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IN REPLY REFER TO:

Attorney Docket No. 82934
Date: 5 May 2003

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Serial Number 10/326,960
Filing Date 12/23/02
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20030605 085

POWER PLUG ADAPTER ASSEMBLY AND METHOD

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT (1) PETER ESTRELA, employee of the United States Government and citizen of the United States of America, (2) WILLIAM C. HELTON, and (3) TIMOTHY A. ADAMS, citizens of the United States of America, and residents of (1) Fall River, County of Bristol, Commonwealth of Massachusetts, (2) Groton, County of New London, State of Connecticut and (3) Voluntown, County of New London, State of Connecticut, have invented certain new and useful improvements entitled as set forth above of which the following is a specification.

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PATENT TRADEMARK OFFICE

1 Attorney Docket No. 82934

2

3 POWER PLUG ADAPTER ASSEMBLY AND METHOD

4

5 STATEMENT OF THE GOVERNMENT INTEREST

6 The invention described herein may be manufactured and used
7 by or for the Government of the United States of America for
8 Governmental purposes without the payment of any royalties
9 thereon or therefore.

10

11 BACKGROUND OF THE INVENTION

12 (1) Field of the Invention

13 The present invention relates generally to power
14 connections and, more particularly, to a power plug adapter and
15 method to maintain a secure power connection in the presence of
16 shock and vibration.

17 (2) Description of the Prior Art

18 Commercial off the shelf (COTS) electrical and electronic
19 equipment are becoming more prevalent in Naval shipboard
20 applications due to the cost benefits associated therewith.
21 COTS units are normally supplied with National Electrical
22 Manufacturer's Association (NEMA) 5-15P, three conductor power
23 plugs, which in turn are inserted into commercial quality NEMA
24 5-15R power receptacles in convenience outlets, power strips, or

1 uninterruptible power supplies. The mated commercial quality
2 plugs and receptacles rely on the friction between the blades of
3 the plug and the receptor devices in the outlet to hold the plug
4 in the receptacle, even under conditions of vibration and shock.
5 The friction fit in commercial quality plugs and receptacles
6 provides an unreliable, inconsistent degree of restraint, and
7 the fit degrades with repeated use. Thus, the COTS grade power
8 plug/receptacle configuration is susceptible to unintentional
9 power interruption caused by dislodging the plug from the
10 receptacle under many shipboard conditions including inadvertent
11 disconnection while cleaning or performing maintenance, mild to
12 severe shock, and shipboard vibration conditions.

13 The COTS grade NEMA power plug/receptacle configuration is
14 contrary to that found in previous shipboard Military
15 Specifications and/or Ship Specifications. These specifications
16 require power to be supplied via hard-wired methods or Military
17 Specification connectors which positively secure the associated
18 power plugs to the receptacles by mating threaded connections.

19 The inadvertent loss of power to equipment in response to
20 shock could cause system reliability problems. Also, due to the
21 high reliability of the existing hard wired and Military
22 Specification connectors, in the event of an unexpected shut
23 down of COTS equipment under normal and/or casualty conditions,
24 and due to the typically difficult to reach NEMA 5-15 style

1 power plug connections, the power conditions may not be
2 initially checked before performing more invasive equipment
3 troubleshooting, resulting in less efficient troubleshooting.
4 U.S. Patents that describe attempts to provide solutions related
5 to this problem include the following:

6 U.S. Patent No. 3,358,265, issued December 12, 1967, to P.
7 O. Robards, discloses contact pins for a power control
8 receptacle that are each provided with a hairpin spring in a
9 contact barrel and a tab extending from a tab holder at one end.

10 U.S. Patent No. 3, 890,025, issued June 17, 1975, to Gene
11 L. Gray, discloses a standard, grounded three-conductor male
12 electrical plug made to positively lock in place in its
13 complementary female socket by friction pressure by means of a
14 single tapered cam member which is connected to the plug body in
15 such a way as to move longitudinally and to rotate within the
16 split, scored ground connector of the male plug.

17 U.S. Patent No. 4,111,509, issued September 5, 1978, to
18 John Novak, discloses a plug for an electrical receptacle outlet
19 having an improved ground prong. The ground prong is supported
20 in the plug body for axial shifting. The end of the prong
21 extending through the plug body is threaded to engage a turn
22 knob and the other end of the ground prong extending from the
23 plug body for insertion in the receptacle is adapted to carry
24 spring filaments which are supported to radially arch by the

1 axial movement of the ground prong in response to the rotation
2 of the knob and thereby secure the plug connected to the
3 receptacle.

4 U.S. Patent No. 4,544,216, issued October 1, 1985, to R. W.
5 Imhoff, discloses a three-prong plug including two active prongs
6 and a grounding prong with an additional locking member which is
7 recessed into the grounding prong. The grounding prong on the
8 male portion of the plug has a V-shaped or U-shaped cross-
9 section with the two sides of the electrical prong coming
10 together with a ramp configuration at the outer end of the
11 prong. An elongated locking member is mounted for longitudinal
12 movement within the cross-sectional configuration of the
13 grounding prong, with the outer end of the locking member
14 engaging the ramp when the locking member reaches its extreme
15 outer position to force the locking member transversely out of
16 the recess within the U-shaped or V-shaped configuration of the
17 third prong and into engagement with a portion of the mating
18 female prong. In addition, arrangements are provided for
19 normally biasing the locking member toward the outer end of the
20 grounding prong; and release arrangements are secured to the
21 male plug and in engagement with the locking member for
22 unlocking the locking member and concurrently by moving the
23 release member in a single direction for pulling the two plugs
24 apart.

1 U.S. Patent No. 5,194,013, issued March 16, 1993, to Morris
2 Propp, discloses a locking electrical plug which has a
3 cooperating tool/key which when rotated in a first direction
4 causes a ground prong extending therefrom to be mechanically
5 expand within a mating female receptacle, thereby preventing
6 inadvertent or accidental removal of the plug from the
7 receptacle, and when rotated in a second direction this again
8 permits the removal of the plug from the receptacle.

9 U.S. Patent No. 5,249,976, issued October 5, 1993, to R. D.
10 Brock, discloses an electrical plug for 3-wire line cords that
11 includes a plug body having a U-shaped grounding pin. A rise pin
12 is disposed between opposing walls of the U-shaped grounding
13 pin. A locking element extending through the plug body includes
14 a threaded proximal portion and a flat distal portion, the
15 distal portion having a ramp disposed over the rise pin and a
16 serrate edge opposite the ramp with the distal portion disposed
17 within the grounding pin opposing walls. A locking knob is
18 threaded onto the proximal portion. With the plug in an outlet,
19 the knob is rotated clockwise to draw the flat distal portion
20 rearward causing the ramp to ride up the rise pin and to cause
21 the serrate edge to grip the inner surfaces of the grounding
22 socket. Rotating the knob counterclockwise releases the serrate
23 edge to permit withdrawal of the plug from the outlet.

1 U.S. Patent No. 6,171,129, issued January 9, 2001, to D. A.
2 Phillips, discloses an electrical adapter with dual, user-
3 operable locking mechanisms for attachment to a standard
4 electrical plug and outlet, one for securing the prongs of the
5 adapter into a socket or wall-mounted outlet or receptacle and
6 the other for securing a standard electrical plug thereto. The
7 two mechanisms work independently of each other to secure the
8 male and female sides of a conventional plug-and-socket
9 combination together. The adapter can be used with existing
10 appliances, hand tools, extension cords, and electrical outlets
11 without the need for rewiring. The male and female ends of the
12 adapter may be connected by an electrical cord to replace a
13 conventional extension cord; alternatively, the locking
14 mechanism can be built into replacement electrical plugs or a
15 wall outlet having approximately the same dimensions as
16 conventional outlets. Use eliminates the annoying problem of
17 power interruptions to appliances, hand tools, and the like that
18 occur when a plug is accidentally pulled loose from its socket.
19 The invention also provides extra safety from electrocution and
20 reduces spark hazards by locking the plug and socket together to
21 help prevent accidental dislodging.

22 The above cited prior art does not provide a means for
23 adapting commonly utilized NEMA power plugs normally found on
24 COTS equipment to provide a highly reliable vibration and shock

1 resistant power connection. Consequently, there remains a long
2 felt but unsolved need for an improved means for connecting NEMA
3 power plugs in a more consistently reliable manner. Those
4 skilled in the art will appreciate the present invention that
5 addresses the above and other problems.

6

7

SUMMARY OF THE INVENTION

8 Accordingly, it is an object of the present invention to
9 provide an improved power plug and receptacle assembly and
10 method.

11 Another object of the present invention is to provide a
12 more reliable connection between a COTS power plug and
13 corresponding power receptacle.

14 Another object is to provide an assembly and method as
15 aforesaid which does not require modification or replacement of
16 the numerous NEMA power plugs and NEMA receptacles found on COTS
17 equipment.

18 These and other objects, features, and advantages of the
19 present invention will become apparent from the drawings, the
20 descriptions given herein, and the appended claims. However, it
21 will be understood that above listed objects and advantages of
22 the invention are intended only as an aid in understanding
23 aspects of the invention, are not intended to limit the

1 invention in any way, and do not form a comprehensive list of
2 objects, features, and advantages.

3 In accordance with the present invention, an assembly is
4 provided for use with a power plug and power plug receptacle
5 wherein the power plug is secured to a power plug cable. The
6 assembly may comprise one or more elements such as, for
7 instance, an adapter with power prong connections wherein the
8 power prong connections mate to the power plug receptacle and
9 the adapter has an adapter receptacle operable for mating
10 engagement with the power plug such that the adapter is operable
11 to electrically connect the power plug to the power plug
12 receptacle. Other elements may comprise a first locking
13 mechanism for securing the adapter to the power plug receptacle
14 and a second locking mechanism for securing the adapter to the
15 power plug.

16 In a presently preferred embodiment, the first locking
17 mechanism may further comprise an expandable element. The
18 expandable element may be mounted within at least one of the
19 power prong connections such that after the power prong
20 connections are inserted into the power plug receptacle the
21 expandable element is expanded to lock the adapter to the power
22 plug receptacle.

23 In a presently preferred embodiment, the second locking
24 mechanism may further comprise a restraining member mountable

1 with respect to the power plug for securing the power plug with
2 respect to the adapter. The restraining member may comprise
3 split components to thereby mount onto the power plug cable.
4 The split components are securable together such that the
5 restraining member is secured around the power plug cable. The
6 assembly may further comprise one or more straps
7 interconnectable between the restraining member and the adapter
8 to thereby secure the power plug to the adapter.

9 In operation, a method is provided that may be utilized for
10 securing a NEMA power plug to a NEMA power plug receptacle to
11 resist vibration and shock without modifying the NEMA power plug
12 or the NEMA power plug receptacle. The method may comprise one
13 or more steps such as, for instance, inserting an adapter into
14 the NEMA power plug receptacle, securing the adapter to the NEMA
15 power plug receptacle, inserting the NEMA power plug into the
16 adapter, and/or securing the NEMA power plug to the adapter.

17 The method may further comprise expanding an expandable
18 portion of at least one prong of the adapter after the adapter
19 is inserted into the NEMA power plug receptacle and/or providing
20 the expandable portion is comprised of an electrometric
21 material. The method may further comprise utilizing a threaded
22 member to apply tension to the expandable portion.

23 The method may further comprise mounting a restraining
24 member to the cable adjacent the NEMA power plug and/or

1 connecting one or more straps between the restraining member and
2 the adapter. In a preferred embodiment, the method may further
3 comprise utilizing split elements to form the restraining member
4 to the cable and/or utilizing one or more straps to secure the
5 split elements together around the cable.

6 The method may further comprise providing at least one
7 first loop on the adapter and at least one second loop on the
8 restraining member and/or inserting one or more flexible straps
9 into the first loop and the second loop.

10 In another embodiment, the invention comprises an assembly
11 with one or more elements such as an adapter with power prong
12 connections wherein the power prong connections mate to the
13 power plug receptacle and the adapter has at least one adapter
14 receptacle operable for mating engagement with at least one
15 power plug, and a first locking mechanism for securing the
16 adapter to the power plug receptacle. The first locking
17 mechanism further comprises an expandable element mounted within
18 at least one of the power prong connections such that after the
19 power prong connections are inserted into the power plug
20 receptacle and the expandable element is expandable to lock the
21 adapter to the power plug receptacle. The assembly may comprise
22 an axially moveable tensioner such that the tensioner is
23 moveable against the expandable element to urge the expandable
24 element to expand radially outwardly.

1 BRIEF DESCRIPTION OF THE DRAWINGS

2 A more complete understanding of the invention and many of
3 the attendant advantages thereto will be readily appreciated as
4 the same becomes better understood by reference to the following
5 detailed description when considered in conjunction with the
6 accompanying drawings wherein corresponding reference characters
7 indicate corresponding parts throughout several views of the
8 drawings and wherein:

9 FIG. 1 is an elevational view, partially in hidden lines,
10 which shows an assembly including a power plug adapter for
11 securing a NEMA power plug to a NEMA socket in accord with the
12 present invention;

13 FIG. 2A is an elevational end view, partially in hidden
14 lines, of an adapter in accord with the present invention;

15 FIG. 2B is an elevational side view, partially in hidden
16 lines, of an adapter in accord with the present invention;

17 FIG. 2C is a sectional side view of an adapter along lines
18 2C-2C in FIG. 2A in accord with the present invention;

19 FIG. 3A is an elevational top view, partially in hidden
20 lines, of a restraining collar in accord with the present
21 invention;

22 FIG. 3B is an elevational end view of the restraining
23 collar of FIG. 3A; and

1 FIG. 3C is an elevational side view, partially in hidden
2 lines, of the restraining collar of FIG. 3A.

3
4 BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 While the present invention is discussed in terms of a
6 specific embodiment that may be used to provide more reliable
7 power connection, other embodiments could also be utilized. For
8 instance, in commercial applications, adapters from one socket
9 to many sockets are sometimes utilized which tend to have
10 insufficient tension in the one socket to hold the entire
11 assembly to the socket, especially after multiple plugs have
12 been inserted. Features of the present invention may be
13 utilized to provide improved adapters. Other embodiments of
14 the present invention are also possible.

15 Referring now to the drawings and, more specifically to
16 FIG. 1, there is shown an adapter assembly 10 in accord with the
17 present invention. In this FIG., prior art objects are
18 indicated with dashed lines. Adapter assembly 10 utilizes
19 adapter 12 that may be locked to a power plug socket, such as a
20 NEMA power plug socket 14. Adapter 12 also includes power
21 receptacles that are the same as those of NEMA power plug socket
22 14 for receiving an existing power plug 16, which is preferably
23 a NEMA power plug. Adapter 12 has two standard power prongs 26

1 and 28 and a modified ground prong 20, as will be discussed in
2 the following text.

3 Adapter assembly 10 further comprises first and second
4 locking assemblies for securing the assembly together to thereby
5 effectively secure power plug 16 to power plug receptacle or
6 socket 14. In a preferred embodiment, adapter assembly 10
7 requires no changes to standard NEMA power plugs and sockets.
8 It will be understood that many different types of locking
9 assemblies may be utilized.

10 In overview of FIG. 1, the first locking assembly is
11 utilized to lock adapter 12 to power socket 14. In a preferred
12 embodiment, an expandable portion 18 is utilized on ground prong
13 20 to secure adapter 12 to power socket 14. Further details of
14 operation of the first locking assembly are discussed
15 hereinafter.

16 The second locking assembly is utilized to lock adapter 12
17 to the existing power plug 16. A restraining collar 22 is
18 securely mounted on an opposite side of power plug 16 from
19 adapter 12. Then straps 24, which may include the readily
20 available nylon tie straps, are utilized to secure restraining
21 collar 22 to adapter 12 via strap slots 64 and 66 in the adapter
22 12 and strap mounts 56 and 58 in the collar 22. Thus, assembly
23 10 results in power connection with greatly increased resistance
24 to shock and vibration.

1 FIG. 2A, FIG. 2B, and FIG. 2C show a detailed construction
2 of a presently preferred adapter 12 in accord with the present
3 invention. FIG. 2C is a sectional view taken along lines 2C-2C
4 of the end view of FIG. 2A. In this case, as compared to FIG.
5 1, expandable portion 18 is shown in a relaxed position.
6 Expandable portion 18 may be made of any suitable material,
7 which when compressed, will expand radially outwardly. Suitable
8 materials may include elastomeric materials. Preferably,
9 elastic materials are utilized so that the expandable material
10 will more easily move radially inwardly to release when the
11 compression is removed. However, if a permanent connection is
12 desired, then this is not necessary.

13 Due to the typically somewhat larger size and cylindrical
14 shape of ground prong 20, the ground prong is a presently
15 preferred location for the expandable member. However, other
16 types of expandable members might be utilized with the other
17 power blades or prongs 26 and 28. Electrical tubular connection
18 portion 30, of ground prong 20, is preferably formed of
19 conductive metal to provide the desired electrical connection.
20 Likewise, power prongs 26 and 28 are preferably formed of metal
21 to produce the desired electrical connection. A tensioner
22 element 32 is slidably mounted within ground prong 20 for
23 movement within tubular connection portion 30. Tensioner
24 element 32 includes compression cap 34 which is utilized to

1 engage and compress expandable portion 18. In this embodiment,
2 tensioner element 32 includes a threaded socket portion 36 to
3 receive tensioning screw 38. Tensioning screw 38 may be
4 conveniently operated through aperture 40 into which a
5 screwdriver may be inserted. Thus, tensioning screw 38 may be
6 rotated to tighten tensioner element 32 and compression cap 34
7 to compress and radially expand expandable portion 18.
8 Expandable portion 18 preferably should be made from a material
9 supporting high elastic strain so that it will retract when
10 tensioning screw 38 is loosened. In this way, adapter 12 is
11 anchored to power plug socket 14. Aperture 40 may also serve as
12 the corresponding ground receptacle to receive the ground prong
13 of power plug 16. Tensioning screw 38 and tensioner element 32
14 may conveniently provide the electrical connection between the
15 ground prong of power plug 16 and ground prong 30 of adapter 12.
16 Thus, adapter 12 has similar sockets, which may preferably be
17 the same as those found in standard NEMA power receptacles, such
18 as sockets 40 and 42 as shown in FIG. 2B, for making electrical
19 connection with and receiving the power prongs from power plug
20 16. Adapter 12 also has strap mounts 64 and 66 which will be
21 discussed in the following text.

22 While the above illustrates how to anchor or lock adapter
23 12 to power plug socket 14, it is also necessary to anchor or
24 lock power plug 16 to adapter 12. While numerous methods and

1 means are available to affect this purpose, in the presently
2 preferred embodiment, restraining collar 22 is utilized.
3 Several different views of restraining collar 22 are shown in
4 FIG. 3A, FIG. 3B, and FIG. 3C. Restraining collar 22 is
5 preferably formed in split sections such as half sections 44 and
6 48. Once sections 44 and 48 are joined together, a cord
7 aperture 49 is defined at the center of collar 22. In this way,
8 sections 44 and 48 can easily mount around the power cord, such
9 as power cord 50 shown in FIG. 1. As shown in FIG 1,
10 restraining collar 22 is mounted on an opposite end of power
11 plug 16 from adapter 12.

12 Half sections 44 and 48 may then be easily clamped together
13 by such means as tie strap 52 shown in FIG. 1. Tie strap 52 may
14 be positioned within groove 54 of restraining collar 22, which
15 groove is shown most clearly in FIG. 3C. Tie straps are readily
16 available and easily tightened to secure half sections 44 and 48
17 together, although other clamps, latches, and the like could be
18 utilized for this purpose.

19 Restraining collar 22 preferably supports outwardly
20 extending tie strap mounts 56 and 58 in which apertures 60 and
21 62 are formed. Likewise, adapter 12 has tie strap mounts 64 and
22 66 as indicated in FIG. 2A and FIG. 2B. Thus, in the present
23 embodiment, two straps may be utilized and inserted into tie
24 strap mounts 56 and 58 on restraining collar 22 and also tie

1 strap mounts 64 and 66 on adapter 12, respectively. As the tie
2 straps, such as tie strap 24 shown in FIG. 1, are tightened,
3 power plug 16 is thereby secured to adapter 12.

4 Thus, in operation adapter 12 may be inserted into socket
5 14. After insertion, then tensioning screw 38 may be rotated to
6 thereby expand expandable portion 18 as indicated in FIG. 1.
7 NEMA power plug 16 can be inserted into the mating NEMA
8 receptacles found in adapter 12. Split components 44 and 48 of
9 restraining collar 22 are mounted to cable 50 and secured
10 together by tie strap 52. Two tie straps may then be inserted
11 into respective tie strap mounts found on adapter 12 and
12 restraining collar 22 and tightened thereby securing assembly 10
13 together. The end result is a power connection assembly that
14 resists vibration and shock without the need to modify or
15 replace the standard NEMA plugs and sockets that come with COTS
16 equipment. In this embodiment, the diameter of adapter 12 and
17 restraining collar 22 is substantially the same as the diameter
18 of the plug so that adjacent power plugs will not interfere with
19 each other. However, the same principle could be utilized in
20 larger diameter adapters that include multiple sockets for
21 connecting multiple power cables to a single receptacle.

22 It will be understood that many additional changes in the
23 details, materials, steps and arrangement of parts, which have
24 been herein described and illustrated in order to explain the

- 1 nature of the invention, may be made by those skilled in the art
- 2 within the principle and scope of the invention as expressed in
- 3 the appended claims.

1 Attorney Docket No. 82934

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3 POWER PLUG ADAPTER ASSEMBLY AND METHOD

4

5 ABSTRACT OF THE DISCLOSURE

6 An assembly is provided for retaining standard electrical
7 plugs within receptacles in environments having vibration and
8 shock conditions that loosen normal electrical plugs. The
9 present invention includes an adapter with a first locking
10 mechanism for locking the adapter to the electrical receptacle.
11 The adapter contains a standard electrical receptacle to receive
12 the power plug prongs of the power plug. In a preferred
13 embodiment, a restraining collar is mounted adjacent the power
14 plug and secured to the adapter with tie straps to thereby
15 secure the power plug to the adapter.

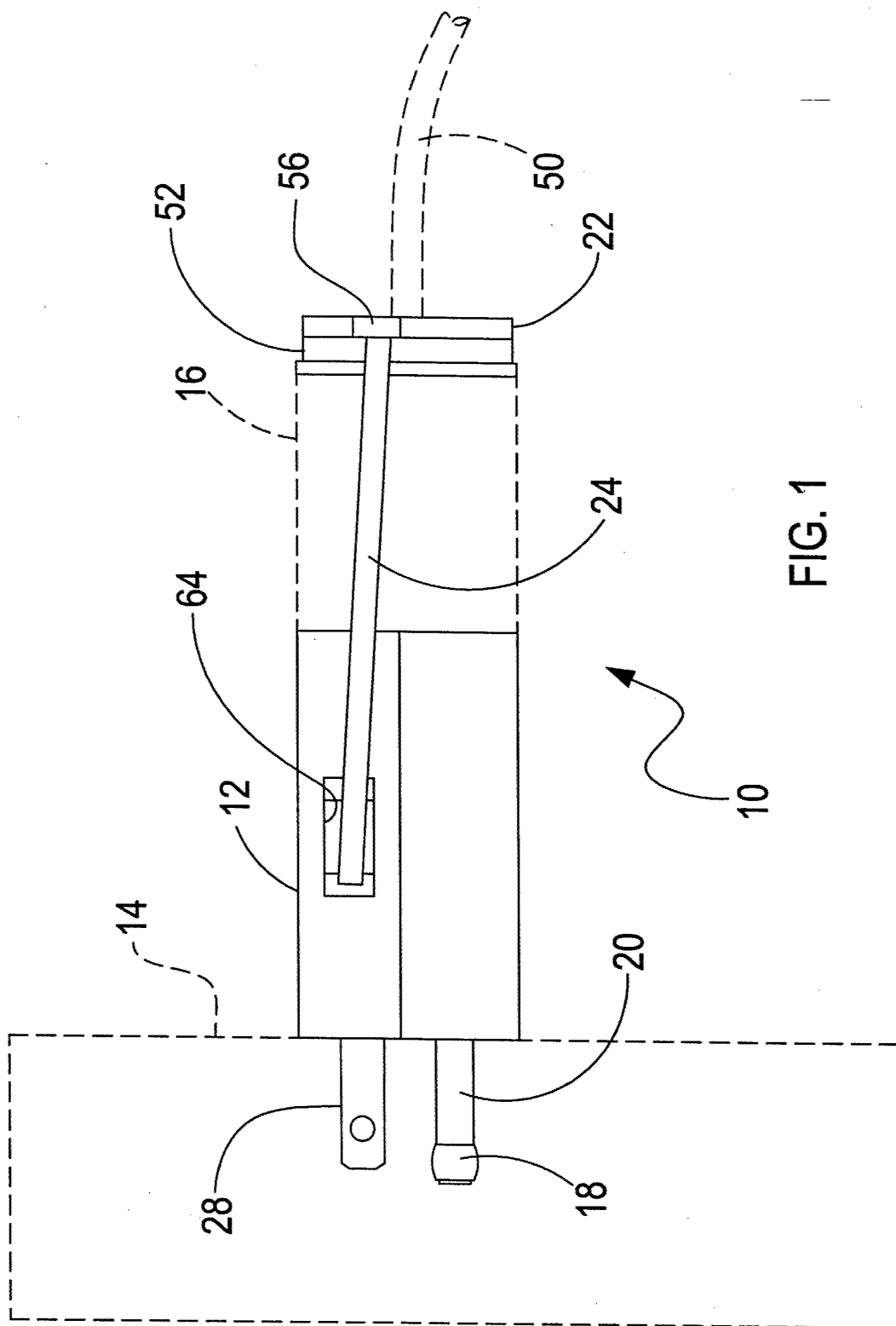


FIG. 1

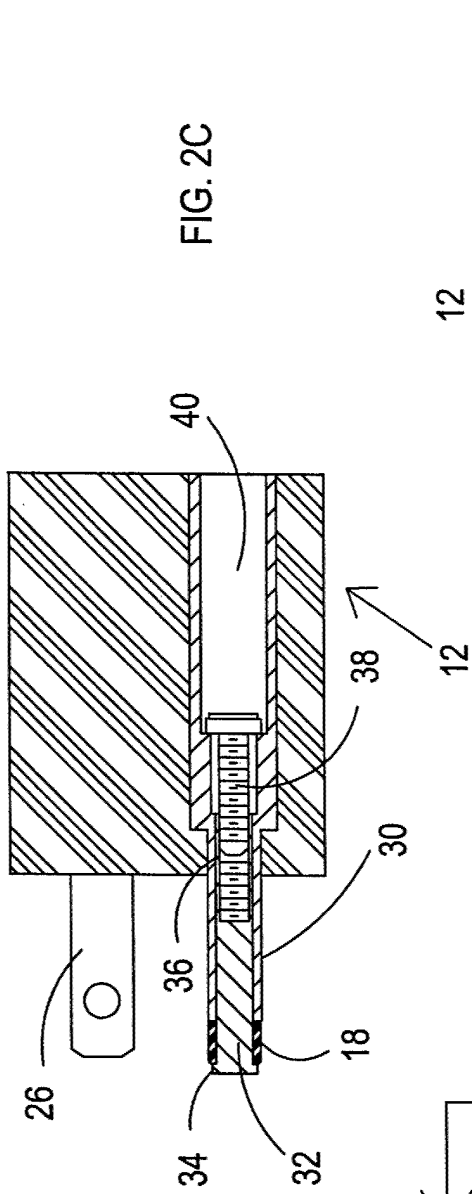


FIG. 2C

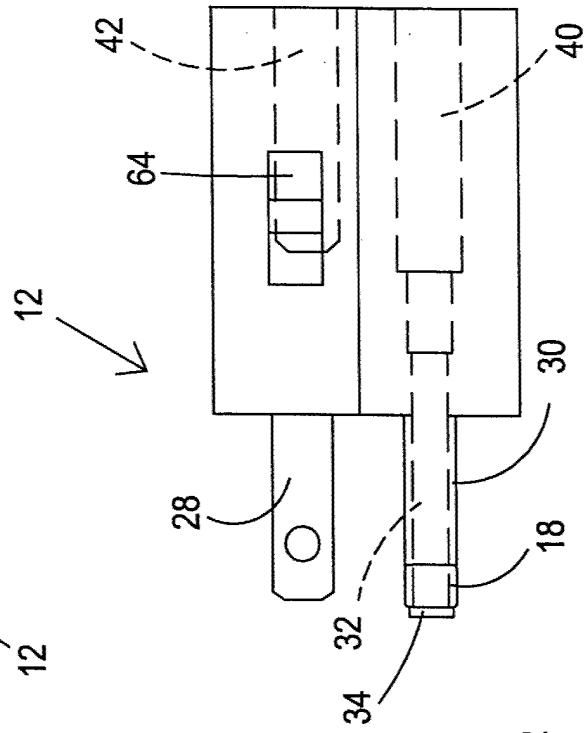


FIG. 2B

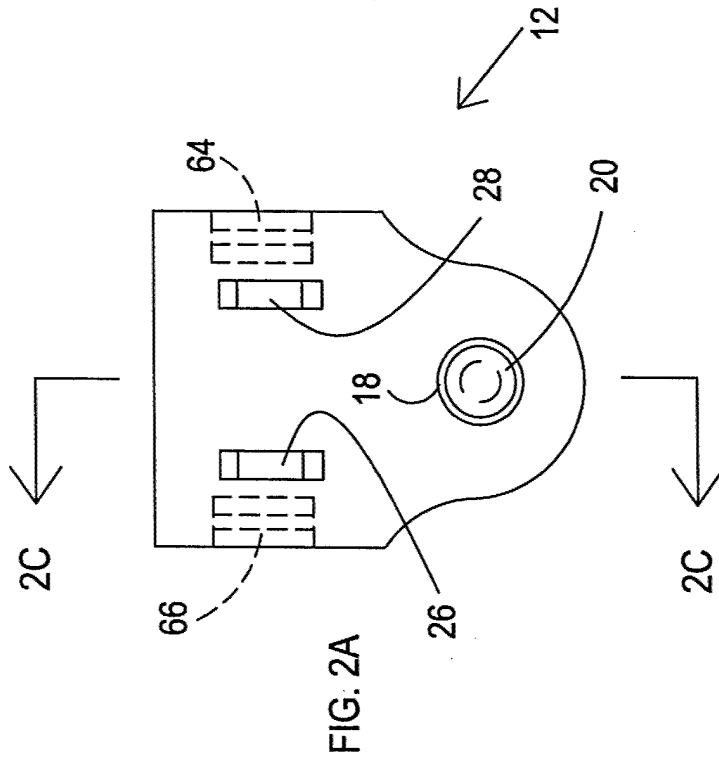


FIG. 2A

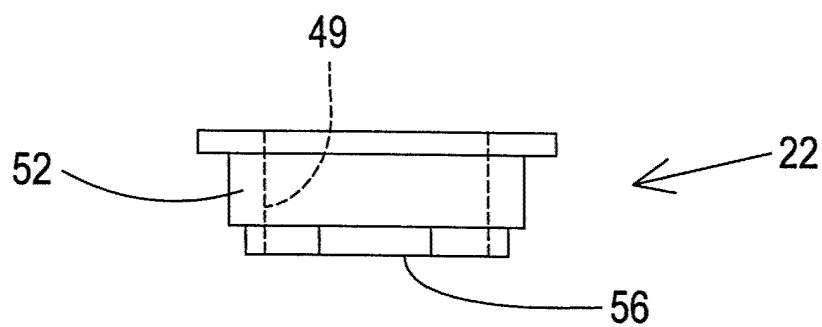


FIG. 3A

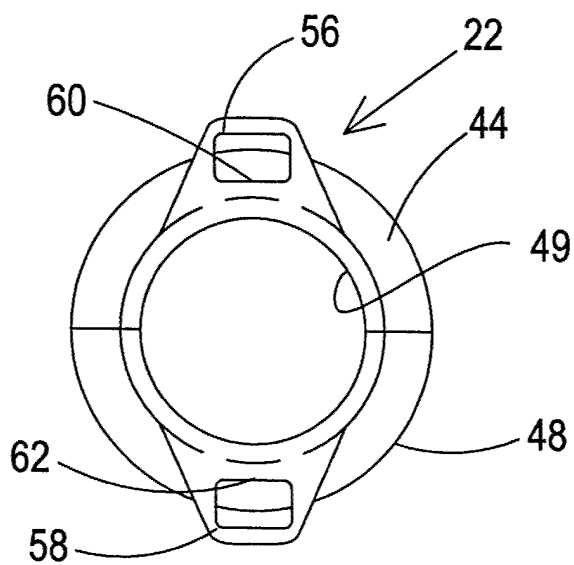


FIG. 3B

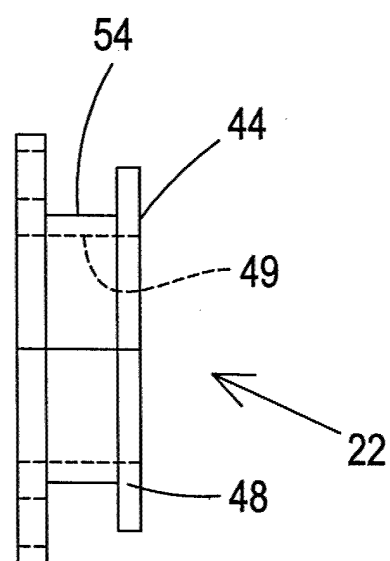


FIG. 3C