(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 March 2006 (09.03.2006)

PCT

(10) International Publication Number
WO 2006/025964 A2

(51) International Patent Classification:
H01R 13/502 (2006.01)

(21) International Application Number:
PCT/US2005/025701

(22) International Filing Date: 20 July 2005 (20.07.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/590,404 22 July 2004 (22.07.2004) US

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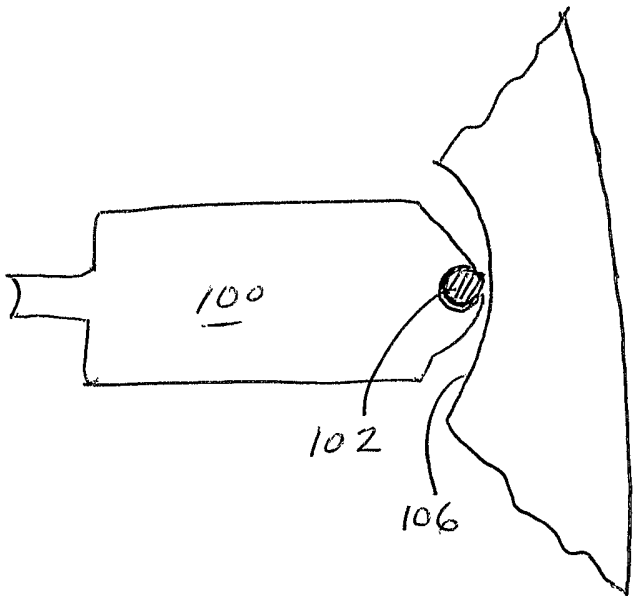
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(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: HARDENED METAL IMPLANT FOR INDENTER OF A CRIMP TOOL FOR CRIMPING PIN AND SOCKET CONTACTS



(57) Abstract: A compound indenter for a wire connector pin, the pin having an axial length and an opening at an end thereof for receiving a wire having an exposed portion and an insulation covered portion, the opening being sized to receive both the exposed portion and a length of the insulation covered portion comprises a first indenter having a plurality of indenting elements for engaging the pin in an axial location overlaying the exposed portion of the wire inserted in the pin and a second indenter having a plurality of indenting elements for engaging the pin in an axial location overlaying the insulation covered portion of the wire inserted in the pin. The apparatus advances the indenting elements of each of the first and second indenters generally concurrently for compressing respective sections of the pin into engagement with the exposed wire portion and the insulation covered portions of the wire.

WO 2006/025964 A2

HARDENED METAL IMPLANT FOR INDENTER OF A CRIMP TOOL FOR CRIMPING PIN AND SOCKET CONTACTS

SPECIFIC DATA RELATED TO THE INVENTION

This invention claims the benefit of U.S. provisional application number 60/590,404, filed July 22, 2004.

BACKGROUND OF THE INVENTION

The present invention relates to a crimping tool for pin and socket contacts and more particularly, to a tool for crimping a pin at two separate distinct locations in which the pin has a different diameter at each location.

Connectors used for aircraft applications generally comply with military specifications (mil spec) standards which require waterproof connectors that utilize a plurality of male and female pins in opposite ends of a mating connector pair to complete electrical connections between wire leads or conductors connected to the connector pair. Typically, the pins are small diameter elements that are replaceable in each of the mating connector pairs. A typical male pin has an end portion that is generally solid and a rear portion which is hollow and designed to receive a bare or stripped wire of a conductor connected to the pin. Such pins generally require only a single crimp in order to fasten the pin to the conductor.

In a new application in which weight is a factor, the conventional copper wire conductors have been replaced by aluminum wire conductors. One problem that exists with aluminum wire conductors is that exposure of the conductor to moisture may result in corrosion of the aluminum wire. Consequently, it has been determined that the use of aluminum conductors requires that the insulating material over the conductor be inserted into the contact pin and crimped in place in order to provide a secure seal and preclude introduction of moisture onto the aluminum conductor where the insulation is stripped to allow electrical contact between the conductor and the pin. This requirement has resulted in a redesign of such contact pins such that the pins have a dual diameter conductor receiving end so that the aluminum conductor can be stripped over a portion of its length for insertion into the pin while allowing a portion of the insulation on the conductor to also

be inserted into the pin and the pin crimped on the insulation to thereby provide a seal to preclude moisture entry around the conductor. As a result of this redesign in pin structure, it has become necessary to provide a crimping tool which is capable of not only crimping the pin about the wire conductor portion but also crimping an enlarged portion of the pin about the insulation on the aluminum conductor. Furthermore, it is important to provide a crimping mechanism which completely crimps the pin about the conductor insulation in such a manner that moisture is precluded from entering around the pin to conductor coupling.

SUMMARY OF THE INVENTION

The present invention is directed to an indenter tool for crimping an open end of a connector pin about an insulation covered wire in order to minimize intrusion of moisture into the pin to prevent oxidation of the wire attached to the pin. In one form, the tool comprises a compound indenter having a first indenter section for crimping an outer open end of the connector pin about the insulation and a second indenter section for crimping or indenting the pin so as to connect the pin to a metallic wire. In an illustrative example, the first indenter section utilizes a pair of opposed indenter elements having facing generally flat anvil surfaces and a second pair of opposed indenter elements having facing arcuate anvil surfaces. The first pair of generally flat surfaced indenter elements are driven into contact with the open end of the pin to cause the open end to first deform into a generally oval configuration. Subsequently, the second pair of indenter elements having arcuate surfaces are driven into contact with the open end of the pin in a direction rotated about 90° from the position of the first pair of indenter elements. The arcuate anvil surfaces compress the open end of the pin into a generally circular configuration while the generally flat surfaces prevent the open end of the pin from expanding outwardly during the compression cycle. The dual action of the two sets of indenter elements thus deform the open end of the pin into a generally circular configuration which fits tightly about the insulation covered wire inserted into the pin. While the first indenter elements have generally flat surfaces, those surfaces could be rounded as needed to create the desired circular compression of the pin about the wire insulation.

A second indenter section includes a plurality of indenter elements that are driven into contact with the pin concurrently with the elements of the first section so that the pin is indented at multiple locations to cause the pin to be crimped onto the non-insulation covered portion of the wire inserted into the pin.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will become apparent from the following detailed description of the invention when read with the accompanying drawings in which:

FIG. 1 is a schematic representation showing the location of a pair of indenters for crimping the pin at two spaced locations;

FIGS. 2a-2c illustrate a sequence of crimping actions for crimping an end of the connector pin of FIG. 1 about insulation on a wire;

FIG. 3 illustrates one form of pneumatically-operated tool for implementing the indenting/crimping functions in accordance with one form of the present invention;

FIG. 4 illustrates one form of hand tool with which the present invention may be used; and

FIGS. 5a-5d and FIGS. 6a-6d illustrate corresponding indenter element positions of each of a pair of indenters in a single tool.

FIGS. 7A and 7b show a partial side view of an indenter incorporating a hardened metal wear tip.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a design of one form of connector pin 10 (sometimes referred to as a contact) having a contact tip 12 and a hollow portion 14 for receiving a nickel-plated aluminum conductor 16 from which insulation has been stripped and for receiving a length of conductor from which the insulation material 18 surrounding the conductor 16 has not been stripped. As can be seen, the open end 14a of the pin portion 14 has a larger diameter opening to allow the insulation material 18 to be inserted at least partially within the portion 14. FIG. 1 also shows the position of a first indenter 20 which is designed to crimp the pin 10 in a conventional manner so as to

capture and hold the conductor 16 within the hollow portion 14. Positioned adjacent the portion 14a of the pin 10 is a second indenter 22 which is designed to crimp the portion 14a about the insulation 18 on the conductor 16. The indenter 22 is uniquely designed to assure that all sides of the portion 14a tightly encompass the insulation 18 to minimize moisture intrusion into the connector pin and potential corrosion of the exposed conductor 16.

Turning now to FIGS. 2A – 2C, there is shown an exemplary embodiment of one form of indenter 22 that may be used to provide the crimping of the section 14a. As shown in FIG. 2A, the indenter 22 comprises two flat tip indenter elements 24, sometimes referred to an anvils. These two indenter elements 24 are designed with flat anvil surfaces to first engage the connector pin portion 14a and to cause that pin portion to deform into the oval shape shown in FIG. 2B. The indenter elements 24 thus bring two sides of the connector pin portion 14a into abutting relationship with the insulation material 18. After compression with the first set of indenter elements 24 and while holding these elements 24 in their compressed position, a second set of indenter elements 26 having arcuate anvil surfaces are brought into contact with the section 14a as shown in FIG. 2C so as to compress the remainder of the section 14a into constriction about the insulation 18. The indenter elements 24 remain in position while the indenter elements 26 are compressed toward pin 10 so as to prevent the contact portion 14a from deforming in another direction. While the result of this form of crimping action may not produce a uniformly smooth connection between the section 14a and insulation 18, the material of the contact is pressed against and into the insulation 18 with sufficient force to provide the moisture proof coupling as necessary to preclude or minimize moisture intrusion into the connector pin and causing corrosion of the aluminum conductor 16. While this exemplary embodiment was generally flat anvil surfaces for elements 24, it will be recognized that the anvil surfaces can be shaped as necessary to achieve the desired result of uniform compression of the pin about the wire insulation.

FIG. 3 illustrates one form of tool head 30 for use as a compound indenter incorporating the indenters 20,22 discussed above. Head 30 includes a circular base plate 32 having a central aperture 34 for passage of an actuating rod (not shown). A housing section 36 is attached to base plate

32 and provides both a covering and a support for the indenters 20,22 and associated actuating mechanism. The indenter 20 comprises the indenter elements 38 mounted within a circular opening 40 in pivotable actuator 42. The opening 40 has an inner surface 44 which functions as a camming surface in contact with distal ends of the indenter elements for driving the indenter elements 38 radially inward when the surface 44 is rotated about a center of the opening 40. The camming surface 44 has a plurality of shaped recessed areas 46 in which the elements 38 are retracted to create the central opening into which one of the pins 10 can be inserted. Rotation of the surface 44 causes the elements 38 to ride out of the areas 46 and be driven radially inward to indent the pin section 14. Spring elements (not shown) well known in the art may be used to forcefully retract the elements 38.

The actuator 42 has an offset arm 48 extending away from the opening 40. At a distal end of the arm 48 there is a bore 50 for receiving an axle 52. A roller or cam follower (not shown) is mounted on the axle 52 and positioned to ride in curved slot 54 in sliding plate 56. Plate 56 moves in a direction transverse to base plate 32. When plate 56 is pushed upward or away from base plate 32, the roller attached to arm 48 rides in slot 54 moving from left to right as shown in FIG. 3 thereby causing actuator 42 to rotate counterclockwise. Rotation of actuator 42 causes the camming surface 44 to drive elements 38 radially inward to effect the indenting function. The elements 38 are released by pulling the plate 56 downward toward base plate 32.

It will be appreciated that elements 38 do not rotate about opening 40 but are held fixed in orientation within tool head 30. The elements 38 are coupled to tool head 30 by a round support bracket 58 which fits into opening 40. The bracket 58 is a mirror image of support bracket 60. Each bracket 58, 60 had a plurality of radially extending slots 62. The elements 38 are seated in slots 62 of bracket 58 and the elements 24, 26 of indenter 22 are seated in slots 62 of bracket 60. When tool head 30 is assembled, bracket 60 overlays and is aligned with bracket 58 so that screws (not shown) may be inserted through aligned screw holes 64 in brackets 58,60 and threadedly engaged with mating holes in housing section 36 to thereby fix the position of the indenters 20,22 with respect to tool head 30.

The indenter 22 is also formed as a combination of the indenter elements 24,26 and a cam surface 66. The surface 66 is a radially inner surface of an opening 68 in a generally circular actuator 70 with distal ends of the elements 24,26 in sliding engagement with the cam surface 66. The elements 24,26, seated in bracket 60 fit into opening 68 in the same manner as described for indenter 20. When assembled, the actuator 70 is bolted to actuator 42 and rotates concurrently. Bolts (not shown) threadedly couple actuators 42 and 70 via bores 72.

A cover plate 74 fits onto and protects the operating elements adjacent base plate 32. An upper cover 76 has a recessed area (not visible in FIG. 3) to fit over the actuator 70. Both plate 74 and cover 76 are coupled to housing section 36 by screws (not shown) passing through the variously shown screw holes. A trigger support bracket 78 is also mounted to the housing section 36 for supporting an actuating trigger (not shown) which may be used in conjunction with a pneumatic operated indenter. The pneumatic cylinder 80 attached to base plate 32 may be a bi-directional unit having a piston extending through aperture 34 and attached to plate 56. Cylinder 80 is a conventional pneumatic actuator as is the locating and attachment of a trigger mechanism to bracket 78.

The indenters of the present invention may also be used in a hand tool in which the cycling of the hand tool is such that crimping of the pin onto the wire is completed prior to the hand tool being completely closed. While this same feature could be used with the pneumatic indenter of FIG. 3, it is not believed necessary since the bi-directional ability of the pneumatic cylinder will forcefully reverse the cam actuator 42. More particularly, the hand tool is designed with a crimping function such that as the handles of the tool are compressed towards each other, the crimping action completes the crimping of the pin onto the wire and the associated insulation and thereafter the indenters are released from the pin prior to the time that the hand tool completes a fully closed cycle. In this manner, the pressure on the indenters in the hand tool against the pin is released prior to full closure of the hand tool thus allowing the crimped wire and pin to be released from the tool. When the pin is removed, the tool can be easily opened. Otherwise, opening the tool with the pin remaining in place requires significant effort to effect a release of

the indenters if they are in contact with the pin. This feature is readily implemented by designing the camming surfaces, such as surfaces 44 and 66 of Fig. 3, to have a recess that allows the indenting elements to retract as the tool reaches the end of the crimping cycle.

Manually operated hand tools are well known in the art and may take the form of the plier type hand tool 82 shown in Fig. 4. However, the tool 82 is modified to incorporate two sets of indenters into a single tool so as to form a compound indenter tool. The two sets of indenters are preferably stacked as shown in the embodiment of FIG. 3 so that concurrent operation is achieved. In this tool, the indenter elements are fixed in position with respect to the non-pivoting handle 84. The camming elements are connected to the pivotable handle 86 so that pivoting movement of handle 86 with respect to handle 84 effects rotation of the cam surfaces of the camming elements. Various methods of attaching the handles 84 and 86 to each other for such pivoting movement are well known in the art as is the method for coupling the camming elements to the pivoting handle 86. Methods of effecting retraction of indenter elements such as elements 38,24,26 are also well known in the art. However, Figs. 5 and 6 are provided to show the motion of the inventive cam arrangement coupled to the tool 82. Fig. 5 comprises the group of Figs. 5A - 5D showing selected steps of movement of the indenter 22 for crimping pin 10 to insulation 18 while Fig. 6 comprises the group of Figs. 6A - 6D showing corresponding steps of movement of indenter 20 for crimping pin 10 to wire 16. The pivotable handle 86 is indicated by line 88 to illustrate the position of the handle during the crimping cycle.

In Figs. 5A and 6A, the handle 86 is in the fully open position and the indenter elements 38 for the pin to wire crimp and the indenter elements 24,26 for the pin to insulation crimp are all shown in the retracted position with respect to pin 10. As the handle 86 is compressed toward handle 84, the cam surfaces 44, 66 begin to rotate and drive the indenter elements radially inward into contact with the pin as shown in Figs. 5B and 6B. In Figs. 5C and 6C, the indenter elements have ridden up onto the most radially inward surface 90 of each cam surface and have completed the crimp of the pin 10 onto the wire 16 and insulation 18. As the handle 84 is compressed further, the cam surface continues to rotate into the position shown in Figs. 5D and 6D such

that the indenter elements have followed the cam surface into respective recessed areas 92 so that the indenter elements are retracted from contact with the pin 10. At this time the wire with the pin 10 crimped thereon may be easily withdrawn from the tool 82 and then the handle 84 released to allow the tool to recycle back to the starting position with the indenter elements retracted into the respective starting recesses 94.

One problem that has been noted with regard to the use of the above described indenter or crimp tool is that the tips of the concave portion of the indenter elements that actually crimp the contact may break off if the metal of the indenter elements is too hard and brittle such as by being of a high carbon content. Conversely, if the indenter elements are made of a less hard and brittle steel, then the wear on the radially outer indenter element end that rides on the cam surface is excessive and shortens the tool life.

The present invention overcomes this wear problem by using a crown or implant of hard metal on the cam surface contact end of the indenter elements. The indenter cam surface 44 in Fig. 3 can be made of a less hard and brittle steel. Referring to Figs. 7a and 7b, there is shown a partial side view of an indenter element 100 fitted with a carbide insert 102. The element 100 corresponds to the indenter element 26 of Fig. 3. The insert 102 fits into a rounded slot 104 formed or cut into the radially outer end 106 (when positioned in the tool head 30) of the indenter element 100 so that the insert 102 functions as the contact between the indenter element and an adjacent cam surface indicated at 106 which may be part of cam surface 44. The insert 102 is a cylindrical shaped element and is preferably press fit into the indenter element slot 104. While it is contemplated that the insert 102 is formed of a carbide material, it is possible that other hardened materials may be used for the insert. Further, the insert could take other configurations such as a mushroom cap shape with a pin attachment to indenter element 100 rather that being an insert into a slot in the indenter element.

While the invention has been described in what is considered to be a preferred form, various modifications and adaptations will become apparent to those skilled in the art. Further, while described with reference to a contact pin, it will be recognized that the description is equally applicable to a contact

socket. Accordingly, the invention is to be interpreted within the spirit and scope of the appended claims.

CLAIMS

What is claimed is:

1. A crimping tool for pin and socket contacts comprising:

a first indenter having a plurality of indenter elements arranged in a circumferential pattern about an opening adapted for receiving a contact, ech of the indenter elements having a first end for engaging the contact and second end;

a cam member having a radially inner cam surface arranged for engaging the second end of the indenter elements, the cam member being moveable to cause the cam surface to react against the contact second end to effect radial displacement thereof; and

a hardened contact tip on the second end of the indenter elements for engaging the cam surface.

2. The crimping tool of claim 1 wherein the hardened tip comprises an insert.

3. The crimping tool of claim 2 wherein the insert comprises a carbide material.

4. The crimping tool of claim 3 wherein the insert comprises a cylindrical shaped element seated in a partially enclosing slot in the second end of the indenter element.

5. The crimping tool of claim 3 and including a second indenter laterally displaced along a length of the contact receiving opening from the first indenter.

6. A compound indenter for a wire connector pin, the pin having an axial length and an opening at an end thereof for receiving a wire having an exposed portion and an insulation covered portion, the opening being sized to receive both the exposed portion and a length of the insulation covered portion, the indenter comprising:

a first indenter having a plurality of radially moveable indenting elements for engaging the pin in an axial location overlaying the exposed portion of the wire inserted in the pin;

a second indenter having a plurality of radially moveable indenting elements for engaging the pin in an axial location overlaying the insulation covered portion of the wire inserted in the pin;

apparatus for advancing the indenting elements of each of the first and second indenter generally concurrently for compressing respective sections of the pin into engagement with the exposed wire portion and the insulation covered portions of the wire, the apparatus comprising a corresponding rotatable cam surface engaging a radially outer end of each of the radially moveable elements of each respective indenter; and

each indenting element having a hardened tip on its outer end for engaging the cam surface.

7. The compound indenter of claim 6 wherein each rotatable cam surface is coupled to a pivotable handle of a plier type hand tool.

8. The compound indenter of claim 6 wherein each rotatable cam surface is coupled to a pivoting arm having a cam follower riding in a horizontally oriented, curved slot in a vertically operating actuator.

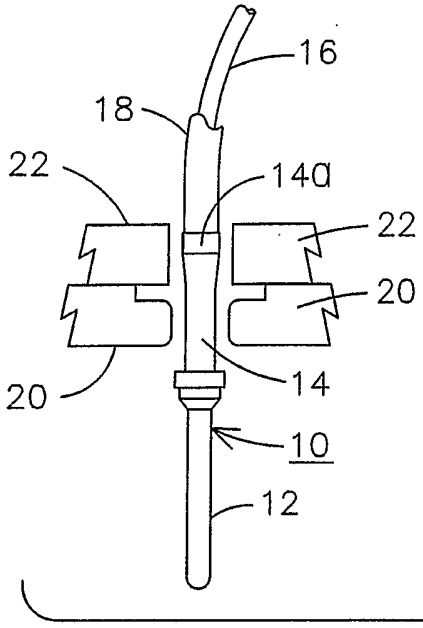


FIG. 1

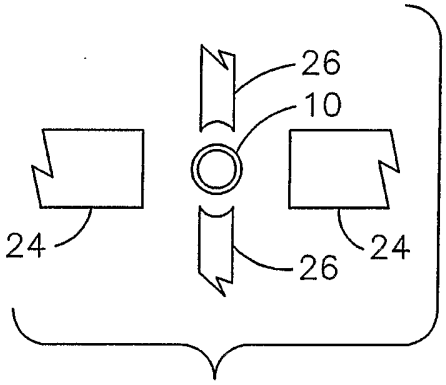


FIG. 2A

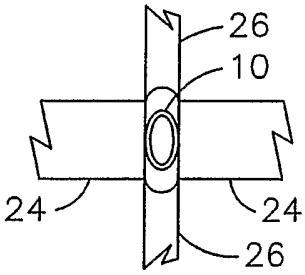


FIG. 2B

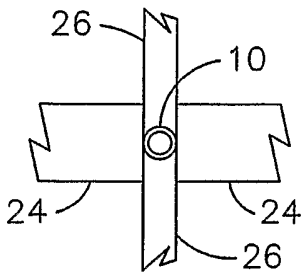


FIG. 2C

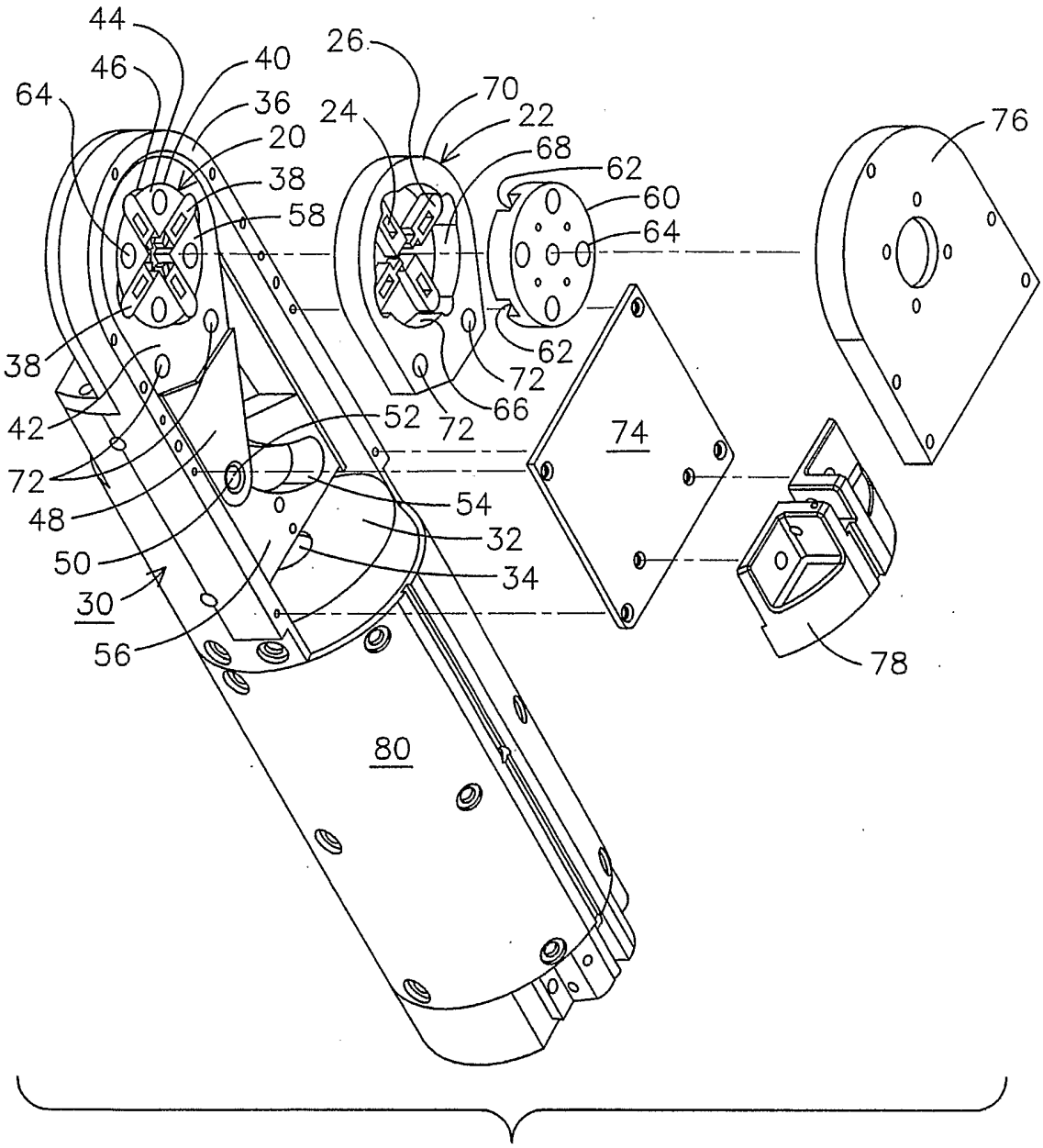

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FIG. 3

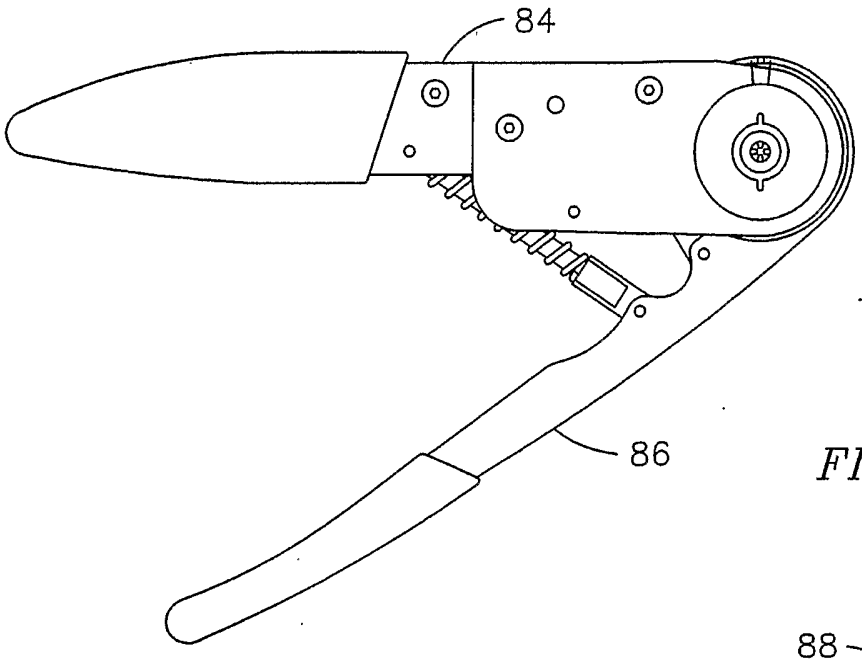


FIG. 4

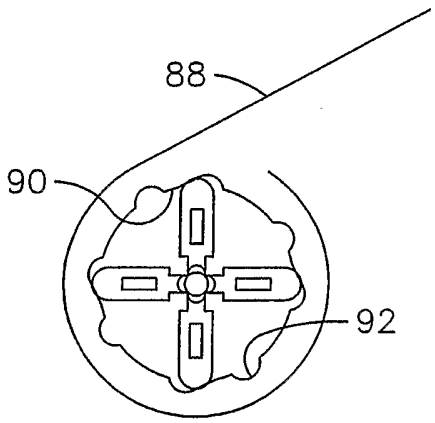


FIG. 5B

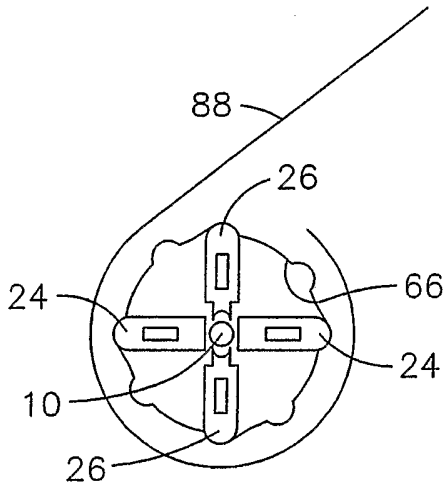


FIG. 5A

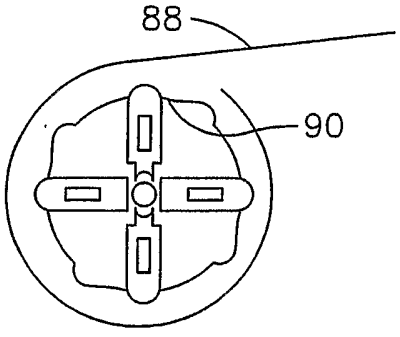


FIG. 5D

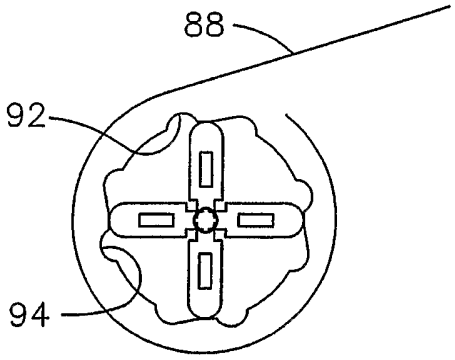


FIG. 5C

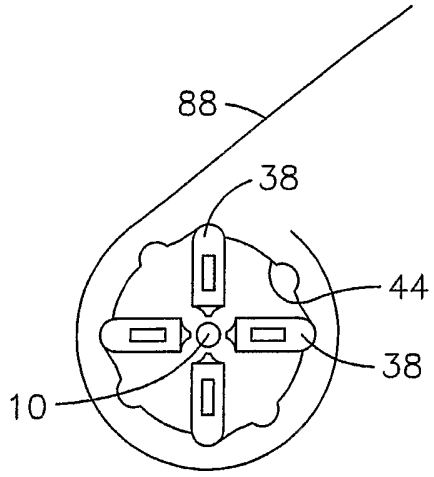


FIG. 6A

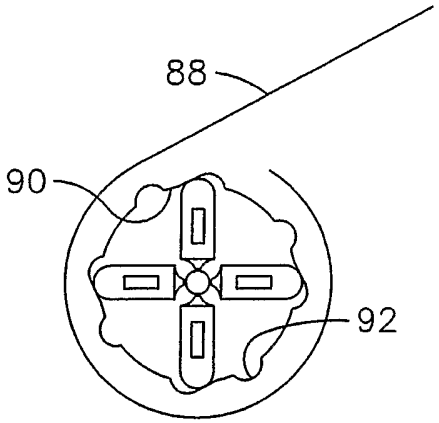


FIG. 6B

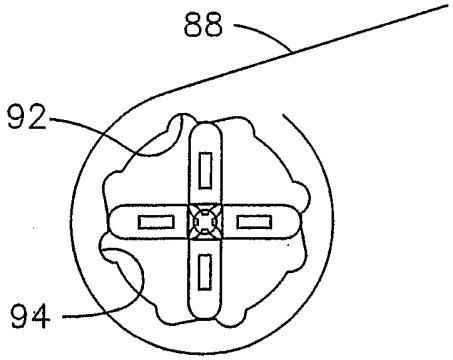


FIG. 6C

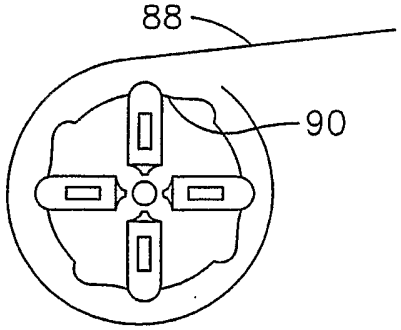


FIG. 6D

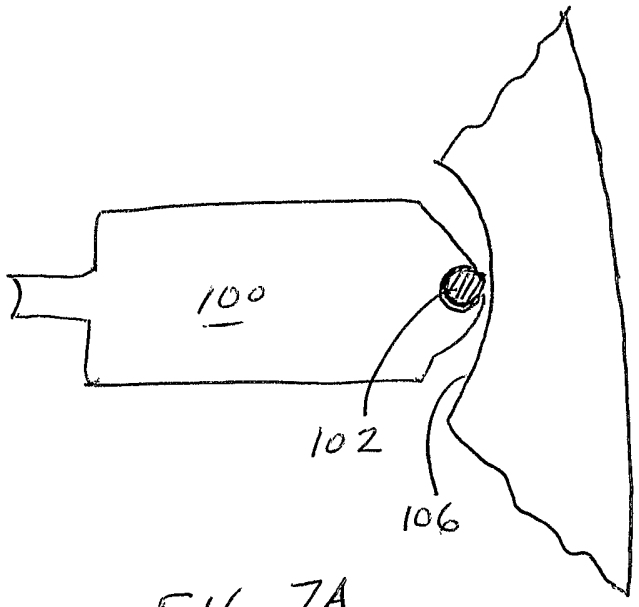


FIG. 7A

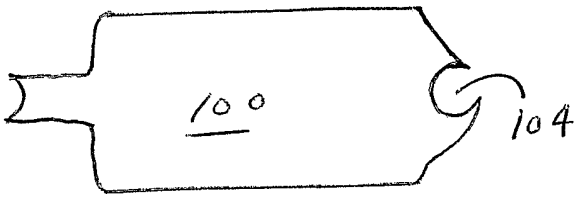


FIG. 7B