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(54) ELECTRICAL CONNECTOR WITH ANTI-ARCING FEATURE

ELEKTRISCHER VERBINDER MIT ANTIKRÜMMUNGSFUNKTION

CONNECTEUR ÉLECTRIQUE AVEC FONCTIONNALITÉ DE SUPPRESSION D'ARC

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Description

FIELD OF THE INVENTION

[0001] The invention relates to electrical connectors, and more particularly, to an electrical connector that suppresses arcing if connected or disconnected while current is flowing.

BACKGROUND OF THE INVENTION

[0002] Electrical connectors generally should not be connected or disconnected while the electrical load is turned on. Electrical arcing between the separated contacts of a live electrical connector present a hazard of fire and of burns to the user, and any such arcing tends to reduce the useful life of the connector.

[0003] Nevertheless, due to the fallibility of human nature, it remains true that electrical connectors may at times be inadvertently connected or disconnected while the electrical load is turned on. When the electricity is alternating current, arcing is less of a problem, because the sinusoidal nature of the alternating current will cause the voltage to be zero at some point during the electrical contact separation, and any arcing will tend to self-extinguish. However, when the electricity is direct current, the voltage is constant and never zero, and electrical arcing between the separating contacts will be maintained over a substantial range of contact separations, creating a burn hazard for the user and reducing the useful life of the connector.

[0004] One approach is to provide a separate, shorter set of contacts within the connector, and configure the connector so that the shorter contacts are engaged after and disengaged before the primary electrical connections. The lack of current across the shorter connection is then used to trigger a separate switching device placed in the primary electrical circuit that shuts off the current in the circuit before the separation of the primary electrical connections. However, adding an additional contact and switching device increases both the bulk and the cost of the system.

[0005] Another approach is to include an insulating barrier that covers the leading end of one of the electrical contacts and blocks the direct through-air path between the contacts as the connectors are mated and un-mated. However, in this approach arcing can still occur through an indirect path that by-passes the insulating barrier.

[0006] What is needed, therefore, is an electrical connector that suppresses electrical arcing between separated contacts during connection and disconnection, without adding an additional connection and switching device.

[0007] EP0354074A1 discloses an electrical connector pair, comprising: a first connector having a first insulating housing; a first electrical contact supported within the first insulating housing; a second connector having a second insulating housing; and a second electrical contact supported within the second insulating housing. An arc-arresting pellet is mounted on each of the two contacts in a position that the pellets make contact before the main contacts and break contact after the main contacts have separated. This absorbs a portion of the arcs formed to avoid damage to the main contacts. DE101 49 201C1 discloses a connector pair in which an end portion of each conductor is formed of an insulating material so that the male connector does not separate from within the female until the insulating portions are in contact with each other. US5213517 discloses an electrical connector in which a tubular member of a non-linear material, whose resistance varies with the electrical field thereon, surrounds the male conductor and is slidable thereon. As the connectors are unmated, the rise in potential of the male connector causes a reduction of the resistance of the tubular member, shorting the conductor to earth and thus preventing formation of an arc.

SUMMARY OF THE INVENTION

[0008] A novel connector pair suppresses electrical arcing between separated contacts during mating and un-mating of the connectors, without including an additional connection or switching device. One general aspect of the invention includes an insulating barrier that suppresses arcing between separated contacts during connection and disconnection of the electrical contacts. The insulation barrier of the present invention thereby protects users from electrical burns and extends the useful life of the connector.

[0009] The insulating barrier includes both a male and a female barrier, at least one of which is configured so that it extends beyond at least one of the contacts and covers the leading edge of the contact. The male and female barriers engage with each other when the contacts are separated, thereby closing off all through-air paths between the contacts and suppressing arcing.

[0010] In embodiments, arcing between separated contacts is further suppressed by constructing the leading edge of at least one of the electrical contacts from a metal having low electrical conductivity, so that the electrical resistance of the connection is significantly increased immediately before the contacts are separated, thereby lowering the electrical current and the energy available for electrical arcing, without adding an additional connection or any special switching circuitry.

[0011] In another general aspect of the present invention, at least one of the electrical contacts in at least one of the connectors is a bi-metal contact having a metallic composition that is configured to create within the contact an operating segment that has low resistance and a transitional segment that has high resistance, where the transitional segment makes exclusive initial and final contact during mating and un-mating of the connectors, and the operating segment conducts current when the connectors are fully mated. In embodiments, the transitional segment is located at the leading end of the electrical contact.

[0012] The features and advantages described herein are not all-inclusive and, in particular, many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings, specification, and claims. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and not to limit the scope of the inventive subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Figure 1A is a partial cross-sectional diagram of a prior art male and female connector pair in a connected configuration;

Figure 1B is a partial cross-sectional diagram of the prior art connector pair of Figure 1A showing arcing during disconnection;

Figure 2A is a partial cross-sectional diagram of a male and female connector pair in a connected configuration according to an embodiment of the present invention;

Figure 2B is a partial cross-sectional diagram of the connector pair of Figure 2A, showing suppression of arcing by the insulating barrier during disconnection;

Figure 3A is a top view of a male and female connector pair shown in a connected configuration according to an embodiment of the present invention.

Figure 3B is a cross-sectional side view of the connector pair of Figure 3A;

Figure 4A is a top view of the male and female connector pair of Figure 3A shown in a partially disconnected configuration.

Figure 4B is a cross-sectional side view of the connector pair of Figure 4A;

Figure 5A is a partial cross-sectional side view of a connector pair similar to Figure 2A, but including a contact having a leading segment made from a high resistance metal; and

Figure 5B is a cross-sectional side view of the connector pair of Figure 5A, shown in a partially disconnected configuration.

DETAILED DESCRIPTION

[0014] With reference to Figure 1A, a typical male and female connector pair of the prior art includes a male contact 100 and a female contact 102. One of the contacts (here the female contact 102) is flexible and is placed under tension by a spring 1 12 so that a shaped region of the contact 102 will ride over the leading end of the male contact 100 and press against a connecting surface of the male contact 100 when the connectors are mated. Insulated housings 104, 106 surround the male and female contacts, and shield the contacts from environmental hazards, as well as providing some protection to a user in case arcing occurs when the user is handling the connector pair. In the prior art example of Figure 1A, additional insulating structures 108, 1 10 are provided proximal to the outer faces of the contacts 100, 102 to support the contacts 100, 102, and to provide receiving channels for the two insulating housings 104, 106 to mate. A spring 1 12 is also included to provide a pressing tension between the flexible female contact 102 and the fixed male electrical contact 100.

[0015] Figure IB shows the connector pair of Figure 1A having been partially disconnected while a voltage is still being applied. The leading ends of the two contacts 100, 102 are separated by a short gap, and through-air electrical arcing 1 14 is taking place between them.

[0016] Figure 2A is a partial cross-sectional illustration of an embodiment of the present invention, shown in a connected configuration. The embodiment is similar to the prior art design of Figure 1A, except that the insulating support structures 108, 1 10 have been replaced by insulating barrier structures 200, 202. The male insulating barrier structure 200 extends beyond the male contact 100, and covers the leading end of the male contact 100. The female insulating barrier 202 extends beyond the female contact 102. In this embodiment, the female barrier 202 is in front of the leading end of the female contact. In similar embodiments it covers or nearly covers the end of the female contact.

[0017] Figure 2B is a partial cross-sectional illustration of the embodiment of Figure 2A shown in a partially disconnected configuration. Although the ends of the two contacts 100, 102 are not separated by a large distance, the male insulating barrier 200 is very near to or physically in contact with the female insulating barrier 202, thereby blocking substantially all through-air arcing paths between the contacts 100, 102. Some embodiments include a spring or other tensioning mechanism that presses the male and female insulating barriers against each other when the connectors are partially disconnected.

[0018] Figure 3A is a top view of the complete connector pair of which Figures 2A and 2B are partial cross sections, shown in a connected configuration. Figure 3B is a cross-sectional side view of the complete connector of Figure 3A. Figure 4A is a top view of the complete connector pair of which Figures 2A and 2B are partial cross sections, shown in a partially disconnected configuration. Figure 4B is a cross-sectional side view of the complete connector of Figure 4A.

[0019] With reference to Figures 5A and 5B, the suppression of arcing of the present invention is enhanced in some embodiments by manufacturing the leading end

of at least one of the contacts 100 from a metal such as nickel-chrome or stainless steel that has a high electrical resistance 500. Figure 5A is a partial cross-sectional side view of an embodiment similar to Figure 2A, except that the leading end 500 of the male contact 100 is made from high resistance metal. The figure shows the connector in a connected configuration, where the female contact 102 physically engages with a part of the male contact 100 that is low resistance, for example copper.

[0020] Figure 5B is a cross-sectional view of the embodiment of Figure 5A shown in a partially disconnected configuration, where the female contact 102 is engaged with the high resistance end 500 of the male contact 100. It can be seen from the figure that during disengagement, the end of the female contact 102 slides from the low resistance portion of the male contact 100 onto the high resistance portion 500 of the male contact 100, and then onto the female insulating barrier 202 which blocks any tendency of the current to arc from the female contact 102 to the end 500 of the male contact 100. The resistance of the circuit is thereby increased during disconnection in two steps, rather than transitioning suddenly from low resistance to near-infinite resistance.

[0021] The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible within the scope of the claims appended hereto.

Claims

1. An electrical connector pair, comprising:

a first connector having a first insulating housing (104);
a first electrical contact (100) supported within the first insulating housing (104), the first electrical contact (100) having a connecting surface that is substantially parallel with a longitudinal axis of the insulating housing and terminates in a leading end of the first electrical contact, the connecting surface including a transitional section (500) at the leading end and an operating section adjacent to the transitional section, the transitional section having a higher resistance than the operating section;
a second connector having a second insulating housing (106);
a second electrical contact (102) supported within the second insulating housing (106), the second electrical contact (102) being configured to laterally engage with the operating section of the connecting surface of the first electrical contact (100) when the first connector is fully mated with the second connector, the second electrical contact (102) being configured to engage exclusively with the transitional section (500) of the connecting surface of the first electrical contact (100) during an initial phase of mating and a final stage of un-mating of the connectors, **characterized by**
a first insulating barrier (200) within the first connector extending beyond and covering the leading end of the first electrical contact (100); and
a second insulating barrier (202) extending beyond the second electrical contact (102) within the second connector, the second insulating barrier (202) being configured so as to be in close proximity with the first insulating barrier (200) when the first and second connectors are partially disconnected and the first and second electrical contacts are separated by a short distance, thereby blocking substantially all through-air arcing paths between the first and second electrical contacts.

2. The connector pair of claim 1, further comprising a contact tensioning mechanism (112) that presses the second electrical contact (102) against the engaging surface of the first electrical contact (100) when the first and second connectors are connected.

3. The connector pair of claim 1, further comprising a barrier tensioning mechanism that presses the first and second insulating barriers (200, 202) against each other when the first and second connectors are partially disconnected and the first and second electrical contacts (100, 102) are separated by a short distance.

4. The connector pair of claim 1, wherein the first electrical contact is a bi-metal contact, and the transitional section (500) is made from a metal having a higher resistance than a metal from which the operating section is made.

5. The connector pair of claim 1, wherein at least one of the first and second electrical contacts includes a terminal for crimping to a wire.

6. The connector pair of claim 1, wherein at least one of the first and second electrical contacts includes a terminal for soldering to a printed circuit or wiring board.

7. The connector pair of claim 1, wherein at least one of the first and second electrical contacts includes a terminal for soldering a wire or and electrical component to the contact.

8. The connector pair of claim 1, wherein at least one of the first and second electrical contacts includes a terminal using insulation displacement for attaching a wire to the contact.

9. The connector pair of claim 1, wherein at least one of the first and second electrical contacts includes a screw terminal for attaching a wire to the contact.

10. The connector pair of claim 1, wherein at least one of the first or second electrical contact is configured with a terminal using a spring mechanism for attaching at least one wire to the contact.

Patentansprüche

1. Elektrisches Verbinderpaar, umfassend:

einen ersten Verbinder mit einem ersten isolierenden Gehäuse (104);
einen ersten elektrischen Kontakt (100), der innerhalb des ersten isolierenden Gehäuses gehalten (104) ist, wobei der erste elektrische Kontakt (100) eine Verbindungsfläche aufweist, die im Wesentlichen parallel zu einer Längsachse des isolierenden Gehäuses ist und in einem vorderen Ende des ersten elektrischen Kontakts endet, wobei die Verbindungsfläche einen Übergangsabschnitt (500) am vorderen Ende und einen Betriebsabschnitt neben dem Übergangsabschnitt aufweist, wobei der Übergangsabschnitt einen höheren Widerstand als der Betriebsabschnitt aufweist;
einen zweiten Verbinder mit einem zweiten isolierenden Gehäuse (106);
einen zweiten elektrischen Kontakt (102), der innerhalb des zweiten isolierenden Gehäuses (106) gehalten ist, wobei der zweite elektrische Kontakt (102) derart konfiguriert ist, dass er seitlich mit dem Betriebsabschnitt der Verbindungsfläche des ersten elektrischen Kontakts (100) in Eingriff gelangt, wenn der erste Verbinder vollständig mit dem zweiten Verbinder verbunden ist, wobei der zweite elektrische Kontakt (102) derart konfiguriert ist, um während einer Anfangsphase des Zusammenfügens und einer Endphase des Lösens der Verbinder ausschließlich mit dem Übergangsabschnitt (500) der Verbindungsfläche des ersten elektrischen Kontakts (100) in Eingriff zu gelangen, **gekennzeichnet durch**
eine erste isolierende Barriere (200) innerhalb des ersten Verbinders, die sich über das vordere Ende des ersten elektrischen Kontakts (100) erstreckt und dieses abdeckt; und
eine zweite isolierende Barriere (202), die sich über den zweiten elektrischen Kontakt (102) innerhalb des zweiten Verbinders erstreckt, wobei die zweite isolierende Barriere (202) derart konfiguriert ist, dass sie in enger Nähe zu der ersten isolierenden Barriere (200) ist, wenn der erste und der zweite Verbinder teilweise getrennt sind und der erste und der zweite elektrische Kontakt durch eine kurze Entfernung voneinander getrennt sind, wodurch im Wesentlichen alle Lichtbogenwege über die Luft zwischen den ersten und zweiten elektrischen Kontakten blockiert werden.

2. Verbinderpaar nach Anspruch 1, weiterhin umfassend einen Kontaktspannmechanismus (112), der den zweiten elektrischen Kontakt (102) gegen die in Eingriff stehende Fläche des ersten elektrischen Kontakts (100) drückt, wenn der erste und der zweite Verbinder verbunden sind.

3. Verbinderpaar nach Anspruch 1, weiterhin umfassend einen Barrierenspannmechanismus, der die erste und die zweite isolierende Barriere (200, 202) gegeneinander drückt, wenn der erste und der zweite Verbinder teilweise getrennt sind und der erste und der zweite elektrische Kontakt um eine kurze Entfernung voneinander getrennt sind.

4. Verbinderpaar nach Anspruch 1, bei dem der erste elektrische Kontakt ein Bimetallkontakt ist und der Übergangsabschnitt (500) aus einem Metall hergestellt ist, das einen höheren Widerstand aufweist als ein Metall, aus dem der Betriebsabschnitt hergestellt ist.

5. Verbinderpaar nach Anspruch 1, bei dem mindestens einer der ersten und zweiten elektrischen Kontakte einen Anschluss zum Crimpen an einen Draht aufweist.

6. Verbinderpaar nach Anspruch 1, bei dem mindestens einer der ersten und zweiten elektrischen Kontakte einen Anschluss zum Anlöten an eine Leiterplatte oder eine Verdrahtungsplatte aufweist.

7. Verbinderpaar nach Anspruch 1, bei dem mindestens einer der ersten und zweiten elektrischen Kontakte einen Anschluss zum Anlöten eines Drahtes oder einer elektrischen Komponente an den Kontakt aufweist.

8. Verbinderpaar nach Anspruch 1, bei dem mindestens einer der ersten und zweiten elektrischen Kontakte einen Anschluss aufweist, der ein Verschieben einer Isolation zum Befestigen eines Drahtes an dem Kontakt verwendet.

9. Verbinderpaar nach Anspruch 1, bei dem mindestens einer der ersten und zweiten elektrischen Kontakte einen Schraubanschluss zum Befestigen eines Drahtes an dem Kontakt aufweist.

10. Verbinderpaar nach Anspruch 1, bei dem mindestens einer der ersten oder zweiten elektrischen Kon-

takte mit einem Anschluss konfiguriert ist, der einen Federmechanismus zum Befestigen mindestens eines Drahts an dem Kontakt verwendet.

Revendications

1. - Paire de connecteurs électriques, comprenant :

un premier connecteur ayant un premier boîtier isolant (104) ;
un premier contact électrique (100) porté à l'intérieur du premier boîtier isolant (104), le premier contact électrique (100) ayant une surface de connexion qui est sensiblement parallèle à un axe longitudinal du boîtier isolant et se termine dans une extrémité avant du premier contact électrique, la surface de connexion comprenant une section de transition (500) au niveau de l'extrémité avant et une section de fonctionnement adjacente à la section de transition, la section de transition ayant une résistance supérieure à celle de la section de fonctionnement ;
un second connecteur ayant un second boîtier isolant (106) ;
un second contact électrique (102) porté à l'intérieur du second boîtier isolant (106), le second contact électrique (102) étant configuré pour venir latéralement en prise avec la section de fonctionnement de la surface de connexion du premier contact électrique (100) lorsque le premier connecteur est entièrement accouplé avec le second connecteur, le second contact électrique (102) étant configuré pour venir exclusivement en prise avec la section de transition (500) de la surface de connexion du premier contact électrique (100) durant une phase initiale d'accouplement et une phase finale de désaccouplement des connecteurs, **caractérisée par**
une première barrière isolante (200) à l'intérieur du premier connecteur s'étendant au-delà de l'extrémité avant du premier contact électrique (100) et recouvrant celle-ci ; et
une seconde barrière isolante (202) s'étendant au-delà du second contact électrique (102) à l'intérieur du second connecteur, la seconde barrière isolante (202) étant configurée de façon à être à proximité étroite avec la première barrière isolante (200) lorsque les premier et second connecteurs sont partiellement déconnectés et que les premier et second contacts électriques sont séparés d'une courte distance, permettant ainsi de bloquer sensiblement tous les chemins de production d'arc électrique à travers l'air entre les premier et second contacts électriques.

2. - Paire de connecteurs selon la revendication 1, comprenant en outre un mécanisme de mise sous tension de contact (112) qui presse le second contact électrique (102) contre la surface de mise en prise du premier contact électrique (100) lorsque les premier et second connecteurs sont connectés.

3. - Paire de connecteurs selon la revendication 1, comprenant en outre un mécanisme de mise sous tension de barrière qui presse les première et seconde barrières isolantes (200, 202) l'une contre l'autre lorsque les premier et second connecteurs sont partiellement déconnectés et que les premier et second contacts électriques (100, 102) sont séparés d'une courte distance.

4. - Paire de connecteurs selon la revendication 1, dans laquelle le premier contact électrique est un contact bimétallique, et la section de transition (500) est réalisée en un métal ayant une résistance supérieure à celle d'un métal en lequel la section de fonctionnement est réalisée.

5. - Paire de connecteurs selon la revendication 1, dans laquelle au moins l'un des premier et second contacts électriques comprend une borne destinée à être sertie à un fil.

6. - Paire de connecteurs selon la revendication 1, dans laquelle au moins l'un des premier et second contacts électriques comprend une borne destinée à être soudée sur une carte de circuits imprimés ou un tableau de connexions.

7. - Paire de connecteurs selon la revendication 1, dans laquelle au moins l'un des premier et second contacts électriques comprend une borne pour souder un fil et/ou un composant électrique au contact.

8. - Paire de connecteurs selon la revendication 1, dans laquelle au moins l'un des premier et second contacts électriques comprend une borne utilisant l'autodénudation pour fixer un fil au contact.

9. - Paire de connecteurs selon la revendication 1, dans laquelle au moins l'un des premier et second contacts électriques comprend une borne à vis pour fixer un fil au contact.

10. - Paire de connecteurs selon la revendication 1, dans laquelle au moins l'un des premier et second contacts électriques est configuré avec une borne utilisant un mécanisme à ressort pour fixer au moins un fil au contact.

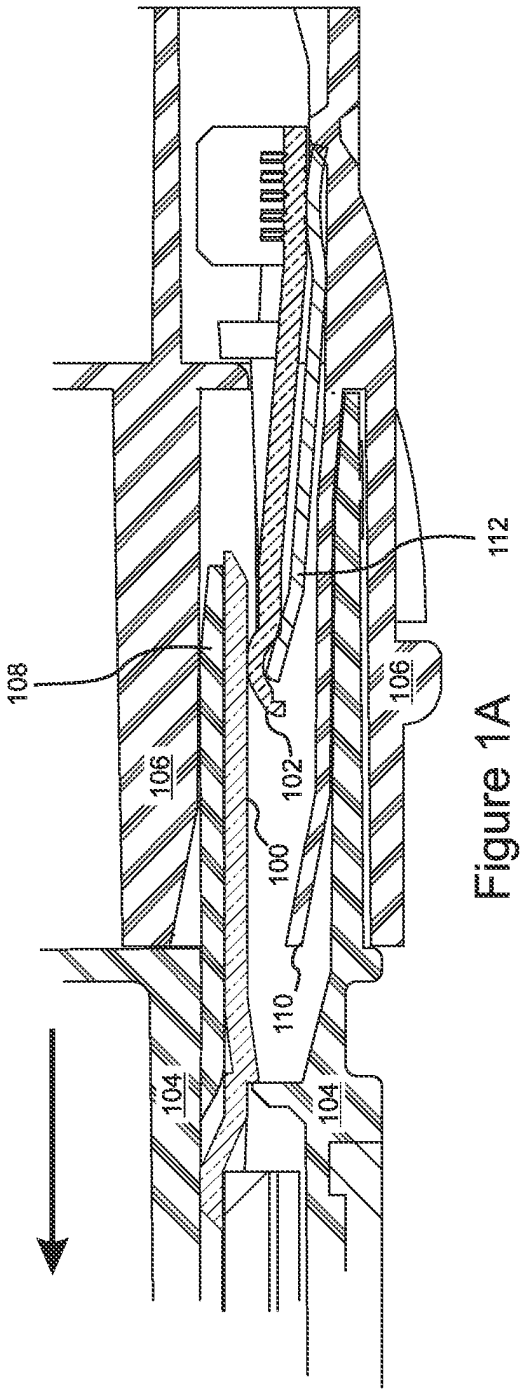

Figure 1A
Prior Art

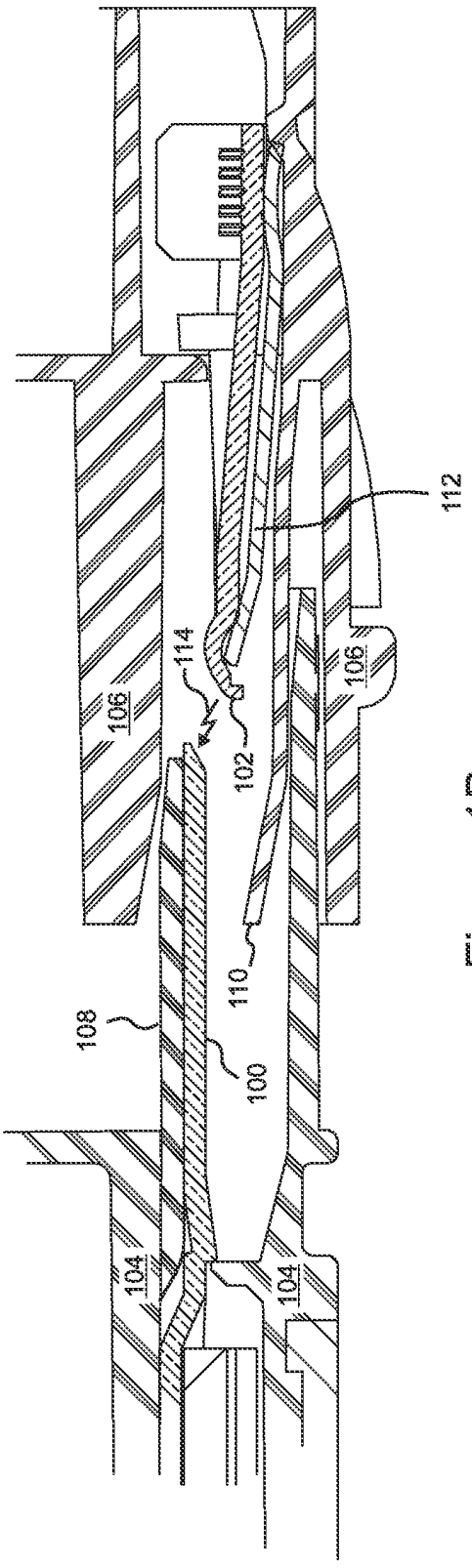

Figure 1B
Prior Art

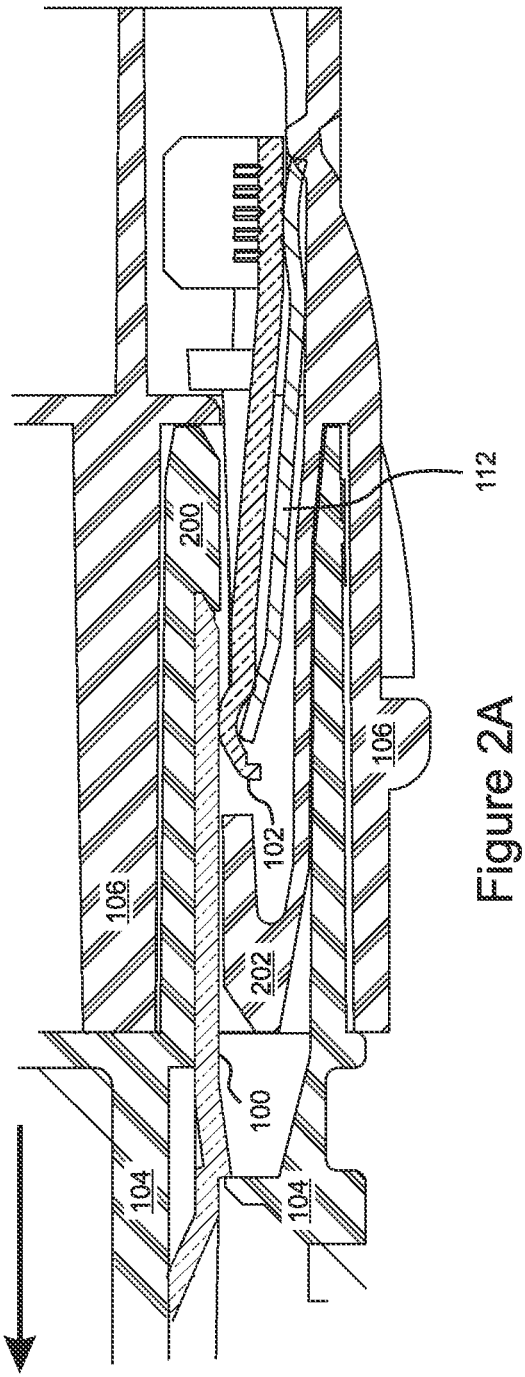

Figure 2A

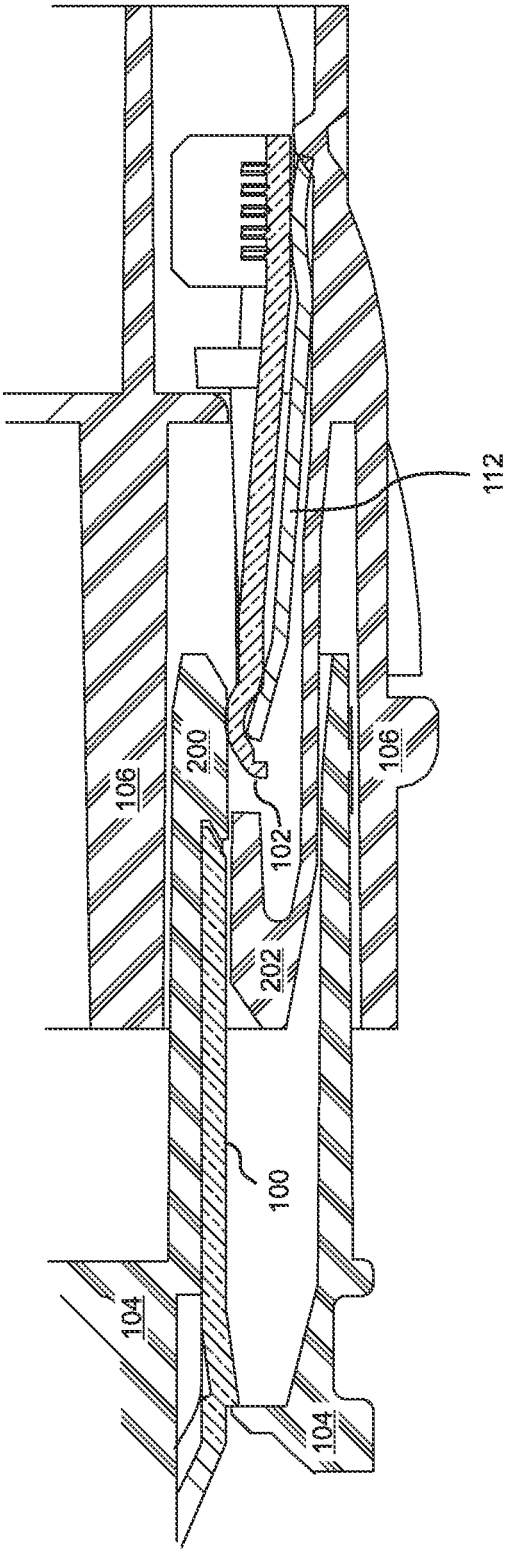

Figure 2B

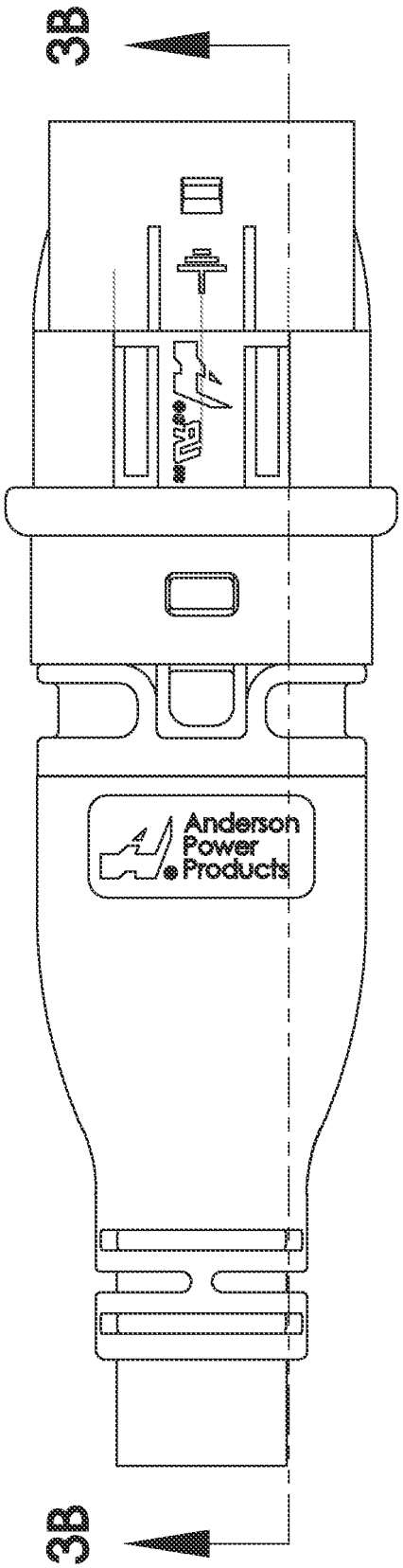

Figure 3A

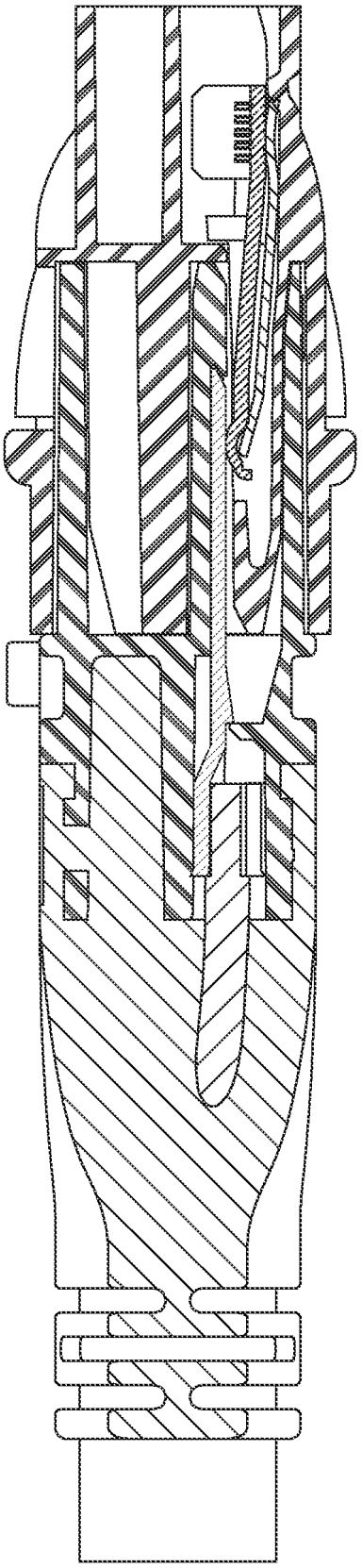

Figure 3B

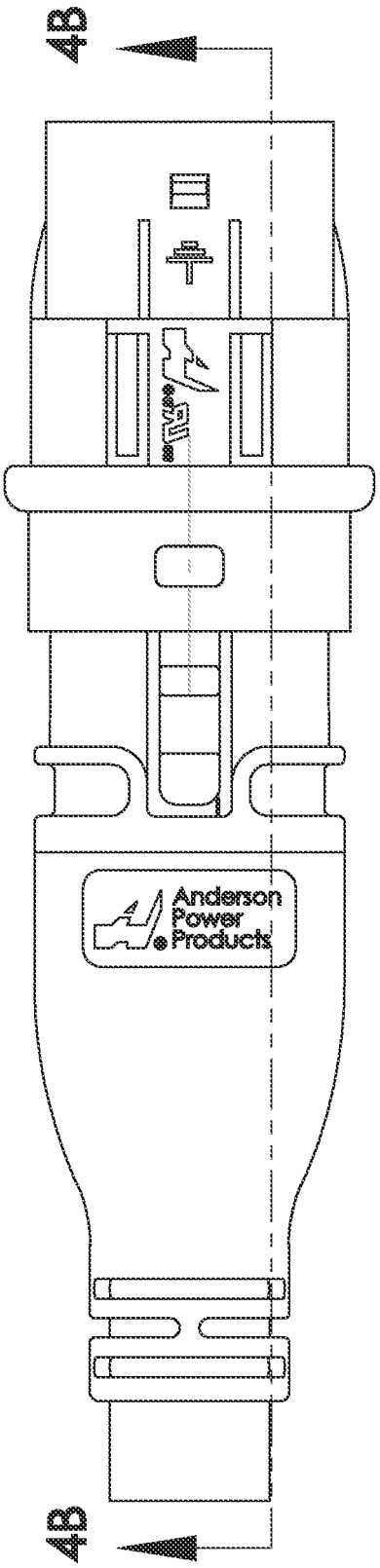

Figure 4A

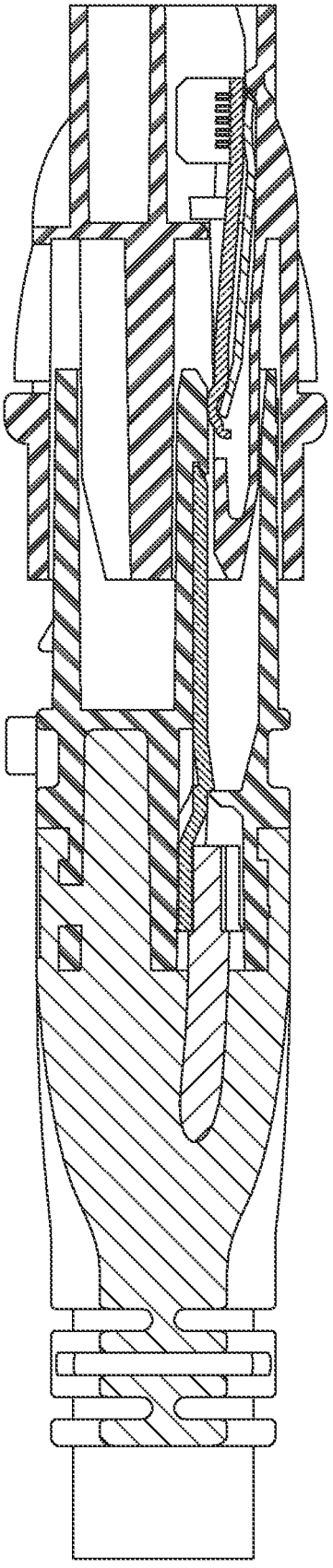

Figure 4B

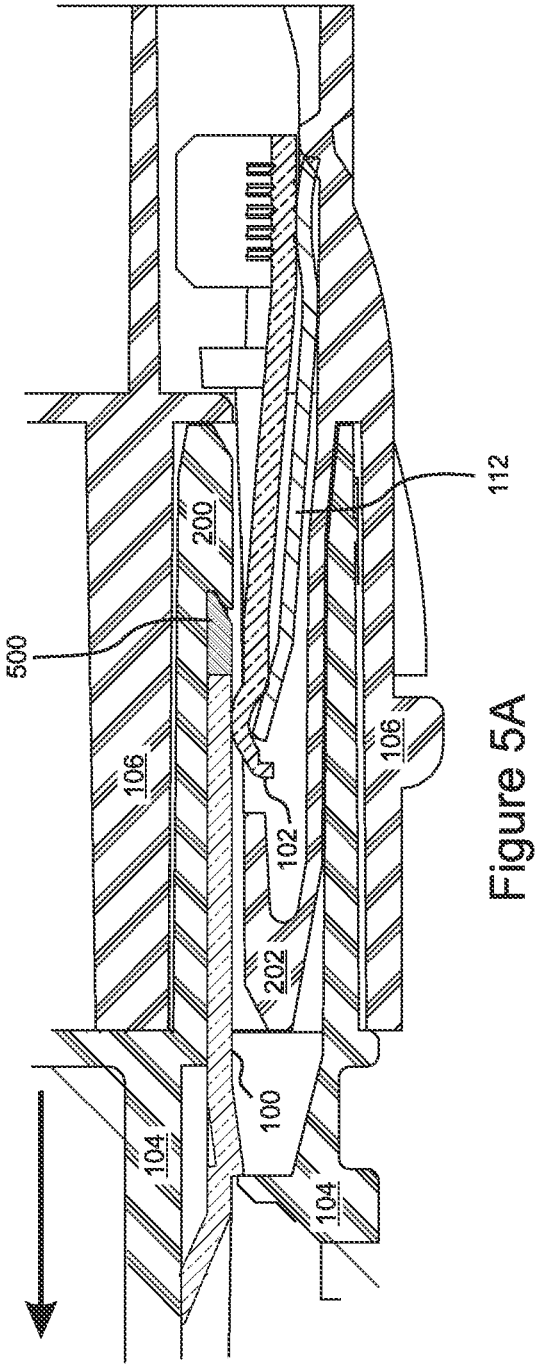

Figure 5A

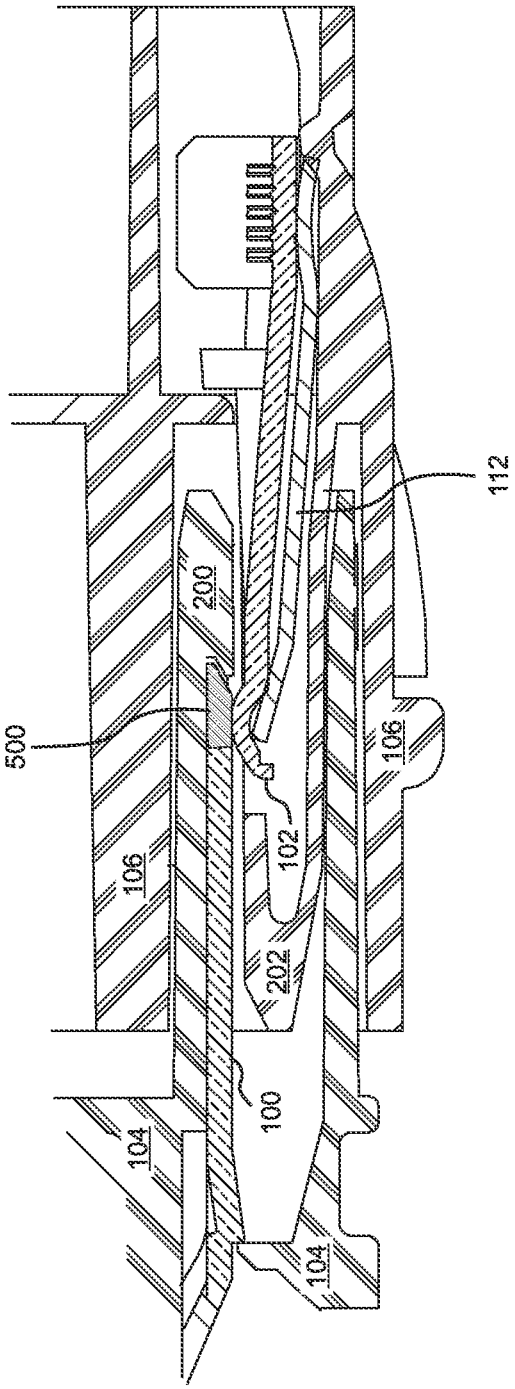

Figure 5B

REFERENCES CITED IN THE DESCRIPTION

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