrically insulating sleeve that surrounds said conductor along a portion of the length of said conductor.

6. The control system of claim 5, further comprising an electrical shield that surrounds said conductor and said electrically insulating sleeve along said portion of the length of said conductor.

7. The control system of any of the previous claims, wherein a distal end of said through passage of said threaded female connector includes an unthreaded bore portion for crimping to an external conductor.

8. The control system of claim 7, wherein said external conductor is an antenna.

9. The control system of claims 7 or 8, wherein said threaded female connector is comprised of brass.

10. The control system of any of the previous claims, wherein said threaded male connector is formed from a standard fastener.

11. A method of providing an electrical connection, comprising:

providing a dielectric mounting block that includes structure defining a stepped passage therethrough, said stepped passage defining a mounting cavity having an interior surface that defines a major inner diameter, said stepped passage further defining an aperture having an interior surface that defines a minor inner diameter, said major diameter being greater than said minor diameter;;

providing a threaded male connector said threaded male connector including a head portion at a proximal end and a shaft portion that extends to a distal end, said head portion and said shaft portion being concentric about a longitudinal axis, said shaft portion including external threads formed thereon, said threaded male connector defining a through bore that extends parallel to said longitudinal axis;

providing a threaded female connector adapted to fit within said mounting cavity, said threaded female connector defining a through passage that includes internal threads that engage said external threads of said threaded male connector;

electrically coupling said conductor to an interior surface of said through bore of said threaded male connector;

inserting said threaded male connector into said stepped passage so that said head portion caps said aperture of said dielectric mounting block and said threaded portion extends into said mounting cavity of said dielectric mounting block; and

inserting said threaded female connector into said mounting cavity of said dielectric mounting block and coupling said internal threads of said threaded female connector with said external threads of said threaded male connector while said threaded portion of said threaded male connector is extended into said mounting cavity of said dielectric mounting block.

12. The method of claim 11 further comprising electrically coupling an external conductor to a distal end of said threaded female connector.

13. The method of claim 12, wherein the step of electrically coupling said external conductor to said distal end of said threaded female connector includes crimping said threaded female connector to said external conductor.

14. The method of claim 11 wherein said interior surface of said aperture of said dielectric mounting block provided in the step of providing said dielectric mounting block includes interior threads for coupling with said external threads of said threaded male connector, the method further comprising threadably engaging said external threads of said threaded male connector with said interior threads of said aperture of said dielectric mounting block.

15. The method of claim 11, wherein said conductor is soldered to said interior surface of said through bore of said threaded male connector in the step of electrically coupling.

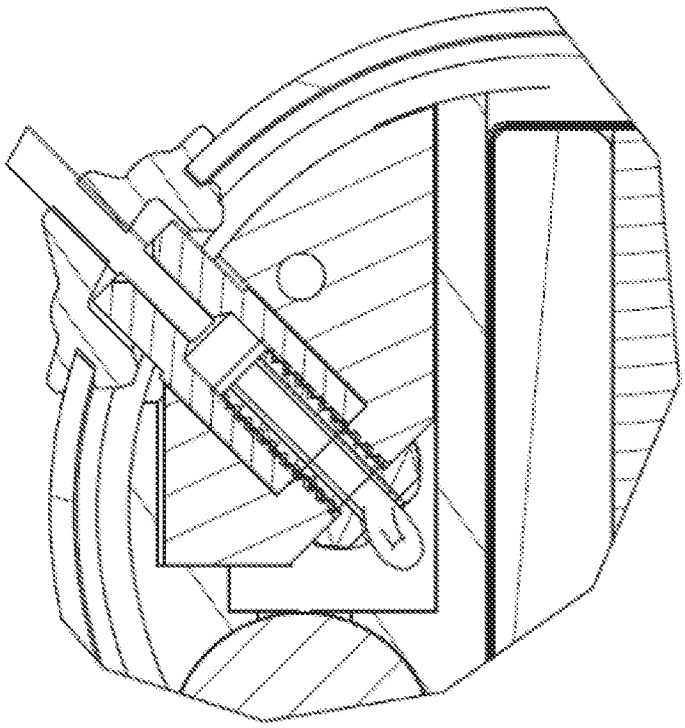

FIG. 3

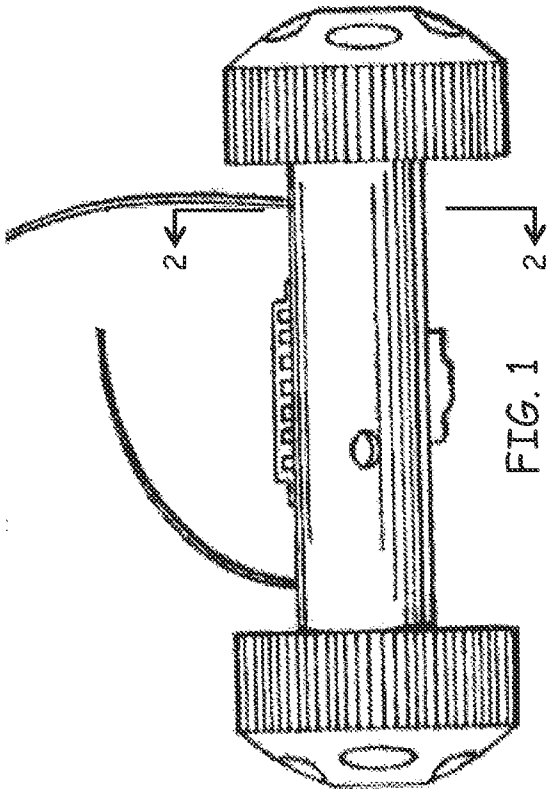

FIG. 1

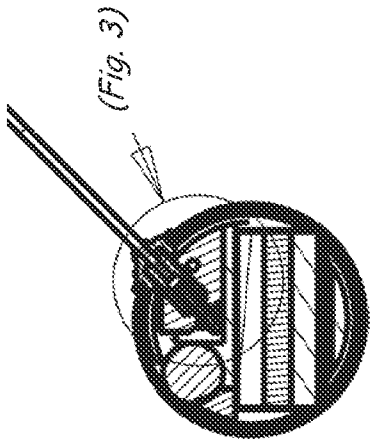

FIG. 2

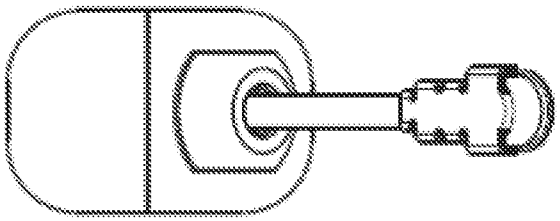

FIG. 5

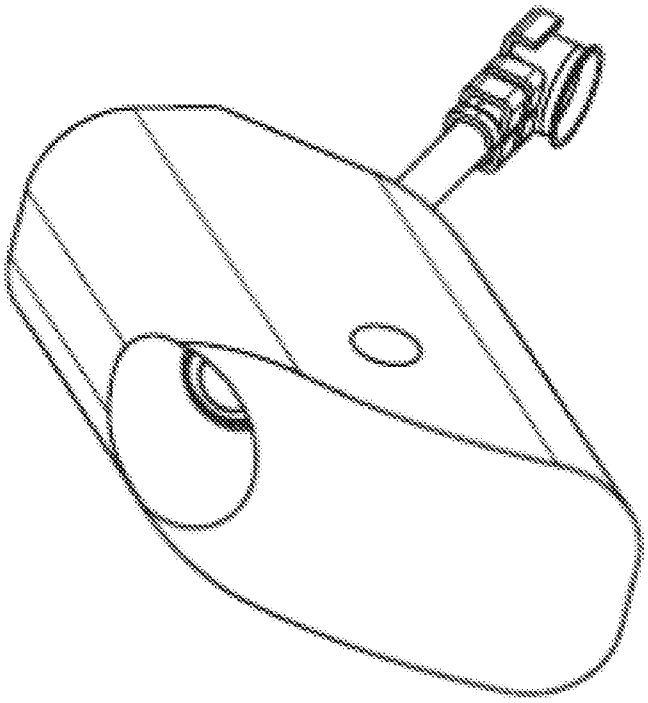

FIG. 4

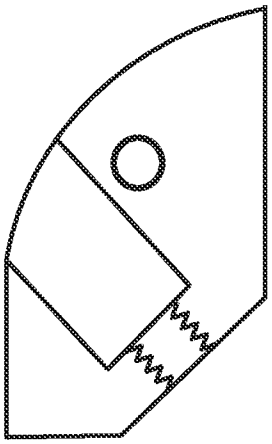

FIG. 7

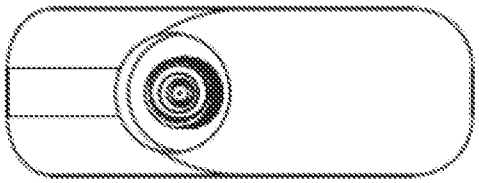

FIG. 6B

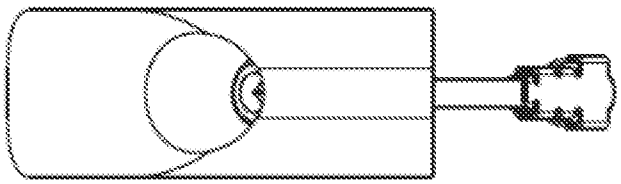

FIG. 6A

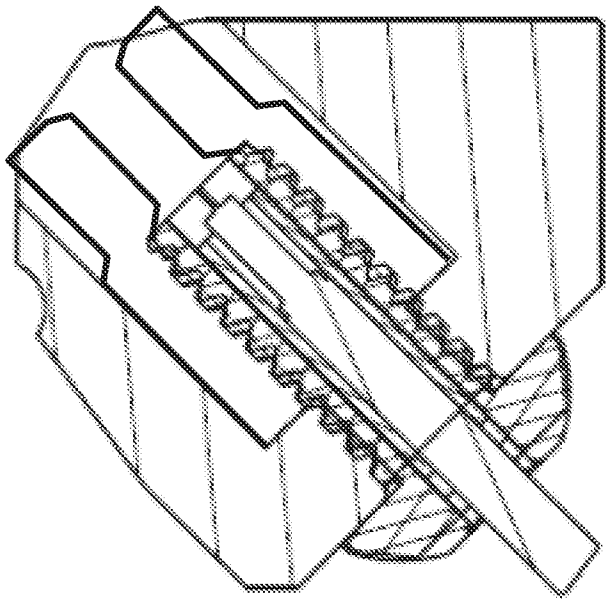

FIG. 9

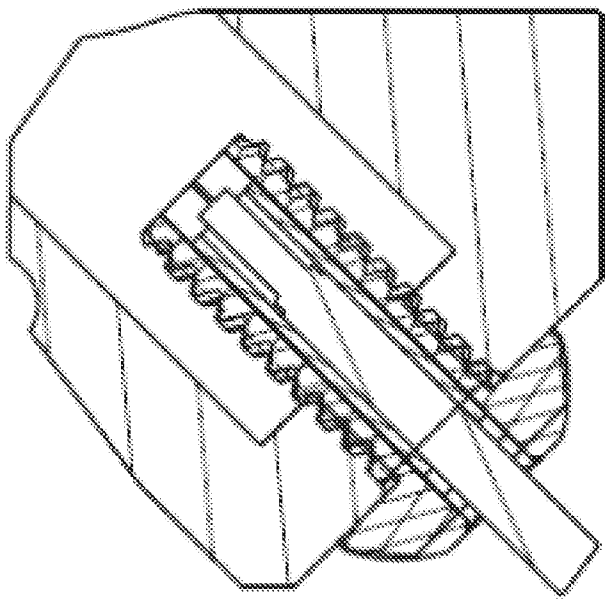

FIG. 8

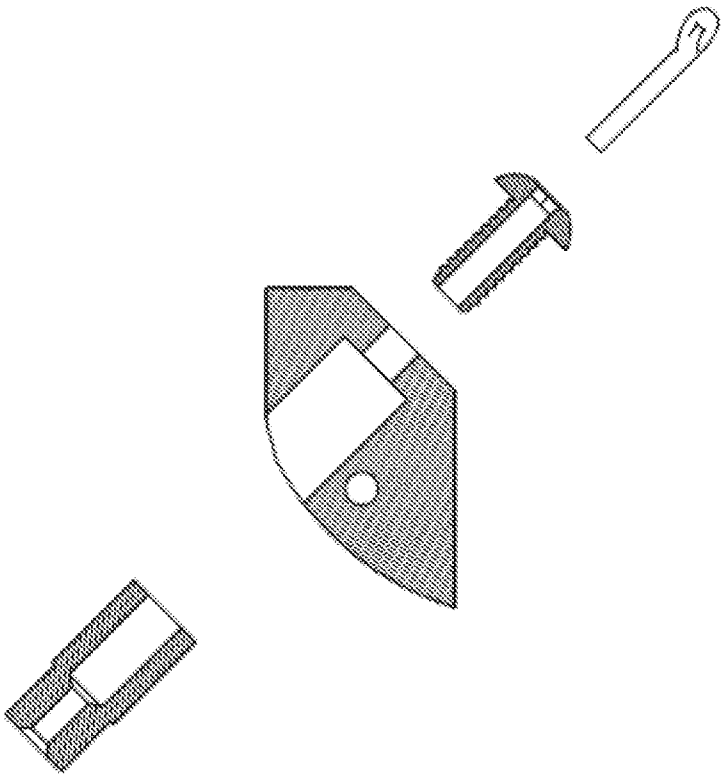

FIG. 10