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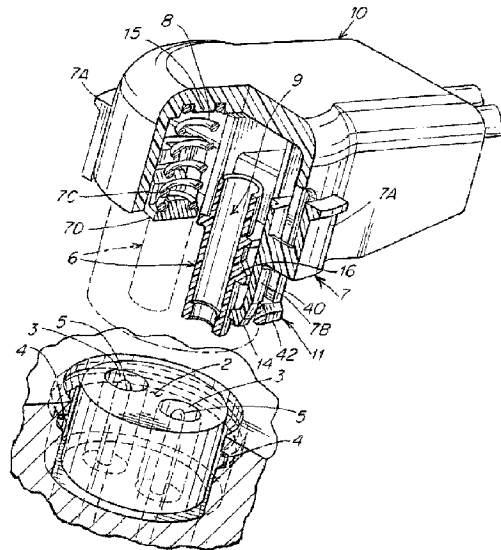
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(54) Titre : CONNECTEUR DE FAISCEAU AUTOMOBILE A AUTO-REJECTION
 (54) Title: SELF-REJECTING AUTOMOTIVE HARNESS CONNECTOR



(57) **Abrégé/Abstract:**

Connector (10, 110) for connecting to a receptacle includes a housing including fins (16) or tripping structures (120), an electrically conductive terminal (12) in the housing, locking beams (11) or latches (113) in the housing, a spring (15, 128), and a slider (7) slidably coupled to the housing and having blocking beams (7B) extending in a mating direction. Alternatively, a slider (114) includes blocking structures (117) and trippable structures (121) extending in the mating direction and that cooperate with the tripping structures (120). The fins (16) or tripping structures (120) engage with the blocking beams (7B) or trippable structures (121), respectively, during an initial stage of movement between the housing and slider (7, 114) against bias of the spring (15, 128) while inward deflection of the locking beams (11) or latches (113) is allowed. The blocking beams (7B) or trippable structures (121) prevent inward deflection of the locking beams (11) or latches (113) after a final stage of the movement between the housing and slider (7, 114), and the connector (10, 110) has an electrically interconnected state only when in the final stage.

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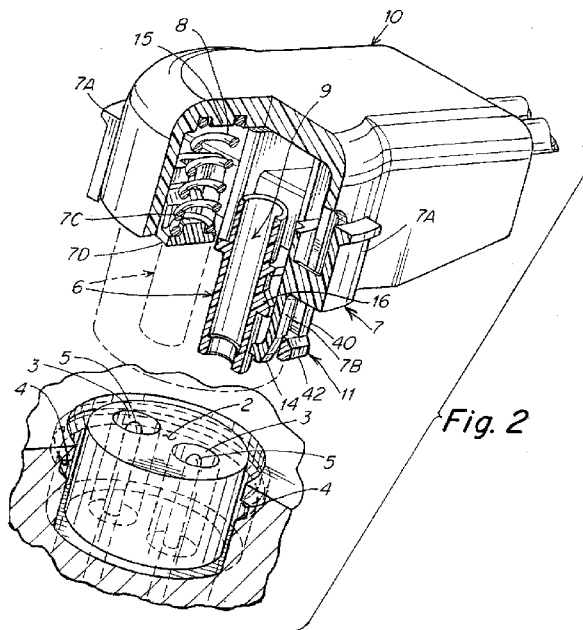
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(54) Title: SELF-REJECTING AUTOMOTIVE HARNESS CONNECTOR

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SELF-REJECTING AUTOMOTIVE HARNESS CONNECTOR

TECHNICAL FIELD

5 The present invention relates generally to internal structures and mechanisms of an electronic connector of a cable. More particularly, the invention relates to internal structures and mechanisms of an electronic controller of a cable used to electronically activate mission-critical safety devices in vehicles.

10 The invention also relates to electric connectors for specific cables, namely, those that have a headshell deploying positive locking means to intermate the cable conductors to those in a receptacle on a device or in a receptacle on another cable assembly, with the locking means being substantially permanent or requiring a deliberate actuation of at least one mechanical component of the cable headshell mechanism in order to disengage the cable headshell from the receptacle.

15 The invention also relates to a self-rejecting automotive harness connector primarily but not exclusively designed to mate electrical wires or cables in a cable harness terminating in a headshell having terminals, to a dedicated receptacle connector having complementary electrically conductive contacts or pins.

BACKGROUND OF THE INVENTION

20 Electrical signals and electric power in vehicles are commonly transmitted by electrical cables grouped into a wiring harness. Wires within the harness are grouped into cables which are installed on electrical and electronic devices and modules throughout the vehicle. Electrical interconnection is afforded by cable end headshells containing a plurality of electrical contacts or terminals which intermate with complementary contacts and terminals in receptacles on the devices and modules.

25 More specifically, there exist connectors that provide for connection of signals and power transmitted through cable harness assemblies which attach to mission-critical safety devices. Since the receptacle is often fixed to structural components of the vehicle relative to the mating motion of the cable harness connector assembly, the connector headshell is considered to plug in to the receptacle and is often referred to as a plug-in connector.

30 Electrical connectors designed to plug in to mission-critical safety device units require exceptionally high levels of confidence in the efficacy and endurance of good electrical interconnect properties throughout the challenging physical environment of mechanical shocks, vibration, temperature variations, during the foreseeable service life of the vehicle.

Additionally for these systems, it is critical to assure correct and reliable installation of the cable to its mating device during the initial assembly of the vehicle and during any repair or maintenance service in which a disconnect and a reconnect of a mission-critical safety device occurs.

5 Common approaches to assure correct and complete connection of a harness to a mission-critical unit include electrical continuity checks and visual inspection or verification that a cable end headshell is properly engaged with the mission-critical unit. Typical interconnect designs for these applications include snapping detents and physical locking and engaging features which prevent undesirable disconnection. Yet these design features are rarely fool-proof and invite an assembly error in which a partially or incompletely mated
10 connector passes an assessment of its electrical interconnectivity while the physical locking features are not completely engaged and fully actuated.

The danger posed by a positive reading of electrical continuity plus a cursory visual inspection failing to detect that an installment is in fact incomplete is that subsequent
15 vibration, shocks, and atmospheric oxidation in service can disconnect the cable or substantially degrade its electrical interconnect properties such that a mission-critical safety device fails to receive an electrically transmitted signal. One such example would be the explosive squibs used to deploy a passenger airbag failing to operate in a moment of dire need.

20 Of potential relevance to the invention, U.S. Pat. No. 7,238,039 entitled "Plug-in Connector Comprising a Secondary Locking Mechanism Impinged by a Spring Force" by Holweg, describes a plug-in connector, in particular for airbag retaining systems, that includes a first housing that can be locked in a mating connector by locking arms, and a secondary locking mechanism that can be loaded with a spring force. The secondary locking
25 mechanism has tongues that block the locking arms after they are engaged in the mating connector, as well as detent arms, that are blocked by one edge of the mating connector during the introduction process, until the locking arms are engaged. At this stage, the detent arms are then adapted to slide off the edge wherein, as a result of the spring force that has been previously built up, the secondary locking mechanism is adapted to be moved into its
30 final position. Mating of the connector may be accomplished in a single motion, and moreover, the connector will provide a self-reject from an incomplete mating, albeit in an inefficient manner relative to the manner in a connector in accordance with the invention provides for a single motion connectivity to a receptacle with a self-reject facet.

Other connector connectivity assurance systems in the prior art of potential relevance generally include electromagnetic actuation or disengagement, rotating or pivoting components, keys, toggles, or rocker actuations, and other elements. Specifically, some latching and locking connectors have latching or locking beams or arms while also having some additional movable component that can reinforce the locked state of the connector by trapping the beam in its engaged state. These secondary or redundant safety features and methods of achieving such a safely redundant locked state are sometimes referred to in the industry as “connector position assurance,” and abbreviated as CPA. “CPA” as used in this specification is not to be confused with an abbreviation meaning “Continued Prosecution Application” as described in MPEP 201.06(d).

Besides CPA, the term “terminal position assurance” or “TPA” occurs commonly and describes the art of assuring that conductive terminals resist being pushed out the back end of a housing during a forward mating motion of a connector.

Examples of such connectors include the following:

Canadian Pat. No. CA2124127(A1) entitled “Electric Connector” by Hopf et al., describes a connector with locking beams that engage a standardized annular undercut in the receptacle during a mating motion of the headshell. A second motion is required to manually slide a locking component in a direction defined by the headshell, which second motion happens to be perpendicular to the mating axis defined by the approach of the connector to the receptacle.

Canadian Pat. Appln. No. CA2265177 entitled “Connector With Automatic Insertion and Ejection” by Boussairy et al., describes a device providing a mating action that is assisted or automated by a spring. There is no self-rejecting action during the mating of the device.

Canadian Pat. No. CA2277682(C) entitled “Connector Module” by Miller, et al., describes a connector module that includes a first connector housing, a second connector housing and a connector positive assurance member. Insertion of the first housing into the second housing causes a latching mechanism located within the assembled first and second housings to latch the housings together so that they cannot be readily disengaged. When the first and second housings are fully engaged in this manner, the connector positive assurance member may be moved from a first position to a second position to assure complete engagement has been effected and to lock the housings together. If the first and second housings are not fully engaged, the connector positive assurance member cannot be moved from such first position to such second position.

European Pat. No. EP0828268A2 entitled "Plug-in Snap Acting Mechanism" by Schaar, describes a mechanism that affords electrical disengagement if insufficient actuation force is applied and then released.

European Pat. No. EP1207591B1 entitled "Plug Connector with Secondary Locking Device" by Gunreben, describes a connector including spring arms that insert into an "arm pit" at the root of the locking arms from an opposite axial direction.

Japan Pat. Appl. No. 2000-159569 entitled "Electronic Device" by Mori, describes a pushbutton switch with a spring providing physical resistance to deter actuation, except by a deliberately sufficient force.

Japan Pat. Appl. No. 08-317870 entitled "Electric Switch" by Aulmann, assures a determinate actuation of the switch by forcing the user to operate a second extraneous element before interconnection by the primary means is achieved.

Japan Pat. Appl. No. 08-028549 entitled "Coupling Device For Switch With Operating Device" by Kozono, describes a headshell and engagement means including a drive shaft therein and oriented slits on the receptacle side, so that a primary coupling force is achieved by rotary mechanical advantage rather than a press-on motion.

Japan Pat. Appl. No. H06-196039 entitled "Separating Device Associated With Circuit Breaker" by Paggi, deploys pins (male features) on a headshell and pin-receiving terminals in a plug side.

Japan Pat. Appl. No. 2009-265042 entitled "Operation Switch" by Kawaguchi et al., describes an electric switch with leaf-spring contacts. There is no feature that confirms an efficacious and reliable locked interconnect condition to the user.

Another published Japanese publication describes a push-button switch that provides for primary and secondary disconnect states, with the final preferred state maintained by the force of a stronger spring overriding that of a smaller, weaker spring.

Japan Pat. Appl. No. 2001-198540 entitled "Push-Lock Switch" by Seki, describes a headshell of a push-button housing that grips the outside of an assembly base, but not an annular recess in a separate receptacle. The movable internal component, called a pusher bar, must clear and subsequently lockingly engage a flange in the assembly base. Release from the locked state of this device is achieved by rotation of the button housing. Release from the locked state cannot be obtained by pulling the button housing away from the receptacle.

Japan Pat. Appl. No. 11-184285 entitled "Locking and Unlocking Mechanism of Cable Connector and Method for Locking and Unlocking" by Takahashi et al., describes a

device having two unlocking assistance plates driven by a stirrup in a manual action by the user.

U.S. Pat. No. 5,183,410 entitled "Connector Assembly" by Inaba et al., describes a connector latching mechanism with a limited degree of self-rejection, and cantilever latch
5 features that reside on the receptacle side of the design, and the trip mechanism for the internal sliding component is accomplished with a pivoting action of a rigid part.

U.S. Pat. No. 5,647,757(A) entitled "Electrical Connector With Terminal Position Assurance" by Chrysostomou, describes a connector with a headshell with a CPA member that operates an additional component called a support member by means of a camming
10 motion. Thus, the second movement is distinct from the first mating motion. The connector therefore does not provide a more convenient single motion mechanism with automated triggering of the CPA, or self-rejection.

U.S. Pat. No. 5,746,618 entitled "Squib Connector for Automotive Air Bag Assembly" by Gauker, shows a device lacking a secondary locking action as well as lacking
15 an automatic snap-on means therefor and self-rejecting action.

U.S. Pat. No. 5,848,912(A) entitled "Half-fitting Prevention Connector" by Okabe, describes a connector that includes a self-reject function, but incorporates its latching function into the sliding component. Latching is thus not a first and primary interaction between a housing and its complementary receptacle, with the slider following later so as to
20 disable unlatching of these primary latching means.

U.S. Pat. No. 5,947,763 entitled "Bi-directionally Staged CPA" by Alaksin, describes a connector that requires a pivot motion for disengagement, and has a manually actuated secondary lock to prevent the pivotal motion. The connector does not offer automatic snap-in of the secondary lock and does not offer self-rejection.

U.S. Pat. No. 6,019,629(A) entitled "Connector" by Ito et al., describes a connector
25 having a cantilever latch on a first headshell with a stub which, during mating, retards a spring-loaded slider component held in a complementary second headshell. A ramp of the slider has a predetermined angle such that a threshold of applied mating force, rather than a predetermined partial or complete mate position, trips the slider to move into a locking
30 position. The slider does not have blocking features, but rather has a window to capture the stub on the aforementioned cantilever. This device will self-reject by means of the spring-loaded slider pushing itself off from the mating face of the complementary second headshell. However, no means of disconnection are disclosed, although pulling the pieces apart until something breaks is an obvious method usually directed to applications outside the scope of

the invention such as where only a connection is authorized, and the breakage during disconnect is used to evince unauthorized tampering.

U.S. Pat. No. 6,024,595(A) entitled "Connector" by Saba et al., describes a connector that includes a slidable detecting member which is not spring-loaded, but rather is operated
5 by a second motion after an initial mating motion. This device does not offer self-rejection from an incomplete mating attempt.

U.S. Pat. No. 6,325,663(B1) entitled "Half-fitting Prevention Connector" by Fukuda, describes a device with a self-rejection effect by means of a slider which includes a resilient portion integral to it. There is no discrete compression element such as a helical spring, nor a
10 secondary locking or blocking function preventing unwanted disconnection in service.

U.S. Pat. No. 6,435,895(B1) entitled "Connector Position Assurance Device" by Fink et al., describes a complex slider component with its own latches, and assumes a complementary pair of connector headshells for mating immediately proximal yet extraneous to the connector housing. Upon a proper intermate of a pair of these generic connector
15 housings, the component is moved further along the mating direction in a second movement so that its latches lock the headshells together while coming to rest, while ribs on a headshell block an unlatching motion. There is no automatic spring-driven interlock or self-rejection action.

U.S. Pat. No. 6,468,104(B2) entitled "Connector" by Yoshihiro, describes a headshell
20 of a first connector having a spring-loaded rotatable dowel with a radial stub which rotates the dowel while riding over the ramp face of a wedge located on a second mating connector. The mated pair is locked when the stored spring force rotates the stub behind the rear vertical face of the wedge. This device has no cantilever beam latches and no automatic locking or blocking beams able to prevent disconnect, and no effective mechanism for self-rejecting
25 from an incomplete mating attempt.

U.S. Pat. No. 6,857,892(B2) entitled "Electrical Connector with Connector Position Assurance Member" by McLauchlan et al., describes two complementary connectors for intermating and includes a manually-driven CPA member requiring a second engaging motion separate from a mating motion of the connectors. The CPA component interferes with
30 unlatching motion of a locked latch but this blocking feature of the CPA is a singular portion centrally located on the CPA.

U.S. Pat. No. 7,326,074(B1) entitled "Connector Position Assurance Device and a Connector Assembly Incorporating the Connector Position Assurance Device" by Lim et al., describes a connector that includes a cable headshell latchable to a complementary in-line

cable connector housing by means of a larger primary latch. The headshell includes a movable component with its own pair of smaller secondary latches. The movable member is slid into latching engagement of its secondary latches to the connector housing and blocks the primary latch from unlatching. The secondary component requires a second movement by the user rather than an automatic stage and release action of an internal slider. Furthermore, the connector does not provide a mechanism for either visual indication of, or self-rejection from an incomplete mating.

U.S. Pat. No. 8,616,914 entitled "Checkable Plug-in Connection and Method for Checking the Connection State of a Plug-in Connection" by Mumper, describes a connector that includes a movable "verification element" on the headshell which becomes visibly displaced after a complete and locked mating attempt and this element functions as a tool to enable disconnection. The verification element can be removed by the installer to prevent unauthorized tampering with a confirmed correct mating condition, because the latching means can only be disabled by re-insertion of the verification element. There is no disclosure of providing for an automatic self-rejection from an incomplete mating.

U.S. Pat. Appln. Publ. No. 2002/0115338(A1) entitled "Connector and Method of Assembling a Connector" by Nakamura, describes a connector that offers self-rejection but does not include an automatically engaging secondary lock, or any blocking means in the secondary lock that are able to prevent disengagement of the primary lock.

U.S. Pat. Appln. Publ. No. 2009/0035980(A1) entitled "Connector and Connector Assembly" by Nakamura, describes a connector housing pierced with an inspection window and another component of a distinct color which indicates a complete mating attempt by moving into a visually verifiable zone in the window.

U.S. Pat. Appln. Publ. No. 2010/0233897(A1) entitled "Electrical Connector Assembly Having Connector Position Assurance Device" by Seo et al., describes a device having a manually actuated secondary lock, but does not offer automatic snap-in of the secondary lock or self-rejection.

U.S. Pat. Appln. Publ. No. 2011/0021060 entitled "Connector" by Urano et al., describes a connector with a manually actuated secondary lock. The connector does not offer automatic snap-in of the secondary lock or self-rejection.

U.S. Pat. Appln. Publ. No. 2004/0038569(A1) entitled "Connector and a Connector Assembly" by Yamaoka et al., describes a connector that provides for something similar to a spring-loaded self-rejection but, rather than including a tripping mechanism to release stored compressed force accumulated during the approach of the connectors being mated, the

rejection force remains accumulated while a secondary redundant lock is established by an additional manual movement of a yet additional sliding component.

U.S. Pat. Appln. Publ. No. 2004/0192098 entitled “Electrical Connector With Spring/Back Self Rejection Feature” by Pavlovic et al., describes a connector that offers self-rejection from an incomplete mate, but does so by contacting the “abutment” surface of a receptacle directly with its resilient member. As the headshell continues in the mating direction, a rejection force is accumulated in the resilient member until, by means of a detent feature in this member, the rejection force is suddenly substantially reduced or redirected upon itself rather than against the receptacle. The connector does not provide a secondary locking of previously engaged latches.

U.S. Pat. Appln. Publ. No. 2006/0086900(A1) entitled “Connector” by Nakamura, describes a connector that includes components similar to the connectors of Lim et al. and Hopf et al. The connector assembly includes a cable headshell including a movable detecting member initially standing proud of the contour of the headshell, which detects an incomplete mating attempt by remaining blocked from allowing itself to be pushed down flush with the headshell contour until a complete mating attempt is made between the headshell and a complementary receiving receptacle. Similar to the Hopf et al. connector, an additional component slidably coupled to the headshell can slide over and cover the detecting member in a second motion perpendicular to and less convenient than the initial mating direction. Also like the Hopf et al. connector, the secondary component requires a second movement by the user, rather than an automatic stage and release action of an internal slider. Furthermore, the connector of Nakamura does not provide a mechanism for either visual indication of, or self-rejection from an incomplete mating attempt.

U.S. Pat. Appln. Publ. No. 2007/0254518(A1) entitled “Electrical Connector Having a CPA Plug” by Nealle, describes a connector that has a sliding CPA member substantially enclosed within a two-part connector housing, but lacks a spring or other compressive member to store and release compressive force to effect the automatic, snap-on locking action. Furthermore, the Nealle connector appears to employ flexural bending of both locking and blocking features. No helical spring, resilient member, or other driving mechanism is disclosed.

U.S. Pat. Appln. Publ. No. 2007/0264863(A1) entitled “Connector and a Connector Assembly” by Nakamura, describes a connector that includes latches on a slider and fins on latch cantilever beams, but does not include a spring-loaded slider and offers no self-rejection action.

U.S. Pat. Appln. Publ. No. 2014/0004732(A1) entitled “Connector Position Assurance Device for a Connector Assembly” by Heil et al., describes a connector that has a manually driven secondary lock operable by a second motion after a mating motion of two connector housings. This secondary lock is neither spring-loaded nor tripped at a predetermined point at which a confirmed complete mating attempt has been established.

DISCLOSURE OF THE INVENTION

An inventive connector assembly includes means for mechanically storing applied insertion force so that in the event of an incomplete mating attempt in which the locking means between the connector and the receptacle do not positively and completely deploy, then the stored force is utilized so as to self-reject, that is, to autochthonously displace and separate the headshell from the receptacle so that failure to completely mate the connectors results in electrical disconnection detectable as a discontinuity during a continuity check, and also the autochthonous displacement is sufficiently egregious that it is visually apparent that proper installation has failed to occur. That is, a housing of the connector includes components that result in two visually distinct positions, namely, a displaced position in which the connector lacks any connection to the receptacle and a mated position in which the connector is unquestionably electrically connected to the receptacle. There is no intermediate position for the connector, i.e., either it has a disconnected position apart from the receptacle or a connected position in electrical engagement with the receptacle, both of which can easily be observed by the person attempting to connect the connector to the receptacle.

An inventive connector assembly accomplishes CPA by using an internal component referred to as a slider which is driven by a compressive member, such as a helical spring, so the slider will release at a predetermined fully mated engagement. So released, the slider is then driven automatically to insert a blocking beam directly behind a previously engaged latching beam, so that the operative space needed for unlatch is blocked. The latch is now trapped in its locked state and the cable-side connector cannot disengage from its complementary plug-side receptacle. The connector assembly is advantageous, in one respect, over prior art connectors in view of this secondary locking element reinforcing these cantilever features against becoming unlatched, and specifically, advantageous over prior art latching connectors lacking cantilevered means of locking into complementary features.

Also, by virtue of the automatic cock and release mating action, an inventive connector differs from prior art devices which include a secondary locking component driven by a second manual motion of the user, devices where the secondary lock component is

substantially external to a connector headshell, and devices using an extraneous component such as a safety clip, “keeper,” trapped hardware, or any supplemental motion to engage a component.

Since the connector is designed to allow a number of mates and unmates (mating
5 releases) during a certain service life, it also differs from latching connectors that are designed to resist or evince unauthorized disconnection by not allowing an unlatch unless some component is forcibly broken (i.e., it is a multiple use connector as opposed to a single use connector). Tangentially, many medical connectors for devices designed for insertion into
10 a human patient are designed to break something when disconnected so as to prevent a previously used device from being reconnected and used again in another human body. A more proximate reason to deny disconnection comes in the trafficking of used auto parts. While used vehicles and larger subassemblies, such as a steering column assembly including a factory-charged airbag, may be traded with little regulatory oversight, a person dissecting the gas-generating device may knowingly or unknowingly encounter the full brunt of 27 CFR
15 55 governing the possession, storage, and transportation of explosives, including the regulation and licensing of such persons. These special self-destructive, tamper-evident, and single-use disposable connector schemes are thus also different from the invention.

An inventive connector also differs from devices that cock a spring during electrical engagement, remain engaged during a service interval, and thereafter release stored spring
20 force to electrically disconnect, such as in overload circuit breakers or timed delay devices. The structure of the inventive connector also differs from mechanisms having opposing springs or multiple springs for motions in a staged sequence rather than acting uniformly and in concert, and differs from over-center, slider-crank, classical 3- and 4-bar linkages, cams and cam-followers, levers and fulcra, all threaded couplings, and also any detenting
25 mechanisms. The structure of the inventive connector also differs from mechanisms including a housing and also a contact or terminal carrier which moves electrical contacts at a rate or in a motion different from the motion of the housing. The inventive connector also differs from connectors making or breaking an electrical short between conductors as a means of electrically signaling a complete mate. Although somewhat similar to connectors including a
30 sliding member that deploys blocking members to prevent a primary latch from disengaging, but which include an integral compressive component rather than being driven by a discrete component, the inventive connector is still different in other respects than such connectors as can be gleaned from the description of the connector.

An inventive connector also advantageously satisfies a requirement of an auto industry specification currently in force by providing both a tactile signal and an audible click when a correct and reliable interconnection has been achieved.

Another important advantage of an embodiment of an inventive connector is that all
5 mechanical actions happen during a single, linear mating action accomplished by press inserting an aligned and registered connector headshell assembly into a complementary receiving receptacle until it is snappingly received into a locked mated state which becomes blocked from becoming unlocked by means of an entirely automatic operation. This single
10 action in a single direction therefore differs from prior art connectors that require two separate actions, in different, sometimes perpendicular directions, in order to provide for a complete mating of a connector to a receptacle.

The connector assembly is primarily designed for an airbag supplemental restraint system, but its use is in no way limited to such a system, and numerous other and diverse uses are contemplated as being within the scope of the invention.

15 Another connector assembly is primarily designed for an airbag supplemental restraint system, but its use is in no way limited to such a system, and numerous other and diverse uses are contemplated as being within the scope of the invention. These uses may be in the automotive field or outside of the automotive field.

For this connector assembly, a cable headshell has at least one or a cluster of two or
20 more electrical terminals of a specified geometry and a complementary receptacle has at least one or a cluster of pins or contacts of a complementary mating position and geometry, and the headshell also has cantilever latches with latching features. The headshell and receptacle have complementary sets of defined physical features whose elements include: a perimeter of a defined size and contoured shape, keyways, stubs, pegs, and recesses. The intermating of
25 these complementary sets of features can enforce a preferred alignment of an installed headshell, and also allow a receptacle to have geometric, standardized coding features which accept only a headshell having the set of complementary coding features, while any other headshell having alternate coding features is rejected and prevented from penetrating into the receptacle.

30 Full-depth, complete insertion of an acceptable headshell results in its latches being received into undercuts of the receptacle and furthermore becoming blocked in their locked state. A robust intermated condition is obtained so that durable electrical conductivity is maintained over the service life of the electrical and electronic equipment.

These inventive connector assemblies offer a new and useful function of self-rejection, which is to visibly and electrically disconnect the headshell from its receptacle unless an insertion of the one into the other is of sufficient completeness. Once a complete electrical engagement has been established, mechanical operations are triggered inside the headshell to establish a primary and a secondary or redundantly locked state so as to prevent accidental or unintended disconnect even during shock, vibration, corrosion, or long-term service life expected of high-reliability automotive components. Furthermore, an electrical continuity check will be successful only when the headshell and receptacle have achieved this high-reliability redundantly locked state.

Therefore, either a successful electrical continuity check or a visual observation of a fully mated state also confirms with high confidence that the electrically connected device will not fail to operate when an appropriate activation signal is delivered to it from the vehicle's safety system controller, and that this readiness to operate will endure at least for the entirety of the reasonable expected service life of the vehicle.

One variant takes advantage of a particular style of receptacle prevalent within the industry, which is a two-terminal application and which until recently included a formed metal shorting clip to maintain an electrical short between the two contacts or pins until a completed physical and electrical mate is established with a complementary headshell.

The development of shorting clips traces its history from commercial use of explosives in demolitions, mining, and quarrying sites where spurious energy from electrostatic effects or radio transmissions became known to induce unwanted electrical currents, resulting the explosive charges detonating at unwanted and unpredictable moments. Shorting clips rendered electrical initiators such as squibs, matches, and blasting caps electrically isolated and inoperative during handling and setting of the charges and when initially connection electrical initiators such as blasting caps or an electric match.

When vehicles began to include airbags, shorting clips were imported into automotive assembly industry from a sense of wariness and trepidation in view of a past record of horrific accidents in outdoor use of squibs. Recent improvements in handling, assembly, and quality control, and especially the awareness and elimination of static electricity and spurious electromagnetic noise (EMI) in a modern factory environment have emboldened the automotive industry and an increasing number of OEMs to dispense with shorting clips with confidence, thereby reducing component and vehicle cost and weight.

For the receptacle used with embodiments of this invention, the shorting clip was formerly located in a recess within the receptacle beneath the exposed, exterior-facing

bulkhead surface of the receptacle. This bulkhead surface is pierced by an access hole, or aperture leading to the shorting clip. The headshell designed to intermate with this receptacle would normally include a peg, stud, pin, or similar protuberance which would penetrate and be received into the aperture during mating and had a length and tip configuration so that in the fully mated state, the penetrating member would impinge on and displace the shorting clip and break its electrical continuity with the contacts or pins, thereby allowing electrical signals or power to be delivered from the cable harness and into the connected equipment. Since the clip was physically wider than the access hole, the distal space beyond the access hole is also larger than the access hole, and can thereby function as a latch receiving undercut of this invention in a similar manner as the latch-receiving undercuts.

In summary, connector assemblies apply a staged sequence of mechanical operations effective at establishing a high-reliability interconnection to the specific application of a current-era receptacle configuration, so that the improved mechanism can be applied to legacy systems currently in demand.

15

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be more fully understood from the following detailed description of embodiments thereof, taken together with the drawings, in which:

FIG. 1 shows an example of a receptacle to which the connector assembly in accordance with the invention can be mated;

FIG. 2 shows an example of an initial approach of the connector assembly in accordance with the invention when being mated to the receptacle shown in FIG. 1;

FIG. 3 shows a connector housing at a first intermediate mating condition;

FIG. 4 is an enlarged view of the area enclosed by arrows 4-4 in FIG. 3;

FIG. 5 shows connector locking components and the receptacle in a second intermediate mating condition;

FIG. 6 shows connector locking components and receptacle in a final mated and locked condition;

FIG. 7 shows a right-angle embodiment of a connector in accordance with the invention depicting right-angle orientation of the mating direction as defined by the terminals, and also depicting a unitary headshell constructed from a housing and a cover;

FIG. 8 is an exploded view of the embodiment of the connector shown in FIG. 7 including all of the components;

FIG. 9 shows an embodiment of an axial headshell housing assembly in accordance with the invention;

FIG. 10 is a perspective view of a connector configured to mate with a coaxial cable in accordance with the invention;

5 FIG. 11 is a perspective view showing the connection of a coaxial cable to an electrical terminal used in the connector shown in FIG. 10;

FIG. 12 is a perspective view of a connector configured to mate with a single signal-carrying wire in accordance with the invention;

FIG. 13 is an exploded perspective view of the connector shown in FIG. 12;

10 FIG. 14 is an exploded plan view of the connector shown in FIG. 12;

FIG. 15 shows a connector similar to that shown in FIG. 2, and approaching the receptacle shown in FIG. 1;

FIG. 16 shows a connector assembly of the current invention partly cut away along a cutting plane to expose internal features;

15 FIG. 17 is an exploded view of the connector assembly shown in FIG. 16;

FIG. 18A is a cross-sectional view showing the relative position of the blocking beam and latch during insertion of the connector assembly into a receptacle;

FIG. 18B is a cross-sectional view taken along the line 18B-18B in FIG. 18A;

20 FIG. 19A is a cross-sectional view showing the relative position of the blocking beam and latch during mating of the connector assembly into the receptacle;

FIG. 19B is a cross-sectional view taken along the line 19B-19B in FIG. 19A;

FIGS. 20A, 20B, 20C, and 20D show tripping features for use in a connector assembly in accordance with various configurations of the current invention;

25 FIG. 21 shows a receptacle having an aperture leading to a cavity having other undercut surfaces available for latching;

FIGS. 22 and 23 show a housing of a connector assembly wherein the latch blocking functionality is separated from the tripping functionality; and

FIG. 24 shows a connector assembly similar to that shown in FIG. 16 but where a single tripping feature interoperates with two trippable structures.

30

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to the accompanying drawings wherein the same reference numbers refer to the same or similar elements, FIG. 1 shows a broken-view partial cross section of a typical, generally circular receptacle as an example of a receptacle to which the inventive connector

assembly is designed to mate in a highly dependable and reliable manner. Certain features of the receptacle are controlled by industry standards and are outside the scope of this invention. Generally, the receptacle offers a substantially annular cavity 1, an outward facing bulkhead surface 2 of a cylindrical form inside the cavity 1 and that is generally perpendicular to the direction of line of action of the mating motion of the connector assembly to the receptacle, and a plurality of terminal-containing apertures 3 within which reside a set of electrical conductive terminals or terminal pins 5.

The apertures 3 in the cylindrical form are defined by a substantially cylindrical surface distant from the edge of the cylindrical form that defines the inner surface of the cavity 1, and the terminals 5 may also be substantially cylindrical as shown in FIG. 1, to thereby define an annular space between each of the apertures 3 and the respective one of the terminals 5 therein. The terminals 5 are electrically connected to an electronic component to be electrically connected to the connector assembly, in a manner known to those skilled in the art to which this invention pertains.

In one embodiment, the number of terminals 5 and the number of contacts and signal lines to be electrically intermated by means of the inventive connector assembly is two.

The annular cavity 1 includes a latch-receiving undercut 4 which may exist as an internal groove following the perimeter of the cavity 1, as in one embodiment, or may be interrupted so as to offer a set of intermittent latch-receiving apertures or pockets extending transverse to the line of action of the mating motion. In either case, a plurality of undercut sites are formed, the purpose of which is described below. The undercut 4 is formed in the surface defining the outer cylindrical surface of the annular cavity 1.

The bulkhead surface 2 may be integral to a receptacle body but is more commonly a permanently installed special insert with physical coding and keying structure designed to accept or reject complementary physical structure integral to the inventive connector assembly, but the specificities of these coding and polarity-enforcing structures are outside the scope of this invention and these keying structures are not illustrated here. Additionally, applications may offer groups of receptacles in close proximity which must be correctly connected to by a plurality of designated headshells, and to eliminate confusion and aid correct assembly, the key-coding of headshells and receptacles which reject mis-wiring is augmented by color-coded molding of plastic parts so that a user having selected one of among several diversely colored headshells can rapidly locate the proper receptacle having an insert of the same color-code, and proceed with correct installation.

Annular cavity 1 may also be considered a deep channel having a contour, substantially annular in shape. The channel is often be a continuous closed contour but may be an interrupted contour. The contour circumscribes the substantially flat bulkhead surface 2 generally perpendicular to the mating direction of a connector into the receptacle. One or more of the apertures 3, also referred to as pockets herein, having the electrically conductive terminals or terminals pins 5, also referred to as contacts or pins, disposed therein, are clustered to form an array. The contoured channel furthermore includes an undercut site of the undercut 4 which may also be continuous along the perimeter or may be intermittent thereby providing several undercut sites. Undercut 4 offers a purchase for latch features of the headshell as described below, and may also be formed by transverse holes or any other feature capable of receiving a latch and of withstanding withdrawal forces. In this invention, surfaces of the receptacle have become available for use, by employing most of the kinematics of the inventions disclosed above, as will also be explained below with reference to, for example, FIG. 21.

FIG. 2 shows a similar broken-view partial cross section of the receptacle of FIG. 1 in proximity to a connector assembly in accordance with the invention which is designated generally as 10. Connector assembly 10 is also referred to as a headshell assembly and includes a plurality of tubular protuberances 6 extending from a lower surface of the headshell assembly (in the configuration shown in FIG. 2) and that thus have a hollow interior. The protuberances 6 are generally parallel to one another, and their parallel axes define a mating direction.

The headshell assembly 10 also includes a plurality of cantilevered locking beams 11 which latchingly engage into the latch-receiving undercut 4 in the receptacle (see FIG. 1). Locking beams 11 are also considered and/or referred to as latching members herein. Female electrical terminals (not shown in FIG. 2) are disposed within the protuberances 6 in the vicinity indicated by reference number 9 so as to electrically contact to the receptacle pins 5 when the headshell assembly 10 is mated with the receptacle.

The design of the female electrical terminals is outside the scope of this invention and they are thus omitted in FIG. 2. However, an example of a female electrical terminal is female contact 12 shown in FIG. 3, described below. Also omitted are electric wires leading into the headshell assembly 10 which are connected to the female electrical terminals. Female electrical terminals may have, however, a variety of different configurations known to those skilled in the art.

Although the illustrated embodiment includes two protuberances 6 each including a female electrical terminal 12, it is possible to construct the headshell assembly 10 with only a single protuberance 6 and a single female electrical terminal 12 (described below with reference to FIGS. 12-14), or more than two protuberances and a corresponding number of female electrical terminals 12.

Headshell assembly 10 also includes a slider 7, which in one embodiment, offers two ears 7A disposed in biradial symmetry and closely fitted to the perimeter of the main body of headshell assembly 10. The slider 7 is slidingly coupled within the headshell assembly 10 by means of a compressive member 8 lightly pre-loaded in compression. In one embodiment, the compressive member 8 is a helical spring, although other comparable structures that enable a force to be exerted on the slider 7 to force it away from the body of the headshell assembly 10 are also within the scope of the invention. Hereinafter, the compressive member 8 may be referred to as a spring.

At rest, the compressive member 8 is disposed between the slider 7 and an upper support wall of the headshell assembly 10 and forces the slider 7 to a fully extended position in the mating direction. At one end, the spring 8 may rest on a spring support portion 7C of the slider 7 that typically defines a projection around which the spring 8 is retained (as shown in FIGS. 2 and 3). The spring support portion 7C is situated in a bridging portion 7D of the slider 7 that bridges the ears 7A (best seen in FIG. 8). Bridging portion 7D presents a solid floor that is preferably reinforced at an area where the spring support portion 7C is formed to enable it to withstand numerous spring-driven impacts. In use, a noise is created by this impact, and would readily be associated by the user with the slider 7 achieving its final position. In this manner, an industry specification called "USCAR-2" that requires both a tactile signal, such as a detent, and an audible noise, such as a click, would be satisfied when the slider 7 reaches its final stage at which electrical connection provided by the headshell assembly 10 is achieved.

At an opposite end, the spring 8 rests on a projection 15 formed on the inner surface of the headshell assembly 10, specifically a cover 20 thereof. This obviously prevents the spring 8 from being ejected from the headshell assembly 10 during use. Other spring retaining structure may also be used in accordance with the invention.

The slider 7 also includes a plurality of blocking beams 7B which extend in the mating direction and which interfere with cantilevered locking beams 11 of the headshell assembly 10 so that with the slider 7 in its extended position, the flexural compliance of the locking beams 11 is denied. That is, the locking beams 11 cannot engage with the latch-

receiving undercut 4 locking sites of the receptacle unless the slider 7 has been moved from the extended position.

More specifically, the structure of the slider 7 includes the ears 7A that each includes a portion extending radially outward and also a portion extending parallel to the mating axis
5 of the connector headshell assembly 10. The radial outwardly extending portion of each ear 7A passes through an interior wall of the body of the headshell assembly 10 such that a portion of the slider 7 is inside the body and a portion of the slider 7 is outside of the body and manually accessible, i.e., the portion of each ear 7A extending parallel to the mating axis of the connector headshell assembly 10 (see FIGS. 2 and 3). The slider 7 is thus movable by
10 grasping the outside portion of the ears 7A.

The slider 7 also includes the blocking beams 7B that extend in the mating direction above and below the area at which the radially extending portion of the ears 7A project (see FIGS. 3 and 4). A styloid 14, described more fully below, is formed at the lower edge of each blocking beam 7B.

FIG. 3 enables a more detailed explanation of the operation of the slider 7 by
15 depicting the headshell assembly 10 in a first intermediate position which is a partial, incomplete engagement with the receptacle. FIG. 3 also shows the receptacle pin 5 in cross-section. A relevant portion of a female contact 12 retained within the main body of headshell assembly 10, as an example of a female electrical terminal described above, offers at least
20 one contact point near the tip of an electrically conductive contact beam or contact blade.

Before proceeding further, it must be appreciated that although the following detailed description of the sequence of operations concentrates on one set of interrelated members at one latching site, a connector assembly in accordance with the invention incorporates a plurality of mating operations at a plurality of sites simultaneously. For example, in one
25 embodiment, latching and locking described below is effected at two substantially diametrically opposed sites within a circular receptacle.

In a first intermediate position, although the contact 12 has not yet touched the receptacle pin 5, the styloid 14 inherent in the blocking beam 7B of the slider 7 is now in contact with the bulkhead surface 2 by its end face, which end face is also perpendicular to
30 the mating direction (see FIGS. 3 and 4). In this intermediate position, the spring 8 has become more compressed since the headshell assembly 10 has been urged toward the receptacle from the position shown in FIG. 2 to the position shown in FIG. 3. Therefore, if the mating force applied to the body of the headshell assembly 10 were removed, the compression in the spring 8 would pass through the slider 7 and present against the bulkhead

surface 2 of the receptacle, opposing the initial mating motion. Left alone, the connector assembly 10 would fall away from the receptacle or at least remain in a position obviously distant from a successful, fully mated installation.

FIG. 5 shows detailed interactions of critical features of the slider 7 and the headshell assembly 10 at a second intermediate position closer to the final and complete engagement of the inventive connector system, in the same cross sectional view as FIG. 4. In this detailed view of the receptacle, a fin 16 in the body of the headshell assembly 10 abuts a backside ramp of the styloid 14 of the blocking beam 7B of the slider 7. Fin 16 is formed on an outer peripheral surface of the protuberance 6. One or more fins 16 may be formed on each of the protuberances 6. Also, the lower surface of the styloid 14, when viewed as shown in FIGS. 4 and 5, includes a step that receives the edge of the bulkhead surface 2.

The styloid 14 may include an inclined upper surface that is designed to contact the fin 16 during intermediate movement of the connector assembly 10 into the receptacle, i.e., the backside ramp (see FIG. 5), and then in view of further movement of the connector assembly 10 into the receptacle, the fin 16 slides along the inclined surface and urges the styloid 14 and blocking beam 7B in its entirety outward to pass over the bulkhead 2 (into the position shown in FIG. 6). During this latter stage, the locking beams 11 pass into the respective undercut site of the undercut 4 on the receptacle (to the position shown in FIG. 6).

Furthermore, the cantilevered locking beam 11 of the body of the headshell assembly 10 is deflected as it approaches, but is not yet latchingly engaged, that is, locked, into the latch-receiving undercut 4 of the receptacle. It is possible, but not necessary, that electrical continuity will have developed between the receptacle pins 5 and the connector terminals 12. In this position, the spring 8 is even more compressed and retains sufficient force that if mating force is removed at this second intermediate position as well, the spring force will present through the styloid 14 of the blocking beam 7B as it abuts the bulkhead surface 2 of the receptacle, and disengage the connector assembly 10 from the receptacle (as described in the first intermediate position of FIGS. 3 and 4. Additionally, any electrical continuity present at this second intermediate position will be terminated by physical disconnection.

Continued insertion of the connector assembly 10 into the receptacle will cause the fin 16 to force the styloid 14 into a displaced state wherein it will evade and fall clear of the rim of the bulkhead surface 2 (see FIG. 6). A fully mated and locked condition is thereby established wherein the slider 7 has lunged further down the receptacle cavity under the force of the spring 8 between the slider 7 and the headshell assembly 10 having been allowed to extend, thereby dissipating its disengagement force. Furthermore, the cantilever locking beam

11 of the body of the headshell assembly 10 is fully engaged within the latch-receiving undercut 4 of the receptacle, and the extended position of the slider 7, having been driven by the spring 8, moves the blocking beam into an interfering position which advantageously prevents the cantilever locking beam 11 from extricating itself from the latch-receiving undercut 4 of the receptacle.

Therefore, in the absence of extreme forces beyond the range of reasonable robustness expected for this connector system, the fully mated and locked condition of the connector will endure. However, in the event that disconnection is desired, a process reversing these elements is followed: by gripping only the ears 7A of the slider 7 and pulling the entire connector assembly away from the receptacle, the spring 8 between the slider 7 and the body of the connector assembly headshell 10 is compressed. The ears 7A of the slider 7 are manually accessible as they are outside of the body (see FIGS. 2 and 3). Then styloid 14 is pulled clear from the cantilever locking beam 11, which can then escape from and disengage from the latch-receiving undercut 4 of the receptacle. Upon such disengagement, the headshell assembly 10 simply pulls free of the receptacle.

FIG. 7 illustrates a right-angle connector design within the scope of the invention. The slider, compressive member, and pin-receiving terminals are omitted for clarity and so as to concentrate on an enclosure housing constructed from a plurality of pieces. Signal carrying cables or wires 30 are illustrated in conjunction with phantom line indication of the orientation of the pin-receiving terminals of a right-angle connector headshell. The headshell is an integral assembly of a housing 19 and a cover 20, wherein the housing 19 includes a plurality of stubs 22 for latching engagement within lumina 21 of the cover 20 by means of mechanical compliance of the cover 20 during a snap-together assembly. Therefore, a substantially rigid and unitary headshell containing the terminals and admitting the signal carrying wires 30 which lead to the terminals is constructed from the housing 19 and cover 20.

Other mechanisms for connecting the housing 19 to the cover 20 are also within the scope of the invention, and such mechanisms will be referred to as connecting means herein. Connecting means thus encompass stubs and lumina, other two-part connecting mechanisms with one part on the housing and the other part on the cover, and any other connectors used to connect a pair of components of a connector together that are known to those skilled in the art to which the invention pertains.

In addition, it is not necessary to provide a plurality of stubs 22 and complementary lumina 21, but rather only a single stub and lumen may be provided.

FIG. 7 also shows that the locking beam 11 includes two spaced apart cantilever sections 38, 40 bridged at their tips by a unitary latching feature 42. The same structure is present on the opposite side of the housing 19. One of the blocking beams 7B is arranged to operate in between each pair of cantilever sections 38, 40 of the locking beam 11.

FIG. 8 is an exploded view of the right-angle connector design shown in FIG. 7 including all of the components. Each female contact 12, of which there are two in this embodiment, is shown as part of a connector terminal 50 that mates with a respective one of the signal carrying wires 30.

FIG. 9 shows an axial or straight connector in which the headshell assembly is constructed from a housing 18 and a plurality of cover components which in this embodiment are a first cover 32 and a second cover 34. The first cover 32 includes a plurality of latches 26 which snappingly engage onto a complementary set of stubs 36 on the housing 18. The second cover 34 includes alignment grooves 24 which register with alignment strakes 25 on the first cover 32. The stubs 22 on the second cover 34 snappingly engage with the internal surfaces of first cover 32 by means of mechanical compliance of the first cover 32 while the second cover 34 is being slidingly assembled onto it.

Other mechanisms for connecting the housing 18 to the cover 32 and the cover 32 to the cover 34 are also within the scope of the invention, and such mechanisms will be referred to as connecting means herein. Connecting means thus encompass stubs and latches, grooves and strakes, other two-part connecting mechanisms with one part on the housing (or first cover) and the other part on the first cover (or second cover), and any other connectors used to connect a pair of components of a connector together that are known to those skilled in the art to which the invention pertains.

In addition, it is not necessary to provide a plurality of latches 26 and complementary stubs 36, but rather only a single latch 26 and stub 36 may be provided. Also, it is not necessary to provide a plurality of grooves 24 and alignment strakes 25, but rather only a single groove 24 and alignment strake 25 may be provided.

FIG. 9 also shows a feature to that shown in FIG. 7, i.e., the locking beam 11 includes two spaced apart cantilever sections 44, 46 bridged at their tips by a unitary latching feature 48. The same structure is present on the opposite side of the housing 18. One of the blocking beams 7B is arranged to operate in between each pair of cantilever sections 44, 46 of the locking beam 11.

Although the preceding description contains many specificities, these should not be construed as limiting the scope of the invention, but as merely illustrative of some preferred

embodiments. For one example, although the headshell illustrated as one preferred embodiment orients the pin-receiving axes of the terminals in a direction substantially perpendicular to the axis defined by the signal wires leaving the connector headshell, such configuration commonly known as a “right-angle” headshell, an additional configuration
5 orients the pin-receiving contacts on an axis substantially parallel to the signal wires leaving the connector headshell, such configuration commonly being known as a “straight type” or “axial” connector.

In another example, the number of signal lines depicted in the connector and receptacle is two, but other embodiments of any number of signals in any array configuration
10 remain within the scope of this invention.

As another example, the invention is described above as mating with a receptacle having a standardized annular undercut, i.e., a singular undercut which is the current industry standard. The headshell assembly 10 does not have to mate with such a receptacle and is equally useful for a receptacle with a non-annular undercut. For example, there may be
15 intermittent grooves or a set of transverse holes piercing the sidewalls of the receptacle cavity. The latter would be particular useful if a specific orientation of the headshell assembly 10 to the receptacle is sought, and swiveling of the connector relative to the receptacle is not desired.

As yet another example, although the embodiments herein include two fins 16 and
20 two locking beams 11, it is conceivable that more than two fins and/or two locking beams might be provided.

Variations of the embodiments described above and illustrated in the drawings are considered to be within the scope of the invention. Among other variations, different features from one embodiment may be incorporated into any other disclosed embodiment to the extent
25 possible.

Among other variations, while the connector described above is designed to generally mate within the perimeter of a single, generally circular groove containing an annular undercut which affords a latch receiving surface, another embodiment of a connector in accordance with the invention is designed to engage in a single groove of a more arbitrary,
30 non-circular contour or a receptacle offering a plurality of grooves can be engaged by a connector designed in accordance with the invention to offer latches specific to any required number of attachment points on the receptacle side.

In a yet further variation, although the body of the connector headshell 10 is shown in FIG. 2 and elsewhere as an integral unit, and in FIGS. 7 and 8 as a two-component and three-

component assembly, respectively, an alternate embodiment may in fact comprise a clamshell or similar assembly of two, three, or even more than three parts designed to snap together to form a unitary headshell structure.

In yet another embodiment, although the illustrated components forming the headshell
5 such as the housing and the cover of FIG. 7 are heterogeneous and dissimilar pieces, a symmetrical design such as a left-half and right-half housing of a right angle connector, or two axially hermaphroditic shells snappingly assembled to form an integral housing of a straight connector all reside within the scope of this invention.

In still another embodiment, although the illustrated components forming the
10 headshell shown in FIG. 9 show the first cover having at least one alignment strake and the second cover having at least one alignment groove, a complementary arrangement of strakes and grooves such that the first cover has at least one alignment groove and the second cover has at least one alignment strake is also considered to be within the scope of this invention.

In still another embodiment, rather than having two ears 7A in biradial symmetry as
15 shown, slider 7 may include any number of actuation affordances including a single, continuous, generally arcuate form closely contoured to the periphery of the headshell body 10, or more than two ears in a symmetrical or non-symmetrical arrangement.

In yet another embodiment, although the compressive member for storing mechanical
20 energy is most often a helical spring 8, any resilient and sufficiently compressible material may be used instead of compressive spring 8 so as to store and release compressive force used to operate the latch locking function of a complete installation or used to reject the connector assembly 10 from the receptacle in the event of an incomplete installation attempt.

In another embodiment, the housing contains not only the slider 7, compressive
25 member 8, and terminals, but also other electrically effective components such as an RF choke, a filter, or one or more ferrite beads, so as to shunt, absorb or reject unwanted electrical noise or spurious electrical energies absorbed elsewhere within the cable harness but not intended or desired to be transmitted through the connector assembly in accordance with the invention nor admitted to the mission critical unit to which it may be attached. Most often, ferrite beads or electromagnetic chokes are used to prevent spurious electrical noise
30 from deleteriously triggering an airbag to deploy when such action is not deliberately signaled by the vehicle's passenger safety and control systems.

In yet another embodiment, although signal cabling as illustrated depicts a twisted
pair of two conductors 30 (see FIGS. 7 and 8, the connector assemblies in accordance with the invention may be configured to be fit for the interconnection of any number of signal

lines, and such signal lines may be configured in twisted braids, flat ribbon cable, or a set of loose wires or a set of wires grouped or gathered within a jacket, including a coaxial cable or a shielded coaxial cable. All of these configurations of sets of signal wires are also within the scope of the invention.

5 Any of the foregoing embodiments, whether illustrated or described, provide advantages for a connector assembly in accordance with the invention in comparison to prior art connectors of a similar type. Among others, one or more embodiments of the connector assembly in accordance with the invention substantially eliminates false confidence in an incomplete interconnection of a cable harness connector headshell to a receiving receptacle.
10 Further, in the case of incomplete mating, since one or more embodiments of the connector assembly in accordance with the invention includes a mechanism that effects a physical rejection of the connector headshell from the receptacle, this serves to uncouple the electrical contacts to terminate electrical interconnection so that a continuity check will fail.

Yet another advantage is that in the case of incomplete mating, since one or more
15 embodiments of the connector assembly in accordance with the invention includes a mechanism that effects a physical rejection of the connector headshell from the receptacle, this provides a visually obvious physical disconnect of the connector headshell from the receptacle or a visually obvious degree of displacement of the headshell from an expected mated position to the receptacle such that correct and complete mechanical and electrical
20 interconnection is not allowed as a reasonable assumption to a user making an interconnect attempt.

Still another advantage is that one or more embodiments of the connector assembly in accordance with the invention facilitate easier assembly of internal components such as the slider, compressive member, terminals and wires leading to the terminals, along with other
25 internal components, by providing a headshell assembly constructed from a plurality of parts such as a housing and a cover.

The connector assembly 10 described above has an optimum connection method to the receptacle to provide for a secure coupling with a self-reject feature. The method involves engaging the connector with the receptacle while ensuring complete and proper connection
30 by moving the housing into the receptacle (from the position shown in FIG. 4), against bias of the spring 8, to cause the blocking beams 7B to abut against the bulkhead surface 2 of the receptacle, then to cause the fins 16 to abut against the blocking beams 7B (the backside ramp thereof) and the locking beams 11 to pass outward of the blocking beams 7B into engagement with the receptacle (see FIG. 5), and then to cause the locking beams 11 to pass

into the locking sites of the undercut 4 of the receptacle and cause the fins 16 to urge the blocking beams 7B outward and enable the blocking beams 7B to be positioned inward of the locking beams 11 and prevent release of the locking beams 11 from the locking sites of the undercut 4 of the receptacle (see FIG. 6). Also, the spring 8 between the slider 7 and the housing is configured such that it causes separation of the connector assembly 10 from the receptacle during the movement of the housing until the locking beams 11 are situated in the undercut 4 of the receptacle.

The fins 16 are situated to engage with the backside ramp of the blocking beams 7B during an initial stage of relative movement between the headshell assembly 20 and the slider 7 against a bias of the spring 8 and allow inward deflection of the locking beams 11 (see FIG. 5). The blocking beams 7B are configured to prevent inward deflection of the locking beams 11 after a final stage of the relative movement between the connector assembly 10 and the slider 7 (see FIG. 6), with the advantageous result that the connector has an electrically interconnected state only when in the final stage. Until reaching the final stage, there is no electrical interconnection between the connector assembly 10 and the receptacle.

To aid in this process, the spring 8 may have a specific construction and provided with operational properties. To wit, the spring 8 configured to exert a reaction force while at the initial stage that is at least 5% greater than a reaction force exerted while residing in the final stage. However, in a preferred embodiment, the reaction force residing in the spring 8 in its final position is minimized to a practical limit, and so an embodiment achieving a compressive force at the initial stage substantially higher than the final stage is preferred. An embodiment in which the spring 8 exerts a reaction force in the initial stage that is up to about 500% greater than the reaction force in the final stage is also contemplated, and resides within the scope of our claims.

This effect, of causing the spring 8 to have a slightly or significantly higher reaction force during the initial stage relative to the final stage, enables the spring 8 to play its primary role in separating the headshell assembly 10 from the receptacle in the event of a missed connection or failed connection attempt. At the same time, the lower reaction force of the spring 8 during the final stage, i.e., after relaxation of the spring 8 that occurs once the headshell assembly 10 is properly mated to the receptacle, would not unduly increase stress on the headshell assembly 10. The reaction force of the spring 8 would be sufficient, however, to keep the blocking beams 7B in place after the mating of the headshell assembly 10 and receptacle.

In a manner like a detent, the reaction force accumulating within spring 8 while moving toward the initial stage, followed by the slightly or substantially reduced force during the excursion of the slider to its final stage are both sensed through a user's hand during installation and communicate a two-part tactile signal to the user which viscerally confirms
5 the successful initial operation of the invention. Additionally, the slider is halted at the end of its excursion to the final stage by an abrupt collision with the housing, and this collision emits both an audible signal and a yet further contribution to the total tactile signal (in this regard, see also the description above relating to the mounting of the spring 8 between spring support portion 7C on the slider 7 and the projection 15 on the headshell assembly 10). The combined
10 high-low-slam tactile signal coupled with the audible collision assures the user that correct and complete installation and the desired high-reliability electrical interconnections have been properly and robustly established.

Further examining this operation, the spring support portion 7C of the slider 7 on which one end of the spring 8 is supported, the seat for the opposite end of the spring 8 on an
15 internal surface of the headshell assembly 10, the construction of the slider 7 with the blocking beams 7B, and the general interaction between the slider 7 and the locking beam 11, may be generally considered to constitute spring control means. These spring control means cause a spring to increase its compression force during an initial mating stage of the headshell assembly 10 with a receptacle, reaching a maximum during the initial stage, and then cause a
20 reduction in the compression force after mating of the headshell assembly 10 with the receptacle. Other structure that affects the spring 8 in which manner, which would be apparent to one skilled in the art in view of the disclosure herein, is contemplated to be within the scope of the invention.

For release of the headshell assembly 10 from the receptacle to enable repeated use of
25 the headshell assembly 10, the slider 7 may be configured to enable manual movement of the blocking beams 7B out of their position preventing release of the locking beams 11 from the undercut 4 of the receptacle to thereby enable release of the locking beams 11 from the undercut 4 of the receptacle and removal of the headshell assembly 10 from the receptacle. Upward movement of the slider 7 effected by grasping ears 7A allows release of the locking
30 beams 11 from the undercut 4.

The engaging of the connector assembly 10 with the receptacle may advantageously require only a single act of relative motion of the connector assembly 10 with respect to the receptacle, with all directions of motion of the connector assembly 10 and slider 7 remaining substantially parallel to the mating direction throughout the entirety of the single act of

relative motion. This single act may be performed at a substantially uniform velocity or at a non-uniform velocity.

A connector in accordance with the invention may have one or more signal carrying wires attached to it. A most common embodiment employs twisted pair wiring (as shown in
5 FIGS. 7 and 9), but in this industry, and for the purpose of the disclosure herein, coaxial cable is also contemplated wherever twisted pair wiring is implemented, and vice versa, especially since twisted pairs are a technological predecessor of coaxial cabling.

For example, U.S. Pat. No. 6,510,152(A) entitled "Coaxial Cable/Twisted Pair Fed, Integrated Residence Gateway Controlled, Set-Top Box" to Georger and Rutkowski, includes
10 a slash-mark in the title itself which implies that the capability to handle one sort of cable inheres handling the other sort as an obvious variant.

Another example of this fungibility is seen with inventors Brandt and Ploehn who in U.S. Pat. No. 7,121,888(B2) entitled "Multiple Wire Cable Connector," use the phrase "coaxial cables or twisted pairs" liberally throughout their specification.

U.S. Pat. No. 4,169,650(A) entitled "Wire-wrap Assembly Connector" to Schweizer, describes a connector used to terminate signal wire, twisted pair and shielded cables and specifies this to be "universal in application in that it can be used with a single wire, a twisted
15 pair, a shielded twisted pair, or a shielded coaxial cable either individually or simultaneously."

U.S. Pat. No. 7,210,940(B2) entitled "Connector with Inductive Coupling" to Baily and Leyson, describes a connector that receives and electrically manages cable which "may
20 be of coaxial or twisted pair construction."

Therefore, the scope of the twisted pair embodiment of the invention also contemplates and includes the use of coaxial cable.

To this end, additional components are required to handle coaxial cable to the best
25 effect, for example a design in accordance with the invention adapted to coaxial cable may either terminate to a pair of terminals as implied in FIGS. 2, 7, and 9, or it may have a single-pin terminal retained by the housing and electrically connected to the center conductor of the coax cable and have at least one secondary compliant interconnection means electrically
30 connected to the braided or served conductive shield of the coaxial cable, and adapted to make a secondary interconnection at a secondary site. This secondary contact is commonly called a "ground contact."

In one example shown in FIGS. 10 and 11, a coaxial connector 52 in accordance with the invention includes a housing adapted to receive a commercially available, axially

compliant contact or pin often called a "pogo pin" 54 and a typical source of such pins is the Mil-Max company of Oyster Bay, NY.

The compliant contact 54 is therefore a ground contact, and in common practice, it is located in the connector housing so that movement in the mating direction allows the ground
5 contact to electrically encounter the receptacle or conductive material of the device holding the receptacle in advance of electrical engagement of the signal terminals. This encounter typically occurs prior to the center conductor of the coaxial cable 58 contacting the central terminal of the coaxial receptacle (not shown).

Unmating of the cable disconnects signal lines prior to disconnecting the ground
10 contact. This method of establishing connection between shielding or grounds between equipment in advance of allowing signal contacts to intermate is well-recognized as useful in industry and has been advertised as "early mate, late break," "EMLB," and "First Mate, Last Break," "FMLB" and other marketing terms. In most respects, the connector 52 has the same or similar components and operation as the connector described above with respect to FIGS.
15 1-9. A housing 19' and cover 20' of the connector 52 differ from housing 19 and cover 20 in that they define at their rear, a channel 56 that can accommodate the coax cable 58, which is larger in cross-section than a twisted pair of signal carrying cables 30 shown in FIG. 7.

Also, the housing 19' is modified to accommodate the compliant contact 54 (see FIG.
20 10). The manner in which the housing 19 can be modified is within the purview of one skilled in the art in view of the disclosure herein. The served or braided shield of the coaxial cable 58 communicates electrically with the pogo compliant contact 54.

It is also possible to modify the slider 7 and housing 19' to include only a single locking beam 11, styloid 14, blocking beam 7B and fin 16. Also, while FIG. 10 depicts the ground contact residing outside the effective perimeter of the annular cavity 1 defined by the
25 receptacle, a connector of this invention may position one or any number of ground contacts to operate within said perimeter or within and outside of said perimeter.

As shown in FIG. 11, the coaxial cable 58 is terminated by the terminal 50 having the female electrical terminal 12. This termination may be in a conventional manner by stripping
30 back the jacket of the coax cable 58 to expose a section of the served or braided shield and then trimmed. The center conductor is then crimped to the terminal 50. The center conductor thus communicates electrically with the terminal 50.

Otherwise, the manner in which the housing 19' cooperates with the slider 7 and spring 8 to provide the operation described above with respect to the cooperation of housing 19 with the slider 7 and spring 8 is essentially the same.

FIGS. 12-14 show an embodiment of a connector 60 including only a single female terminal 50 having a female electrical contact 12. The housing 19 is therefore constructed to accommodate only this single female electrical terminal 50, e.g., there is only a single channel 66 at the rear to allow for passage of a single signal carrying wire into the interior of the connector 60. The slider 7, housing 19 and cover 20 may otherwise have essentially the same construction as in any of the embodiments described above.

As in the coaxial cable connector embodiment described above with respect to FIGS. 10 and 11, the slider 7 and housing 19 may be modified to include only a single locking beam 11, styloid 14, blocking beam 7B and fin 16. Thus, a single-fin, single latching site connector is provided for enabling mating with single signal-carrying wires or cables.

Modifications of the connectors described herein are also contemplated and considered part of the invention. As an example, in the illustrated embodiments, the blocking beams 7B of the slider 7 are situated radially inward of the locking beams 11 and diametrically opposite one another along a center line of the headshell assembly 10. Thus, the distance from the mating axis to the styloid 14 of each blocking beam 7B is less than a distance from the mating axis to the respective locking beam 11 interacting with each blocking beam 7B. However, this diametric opposition is not required and the blocking beams 7B and locking beams 11 may be situated on a centerline offset from the diameter of the headshell assembly 10, yet still maintaining the distance from the mating axis to the styloid 14 of each blocking beam 7B less than the distance from the mating axis to the respective locking beam 11 interacting with each blocking beam 7B. This could reduce the overall diameter of the headshell assembly 10 since the ears 7A of the slider 7 would not project beyond the headshell assembly 10 as much as shown in the illustrated embodiments.

One or more of the embodiments of the invention disclosed above differ from the prior art mentioned in the background of the invention section above.

Indeed, some of the prior art mentioned above, although generally describing electrical connectors with latching means, spring assisted actuations, and locking means to resist disconnection after a successful and correct act of electrical interconnection, does not generally use a compressible member, such as at least one helical spring, in a mode which facilitates rejection of a first plug connector from its complementary receptacle in the event that a complete and correct mating is not achieved. The connectors of some of the prior art mentioned above also do not establish an effective primary latch and secondary lock condition, all with one continuous mating motion, i.e., there does not appear to be any

combination of the same set of components in the same arrangement to achieve the same beneficial effects of the inventive connector as disclosed herein.

For example, with respect to the Holweg connector, in this connector, the orientation of the cantilever roots of the locking arms relative to that of the blocking beams is reversed relative to the orientation in one or more embodiments of the invention disclosed above. As
5 such, the kinematics of primary and secondary locking are entirely different.

Moreover, while the Holweg connector includes a functionally similar spring-loaded CPA, its trip mechanism as described appears to depend on Euler buckling of the locking arms once a compressive force sufficient for buckling has accumulated in the beams,
10 whereafter they slide off an obstructing face of the mating receptacle and then the mating motion may proceed. Since the tripping point of a connector in accordance with the Holweg invention is controlled by exceeding some threshold of columnar force, which is itself dependent on a number of variabilities such as the spring constant and production dimensions of a spring or other compression member and also dependent on the material property of the
15 locking arms, all these may affect and perturb the exact buckling point of the beams, and add randomness to the behavior and reliability of this mechanism. Disadvantageously, the tripping point in the Holweg connector is not directly related to an exact and predictable designated relative position of the mating cable connector to its receiving receptacle.

Even further, if plastic or other hygroscopic materials are used as is common within
20 our industry, the rigidity of the locking arms in the Holweg connector in buckling may be at least somewhat dependent on the immediate history of atmospheric humidity experienced by each individual device. For example, if nylon is used for this part, then one device held in storage for weeks at a humid coastal location could trip differently than another device received in an arid, high-elevation location after having been shipped directly from the
25 molding facility which makes these parts.

By contrast, the tripping point of connectors in accordance with the invention is reliably defined by the interaction of fin features on a housing engaging the backside surface of styloids of the slider, so the desired kinematic action occurs at a point of engagement directly related to the relative position of the parts being mated. Factors affecting the trip
30 point of the connector may also be directly determined by extrinsic, accessible, and measurable dimensions, e.g., the mere shapes of interacting parts. Therefore, the trip point is more easily and exactly controlled because holding profile tolerances in molding is much better understood than maintaining a repeatable uniformity of several material factors such as structural composition in solidification, flow orientation of composite fibers, anisotropic

effects, and other intrinsic material properties required when producing the Holweg connector. Connectors in accordance with the invention are therefore expected to provide superior consistency in performance in any environment where installed.

5 With respect to the Hopf et al. connector that requires two separate motions each in a respective, distinct direction of motion to provide for connector engagement, an embodiment of a connector in accordance with the invention advantageously accomplishes both a primary and a secondary lock by means of a single, convenient, intuitive motion.

10 Moreover, the second, locking motion of the Hopf et al. connector is allowed even when the first motion, i.e., the full insertion into the mating receptacle, is not properly achieved. In comparison, in one or more embodiments of a connector in accordance with the invention, the headshell self-rejects so that in tandem with creating an electrical disconnect detectable by a continuity check, and when rejecting from an incomplete mate, either falls away completely from the attempt or noticeably stands proud from the expected mating location, and rests instead in a visually detectable displaced position contraindicative of the expected correct and complete mated state. Additionally, one or more embodiments of the invention advantageously emits an audible click and a compelling tactile snap feel when 15 correctly mated, so that the absence of these ergonomic signals will lead reasonably alert and experienced user to question whether the mate attempt was successful and prepare a subsequent attempt if it was not.

20 In the event of an improper mate of one or more embodiments of the invention, the self-rejecting motions advantageously reset all the components into a position immediately ready for the subsequent corrective mating attempt. Deleteriously, the Hopf et al. connector must be manually reset by means of a motion inconveniently perpendicular to the mating axis and mating motion.

25 With respect to the Gunreben connector, the locking arms of this connector are axially reversed as compared to one or more embodiments of the invention, and the spring arms insert into the "arm pit" at the root of the locking arms from an opposite axial direction. In comparison, the blocking beams of one or more embodiments of the invention slide in behind the cantilevered locking beams while all are oriented in the same insertion direction and all these extend from the headshell. With this construction, an embodiment of the invention is 30 more axially compact and further, bending stresses during latching are stored in material zones more remote from receptacle surfaces subject to collision shocks during the initial registration phase of a mating attempt. Also, this embodiment of the invention is likely to be less susceptible to damage in this regard than the connector of Gunreben.

With respect to the Inaba et al. connector assembly, one or more embodiments of the invention is tripped differently by means of fins engaging ramps at a predetermined intermediate stage of the mate, and the internal slider is guided exclusively in-line with the mating axis of the inventive connector.

5 With respect to the connector of McLauchlan et al., one or more embodiments of the invention is adapted to provide a plurality of latch sites along a substantially peripheral contour of a connector and receptacle system and provides individual locking beams and blocking beams designed to act automatically and in concert at a particular and predetermined trip point during a single mating motion.

10 With respect to the connector of Nakamura (US 2007/0264863(A1)), although this connector includes elements that might be considered similar to those of the disclosed invention, these elements do not cooperate in the same manner as those in the invention and thus cannot provide the advantages obtained by the cooperation of the elements as in the invention. Moreover, the connector does not offer the advantageous secondary blocking
15 effect present in embodiments of the invention which prevents a latched connector from becoming unlatched.

Referring now to FIGS. 15-24, FIG. 15 shows a connector assembly having a headshell 110 that deploys positive locking means such as latches 113 or cantilevered locking beams to effect a substantially permanent intermate, which in most embodiments requires a
20 deliberate actuation of at least one mechanical component of the cable headshell mechanism in order to disengage the cable headshell 110 from the receptacle after such a mate has been established, and the internal mechanism is also designed to autochthonously disconnect itself visibly and electrically from an interconnected state if the extent or distance of intermating of the headshell 110 into its receptacle is incomplete. As mentioned above, this action is called
25 "self-rejecting."

The mechanism includes a slider 114 which is a substantially internal component of a cable headshell assembly, but most commonly including externally accessible portions offering flanges or ears 114' affording finger grip pulling action for disconnect.

The headshell 110 includes latching beams which are substantially rigid beams having
30 a longitudinal axis substantially parallel to the mating axis, and at least one tooth or flange feature hereafter called a latch 113, extending transverse to the longitudinal axis as a locking feature. Within this specification, item 110 can refer to the headshell assembly of a housing and one or more cover components, or just the primary component of the headshell assembly which is called a housing.

The receptacle has at least one undercut 4 including one or more undercut sites as mentioned above (see FIG. 1), and that receive the latch 113 and secure the latching effect. The latching beam is deflected as it approaches, but is not yet latchingly engaged, that is, locked, until sufficient penetration of the headshell 110 into the receptacle allows the latch
5 113 to enter into the latch-receiving undercut 4 of the receptacle. To allow unlatching, the latching beam (latch 113) must be allowed to deflect into the space as was used in its approach. The volume of space swept by the deflection of the latching beam is called an operating space.

The slider 114 operates with a compressive member such as a spring 128 to extend
10 blocking structures such as blocking beams, which are a part of the slider 114, so that they come to rest adjacent to the latching beams in the operating space required by latching beams to unlock from their locked state. In establishing a completely mated state, the spring 128 is allowed to move the slider 114 in the mating direction of the headshell 110 so that its blocking beams occupy the operating space required for an unlatch, thereby trapping the latch
15 of the cantilever latching beam within the undercut 4 of the receptacle.

An exactly staged sequence of events occur during the mating action of the connector as described above and is summarized here: First, on approach of the connector headshell 110 to the receptacle, initial contact occurs between an end face 115 of a styloid feature of a trippable beam and the bulkhead surface 2 of the receptacle. This is the first
20 intermediate position.

Note that if mating force is withdrawn from the headshell while at this first intermediate position, compression in the spring 128 would pass through the slider 114 and present against the bulkhead surface 2 of the receptacle, opposing the initial mating motion. Left alone, the connector assembly would entirely fall away from the receptacle or at least
25 remain in a position obviously, visually displaced from a successful, fully mated installation. The disconnection or displacement is one mode of self-rejection.

Next, further movement of the connector headshell in the mating direction inserts the latches 113 of the latching beams into the receptacle on approach to their complementary latch-receiving undercut sites further within the receptacle. The slider 114 is stalled at this
30 point, so the spring 128 becomes increasingly compressed between the stationary slider 114 and the moving headshell of the connector assembly.

Opposite its end face 115, the styloid at the tip of a trippable beam has a backside ramp face 116. The housing includes protuberances 6 and 6' having hollow centers 111 which receive electrical terminals disposed therein and extend in the mating direction and

define a mating axis. The electrical terminals are outside the scope of this invention and are not shown.

Continuing past the first intermediate position towards a second intermediate position in the mating action, electrical contact may develop between the headshell terminals and the receptacle terminals or pins 5, but electrical disconnect would occur by the self-rejection previously described.

Further movement in the mating direction arrives at a second intermediate position closer to the final and complete engagement of the connector system. At this point, a fin or stub 112 in the body of the headshell assembly abuts an inclined feature, i.e., the backside ramp 116 of the styloid of the trippable beam 121 of the slider 114.

In embodiments disclosed above, one or more fins 112 reside on an outer peripheral surface of a terminal-containing protuberance 6. However, this application introduces alternate embodiments and locations of the fins which will be referred hereafter as tripping features 112 or tripping structures. The function of a tripping feature 112 is to interoperate a backside ramp 116 of the slider 114 so as to slide along and urge the styloid of the slider 114 and trippable beam in its entirety outward so as to bypass the bulkhead surface 2 (see FIGS. 5 and 6).

During this stage at the second intermediate position, the cantilevered latch 113 of the headshell assembly is deflected as it approaches, but is not yet latchingly engaged, that is, locked, into the latch-receiving undercut 4 of the receptacle. However, the interoperation of the tripping feature 112 and the backside ramp 116 of the trippable beam of slider 114 now displaces the styloid so it will evade and fall clear of the rim of the bulkhead surface 2 exactly in tandem with further motion in the mating direction sufficient for the latches 113 of the latching beams to insert themselves into the undercut 4 of the receptacle and achieve their locked state (see FIG. 6).

With the formerly stalled slider 114 now free to move further in the mating direction as driven by the compressive force accumulated in the spring 128, the slider 114 lunges further down the inside the contoured channel of the receptacle cavity 1, which moves part of the blocking beam into an interfering position which advantageously prevents the latch feature of cantilever locking beam from extricating itself from the latch-receiving undercut 4 of the receptacle. A final, complete, locked, and fully-mated condition is thus achieved, which will endure in the absence of extreme forces beyond the range of reasonable robustness expected for this connector system.

In the event that disconnection is desired, a process reversing these events is followed: by gripping only the ears 114' of the slider 114 and pulling the entire connector assembly away from the receptacle, the spring 128 between the slider 114 and the body of the connector assembly headshell 110 is compressed. The ears 114' of the slider 114 are manually accessible as they are outside of the body. Then, the blocking beam is pulled clear from the cantilever latching beam, which can escape from and disengage from the latch-receiving undercut 4 of the receptacle. Upon such disengagement, the headshell assembly simply pulls free of the receptacle.

The foregoing with the exception of the specific descriptions concentrating on the shapes and locations of the tripping features 112 are described above. Also, the blocking beam may be substantially the same beam as the trippable beam, having a styloid with its end face 115 and also having a backward-facing ramp 116.

Referring now to FIGS. 16 and 17, more aspects of the current invention may be seen. FIG. 16 is a cutting-plane or section view through the connector assembly and the cutting plane is parallel to but offset from a plane passing through two axes of the two terminal-holding protuberances of the particular embodiment shown. FIG. 17 is an exploded view of the connector assembly headshell 110. Differing from the embodiments disclosed in, for example, FIGS. 3-6, the slider 114 of the current invention may have a first set of trippable structures such as beams 121 designated to interoperate with tripping features or structures 120 and more important, the slider 114 may have a second set of other beams acting as blocking beams 117 which do not necessarily interoperate with the tripping features 120.

As used herein, the "set" of trippable structures is defined so that it may include only a single trippable structure or a plurality of trippable structures. Similarly, whenever a "set" of a component or element, such as the second set of blocking beams 117, is mentioned herein, it may include only a single one of the identified components or elements, or a plurality of the components or elements. Usually, whenever one set of components or elements cooperate or engage with another set of components or elements, there will be the same number of components or elements in each set and each component from one set will cooperate or engage with a respective one of the components from the other set. Nevertheless, this one-to-one correspondence is not required in all embodiments of the invention (see the discussion below with reference to FIG. 24).

The blocking beams 117 merely interpose themselves to occupy the operating spaces of the latches 113 so as to block them from extricating themselves from any complementary undercut 4 wherein they reside while in a locked and blocked state (see FIGS. 19A and 19B).

Since both sets of beams are portions of the same part, i.e., the slider 114, it is assured that any act tripping the trippable beams so as to allow the slider 114 to plunge downward under force from the compressive member will simultaneously drop any and all blocking beams into their interfering positions adjacent their respective latching beams.

5 Embodiments disclosed in for example, FIGS. 3-6, have fins arising from the hollow, terminal-holding protuberances 6, and the effective profile of the fin is generally oriented in a plane passing through the axis defined by the protuberance 6. However, for the embodiments shown in FIGS. 16 and 17 at least, the surfaces of a tripping feature 120 operate in a plane not necessarily passing through the axis of a protuberance. In FIG. 16 for example, the
10 cutting plane offset from a plane passing through two axes of the two terminal-holding protuberance happens to show all the necessary operating features of this and the related invention: the tripping features 120 emerging from the terminal-holding protuberances 6, and also the end faces 115 and the backward facing ramps 116 of the styloids of the trippable beams 121. Also seen is a first latching beam which in this embodiment is a twin-beam
15 design with a latch 113 bridged at its tip according to the related invention, and a second latching beam with its latch 113' is diametrically opposed to the first latch 113.

As seen in FIG. 17, the connector assembly headshell 110 comprises a cover 124 and a housing 126 that mate with one another in any manner known to those skilled in the art, including using the structure disclosed above. The spring 128 is placed between the cover
20 124 and the slider 114. Each female contact 30 is shown as part of a connector terminal 132 that mates with a respective one of the signal carrying wires 134.

FIG. 18A is a cross-sectional view through the midplane of a bridging member of the twin-beam latch 113 and a portion of the blocking beam 117, and shows the position of the blocking beam 117 distant from the latch 113 to enable the latch 113 to flex inward as it
25 moves along the surface of the receptacle toward and finally into the undercut site or sites (this inward flexing or deflection being represented by the phantom lines). FIG. 18B shows the absence of the blocking beam 117 behind the latch 113, wherein the connector assembly headshell 110 can be moved into its final mated state.

FIG. 19A shows the position of the blocking beam 117 in the final inserted state of
30 the connector assembly headshell 110 into the receptacle. As shown in FIG. 19B, the blocking beam 117 is between the latch 113 and the inner surface of the receptacle and thus prevents inward deflection of the latch 113 and removal of the latch 113 from the undercut site or sites.

Next, FIG. 20A illustrates an embodiment in which a cluster of terminal-holding protuberances 6 each have tripping features 112 according to the related invention, because it is seen that the tripping features 112 not only emerge from the protuberances 6, but they are each oriented so that their active features operate substantially within a plane containing the axis defined by the protuberance 6 whence they originate. It should also be noticed that although embodiments having both one and having more than one electrical lines are contemplated, and although most drawings in this application show two lines, this particular embodiment within the scope of the invention has four lines.

FIGS. 20B, 20C and 20D illustrate additional embodiments for the arrangement of tripping features and their attachment to the housing body of the connector assembly headshell 110. These embodiments allow the trippable beams to be located independently from the location or configuration of the terminal array.

This independence is illustrated in FIG. 20B where it is further shown that the tripping feature 120 need not be affixed to or arise from a terminal-holding protuberance 6. Rather, in this embodiment, a separate support means 171 such as a stud, a strut, a tombstone, or a peg, can support the tripping feature 120 at a proper position. The support means 171 encompass any structure that extends from the housing of the connector headshell in a mating direction, which is the same direction in which the protuberance 6 extends. The support means 171 are spaced apart from the protuberance 6.

As shown, the support means 171 have a rectangular cross-section in the mating direction and a broad side facing the protuberance 6, but this orientation of the support means 171 does not limit the invention.

The presence of only a single tripping feature 120 on the broad side of the support means facing away from the protuberance 6 is also just an example of this embodiment, and alternatively or additionally, another tripping feature 120 may be located on the broad side facing the protuberance. If multiple tripping features 120 are provided on the support means 171, they may be the same or different.

Moreover, the support means 171 are preferably made of a sufficiently rigid material that will allow the tripping feature 120 to perform its function as described herein.

Note also that FIG. 20B shows an embodiment having only one electrical line. However, it is contemplated that the protuberance 6 may house more than one terminal.

FIG. 20C shows that in yet another embodiment, a means of support 171 which supports more than one tripping feature 120 is contemplated and shown. The support means 171 encompass any structure that extends from the housing of the connector headshell in a

mating direction, which is the same direction in which the two-terminal-housing protuberance 6 extends. As shown, the support means 171 have a rectangular cross-section in the mating direction and a narrow side facing an approximate center of the protuberance 6, but this orientation of the support means 171 does not limit the invention.

5 This drawing shows two nose-like tripping features 120 on opposite broad sides of a planar support means 171, but any number of such tripping features 120 may also be contemplated, for example a support means in the form of a polygonal rod with at least one tripping feature arising from each face of the polygon. Such a support means may also be used in the other embodiments disclosed herein.

10 Although most of the tripping features illustrated and described herein appear substantially triangular in shape or in cross section, other shapes capable of interoperating correctly with a backside ramp of a styloid of a trippable beam are also contemplated. In the embodiment shown in FIG. 20D, a round stud 172 emerges from a terminal-holding protuberance 6 such that the stud 172 has an axis substantially perpendicular to the axis
15 defined by the terminal-holding protuberance 6. Of course, the use of round studs emerging from other means of support 171 are also contemplated within the scope of the invention.

 FIG. 21 illustrates a receptacle as described in the summary of the invention section above. The particular variant is a two-line application which typically includes a formed metal shorting clip actuated by a proboscis on the complementary headshell. In this
20 embodiment, the bulkhead surface 2 is pierced by an access hole or aperture 181 leading to a distal space beyond the access hole which, being larger than the access hole 181, offers at least one ceiling surface 182 which thereby functions as a latch receiving undercut in a similar manner as the latch-receiving undercut sites of the embodiments disclosed above. Here also, it can be clearly seen that the location of a latching beam may be entirely
25 independent from the location or configuration of the contact array of configuration of the connector.

 Furthermore, besides offering latch receiving surfaces 182, the rim of the access hole or aperture 181 may be used to halt a trippable beam of the slider so that when tripped, the beam falls away from this rim and plunges into the aperture 181.

30 FIGS. 22 and 23 show a housing of a connector assembly including a single protuberance 6 with a stud 172, i.e., a peg, during its mating with a receptacle similar to the receptacle shown in FIG. 21. The stud 172 first is moved to engage the trippable beam 121 that abuts against the bulkhead surface 2 from the position shown in FIG. 22. After the stud 172 engages and trips the trippable beam 121, moving it outward over the bulkhead surface 2,

the blocking beam 117 of the slider is moved inward to a position behind the latch 113 (shown in FIG. 23). At the same time, the trippable beam 121 enters into the aperture 181 during the continued inward movement of the slider.

Referring finally to FIG. 24, this embodiment includes most of the same structure as identified above and operates in substantially the same manner. The major difference in this embodiment is that there is a single tripping feature 120A on the protuberance 6 that projects from opposite sides of the protuberance 6. As such, this singular tripping feature 120A is able to interoperate simultaneously with two trippable beams 121. Embodiments wherein a single tripping feature interoperates with two or more trippable beams are thus part of the invention.

10 The cable headshell 110 described above has an optimum connection method to the receptacle to provide for a secure coupling with a self-reject feature. The method involves engaging the connector with the receptacle while ensuring complete and proper connection by moving the housing into the receptacle, against bias of the spring, to cause the trippable beams 121 of the slider 114 to abut against the bulkhead surface 2 of the receptacle (via the end faces 115), then to cause the tripping features 120 to abut against the trippable beams 121 (specifically against the backside ramp 116) and the latches 113 to pass outward of the trippable beams 121 into engagement with the receptacle. The movement also causes the latches 113 to pass into the undercut site or sites of the receptacle and causes the tripping features 120 to urge the trippable beams 121 outward and enable the trippable beams 121 to be positioned inward of the latches 113 and prevent their release from the undercut site or sites of the receptacle. The latch release prevention is also aided by the blocking beams 117 of the slider 114.

Also, the spring between the slider 114 and the housing is positioned such that the spring causes separation of the connector from the receptacle during the movement of the housing until each of the latches 113 is situated in the undercut site or respective one of the undercut sites of the receptacle (the "self-rejecting" feature).

Each tripping feature 120 is configured to engage a respective styloid and interact with the styloid such that the movement of the housing into the receptacle initially causes the tripping features 120 to contact the styloids and continued movement of the housing into the receptacle after such contact causes the tripping features 120 to displace the styloids to move out of contact with the bulkhead surface 2 of the receptacle. The slider 114 may also be configured to enable manual movement of the trippable beams 121 out from a position which prevents release of each of the latches 113 from the undercut site or sites of the receptacle, to

thereby enable release of each of the latches from the undercut site or sites of the receptacle and removal of the connector from the receptacle.

5 The engaging of the cable headshell 110 with the receptacle may advantageously require only a single act of relative motion of the cable headshell 110 with respect to the receptacle, with all directions of motion of the cable headshell 110 and slider 113 remaining substantially parallel to the mating direction throughout the entirety of the single act of relative motion. This single act may be performed at a substantially uniform velocity or at a non-uniform velocity.

10 Therefore, although the preceding description contains many specificities, these should not be construed as limiting the scope of the invention, but as merely illustrative of some preferred embodiments. Variations of the embodiments described above and illustrated in the drawings are considered to be within the scope of the invention, and thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.

15

CLAIMS:

1. A receptacle connector for connecting to a plug connector, the receptacle connector comprising:

a housing including a plurality of fins;

at least one electrically conductive terminal at least partly situated in said housing and defining a mating axis and a mating direction;

a plurality of cantilevered locking beams arranged in said housing; a slider slidingly coupled to said housing and including a plurality of blocking beams extending in the mating direction; and

a compressive member arranged to urge said slider outward away from said housing in the mating direction,

wherein said fins are situated to engage with said blocking beams during an initial stage of relative movement between said housing and said slider against a bias of said compressive member and allow inward deflection of said locking beams, and

wherein said blocking beams are configured to prevent inward deflection of said locking beams after a final stage of the relative movement between said housing and said slider, and the receptacle connector has an electrically interconnected state only when in the final stage.

2. The receptacle connector of claim 1, wherein said at least one terminal is a pin-receiving terminal.

3. The receptacle connector of claim 1, wherein said cantilevered locking beams extend as latches in the mating direction.

4. The receptacle connector of claim 1, wherein said locking beams are sized so as to extend past a bulkhead surface of the plug connector and shaped so as to latchingly engage with a plurality of undercut sites when the receptacle connector is mated with the plug connector.

5. The receptacle connector of claim 1, wherein each blocking beam terminates at a respective end as a styloid having an end face perpendicular to said mating direction, said styloid being radially inward of a respective one of said locking beams, and wherein a distance from the mating axis to the styloid of each of said blocking beams is less than a distance from the mating axis to the respective one of said locking beams interacting with each of said blocking beams.
6. The receptacle connector of claim 5, wherein each of said fins of said housing is configured to engage a respective one of said styloids at the initial stage of relative movement between said housing and said slider.
7. The receptacle connector of claim 5, wherein at least one of said locking beams comprises a pair of spaced apart cantilever sections, said cantilever sections having tips and being bridged at said tips by a unitary latching feature.
8. The receptacle connector of claim 7, wherein at least one of said blocking beams is arranged to operate in between said pair of cantilever sections of said at least one locking beam.
9. The receptacle connector of claim 1, wherein said housing includes at least one protuberance adapted to house said at least one terminal, a respective one of said fins being arranged on an outer surface of said at least one protuberance.
10. The receptacle connector of claim 1, wherein said housing extends radially from the mating axis.
11. The receptacle connector of claim 1, wherein said housing extends axially along said mating axis in a direction opposite that of the mating direction.
12. The receptacle connector of claim 1, wherein said compressive member comprises a helical spring.
13. The receptacle connector of claim 1, wherein said compressive member has a compressive modulus allowing manual actuation such that movement of said slider in a

direction along the mating axis clears said blocking beams from interfering with inward deflection of said locking beams.

14. The receptacle connector of claim 1, wherein said compressive member is configured to exert a reaction force while at the initial stage that is at least 5% greater than a reaction force exerted while residing in the final stage.

15. The receptacle connector of claim 1, wherein said compressive member is configured such that during the initial stage of relative movement, said compressive member is sufficiently compressed both to exert an outward force urging said housing away from the plug connector and to maintain a displaced position of said housing distinct from a position of an electrically mated state with the plug connector.

16. The receptacle connector of claim 15, wherein said housing is configured such that in the displaced position of said housing, said housing is visually distinct from a position in which said housing is electrically connected to the plug connector.

17. The receptacle connector of claim 1, wherein said housing comprises:

a body including a latching stub; and

a cover including a complementary lumina which snappingly engages onto said

stub,

said slider, said compressive member and said at least one terminal being housed in an enclosure defined by said body and said cover.

18. The receptacle connector of claim 1, wherein said housing comprises: a body including a latching stub; and

a cover including a complementary latch which snappingly engages onto said

stub,

said slider, said compressive member and said at least one terminal being housed in an enclosure defined by said body and said cover.

19. The receptacle connector of claim 1, wherein said housing comprises: a latching stub;

a first cover including a complementary latch which snappingly engages onto said stub, and an alignment strake; and

a second cover including an alignment groove complementary to said alignment strake of said first cover, and a latching stub snappingly received within said first cover while said groove of said second cover is slidingly coupled to said strake of said first cover, said slider, said compressive member, and said at least one terminal being housing in an enclosure defined by said first cover and said second cover.

20. The receptacle connector of claim 1, wherein said housing comprises: a latching stub;

a first cover including a complementary latch which snappingly engages onto said stub, and an alignment groove;

a second cover including an alignment strake complementary to said alignment groove of said first cover, and a latching stub,

said stub of said second cover being snappingly received within said first cover while said strake of said second cover is slidingly coupled to said groove of said first cover, said slider, said compressive member, and said at least one terminal being housing in an enclosure defined by said first cover and said second cover.

21. The receptacle connector of claim 1, wherein said at least one electrically conductive terminal consists of a single electrically conductive terminal.

22. The receptacle connector of claim 21, wherein said single electrically conductive terminal is configured to electrically connected to a center conductor of a coaxial cable, further comprising a compliant contact arranged at least partly in said housing and configured to electrically engage with a shield of the coaxial cable.

23. A receptacle connector for connecting to a plug connector, the receptacle connector comprising:

a housing including a fin;

an electrically conductive terminal at least partly situated in said housing and defining a mating axis and a mating direction, said electrically conductive terminal being configured to electrically connect to a conductor of a cable or wire to be terminated by the receptacle connector;

a locking beam arranged in said housing;

a slider slidingly coupled to said housing and including a blocking beam extending in the mating direction; and

a compressive member arranged to urge said slider outward away from said housing in the mating direction, and

wherein said fin is situated to engage with said blocking beam during an initial stage of relative movement between said housing and said slider against a bias of said compressive member and allow inward deflection of said locking beam, and

wherein said blocking beam is configured to prevent inward deflection of said locking beam after a final stage of the relative movement between said housing and said slider, and the receptacle connector has an electrically interconnected state only when in the final stage.

24. A method for securely coupling a receptacle connector to a plug connector, the receptacle connector including a housing having a plurality of fins, at least one electrically conductive terminal at least partly situated in the housing and defining a mating axis and a mating direction, a plurality of cantilevered locking beams arranged in the housing, a slider slidingly coupled to the housing and including a plurality of blocking beams extending in the mating direction, and a compressive member arranged to urge the slider outward away from the housing in the mating direction, and the plug connector including a bulkhead surface, a cavity having latch-receiving undercut sites,

and at least one electrical terminal adapted to mate with the at least one terminal of the receptacle connector, the method comprising:

engaging the receptacle connector with the plug connector while ensuring complete and proper connection by moving the housing into the plug connector, against bias of the compressive member, to cause the blocking beams to abut against the bulkhead surface of the plug connector, then to cause the fins to abut against the

blocking beams and the locking beams to pass outward of the blocking beams into engagement with the plug connector, and then to cause the locking beams to pass into the undercut sites of the plug connector and cause the fins to urge the blocking beams outward and enable the blocking beams to be positioned inward of the locking beams and prevent release of the locking beams from the undercut sites of the plug connector; and

positioning the compressive member between the slider and the housing such that the compressive member causes separation of the receptacle connector from the plug connector during the movement of the housing until the locking beams are situated in the undercut sites of the plug connector.

25. The method of claim 24, further comprising:

configuring each of the plurality of blocking beams with a styloid to thereby provide a plurality of styloids; and

configuring each of the fins of the housing to engage a respective one of the styloids and interact with the styloid such that the movement of the housing into the plug connector initially causes the fins to contact the styloids and continued movement of the housing into the plug connector after such contact causes the fins to displace the styloids to move out of contact with the bulkhead surface of the plug connector.

26. The method of claim 24, further comprising configuring the slider to enable manual movement of the blocking beams out of their position preventing release of the locking beams from the undercut sites of the plug connector to thereby enable release

of the locking beams from the undercut sites of the plug connector and removal of the receptacle connector from the plug connector,

27. The method of claim 24, further comprising forming the fins on at least one protuberance that houses the at least one terminal of the receptacle connector.

28. The method of claim 24, wherein the step of engaging the receptacle connector with the plug connector comprises performing a single act of relative motion of the receptacle connector with respect to the plug connector, with all directions of motion of the housing and slider remaining substantially parallel to the mating direction throughout the entirety of the single act of relative motion.

29. A method for securely coupling a receptacle connector to a plug connector, the receptacle connector including a housing having a plurality of fins, at least one electrically conductive terminal at least partly situated in the housing and defining a mating axis and a mating direction, a plurality of cantilevered locking beams arranged in the housing, and a slider slidably coupled to the housing and including a plurality of blocking beams extending in the mating direction, and the plug connector including a bulkhead surface, a cavity having latch-receiving undercut sites, and at least one electrical terminal adapted to mate with the at least one terminal of the receptacle connector, the method comprising:

moving the housing into the plug connector in a single act of relative motion of the housing into the plug connector, with all directions of motion of the housing and slider remaining substantially parallel to the mating direction throughout the entirety of

the single act of relative motion, to cause the blocking beams to abut against the bulkhead surface of the plug connector, then to cause the fins to abut against the blocking beams and the locking beams to pass outward of the blocking beams into engagement with the plug connector, and then to cause the locking beams to pass into the undercut sites of the plug connector and cause the fins to urge the blocking beams outward and enable the blocking beams to be positioned inward of the locking beams and prevent release of the locking beams from the undercut sites of the plug connector; and

preventing the receptacle connector from mating with the plug connector during the single act of relative motion until the locking beams are situated in the undercut sites of the plug connector.

30. The method of claim 29, wherein the step of preventing the receptacle connector from mating with the plug connector during the single act of relative motion until the locking beams are situated in the undercut sites of the plug connector comprises:

positioning a compressive member, having a bias against which the housing acts when moved into the plug connector, between the slider and the housing; and

configuring the compressive member to urge the slider outward away from the housing in the mating direction and cause separation of the housing from the plug connector until the locking beams are situated in the undercut sites of the plug connector'

31. The receptacle connector of claim 1, wherein each of said blocking beams is radially inward of a respective one of said locking beams.

32. The receptacle connector of claim 1, wherein a portion of each of said blocking beams that engages with a respective one of said fins is inward of a respective one of said locking beams.

33. The receptacle connector of claim 1, wherein each of said locking beams is entirely outward of a respective one of said blocking beams.

34. The receptacle connector of claim 1, wherein each of said blocking beams is interposed between a respective one of said fins and a respective one of said locking beams with said respective one of said fins being inward of said blocking beam and said blocking beam being inward of said respective one of said locking beams.

35. The receptacle connector of claim 1, wherein each of said fins is distanced from a respective one of said locking beams and a space is provided between said fin and said respective one of said locking beams into which a respective one of said blocking beams is movable.

36. The receptacle connector of claim 1, wherein each of said fins is situated on one side of a respective one of said blocking beams and a respective one of said locking beams is situated on an opposite side of said respective one of said blocking beams.
37. The receptacle connector of claim 1, wherein each of said fins is configured to engage with a respective one of said blocking beams to urge said respective one of said blocking beams toward a respective one of said locking beams after the initial stage of movement.
38. The receptacle connector of claim 23, wherein said blocking beam is radially inward of said locking beam.
39. The receptacle connector of claim 23, wherein a portion of said blocking beam that engages with said fin is inward of said locking beam.
40. The receptacle connector of claim 23, wherein said locking beam is entirely outward of said blocking beam.
41. The receptacle connector of claim 23, wherein said blocking beam is interposed between said fin and said locking beam with said fin being inward of said blocking beam and said blocking beam being inward of said locking beam.
42. The receptacle connector of claim 23, wherein said fin is distanced from said locking beam and a space is provided between said fin and said locking beam into which said blocking beam is movable.
43. The receptacle connector of claim 23, wherein said fin is situated on one side of said blocking beam and said locking beam is situated on an opposite side of said blocking beam.
44. The receptacle connector of claim 23, wherein said fin is configured to engage with said blocking beam to urge said blocking beam toward said locking beam after the initial stage of movement.

45. A plug-in connector for connecting to a receptacle, the connector comprising:
- a housing including at least one tripping structure;
 - at least one electrically conductive terminal at least partly situated in said housing and defining a mating axis and a mating direction;
 - at least one latch arranged in said housing;
 - a slider slidingly coupled to said housing and including at least one trippable structure extending in the mating direction and that cooperates with said at least one tripping structure of said housing; and
 - a compressive member arranged to urge said slider outward away from said housing in the mating direction, and
- wherein said at least one tripping structure of said housing is situated to engage with a respective one of said at least one trippable structure of said slider during an initial stage of relative movement between said housing and said slider against a bias of said compressive member while inward deflection of said at least one latch is allowed, and
- wherein said at least one trippable structure of said slider is configured to prevent inward deflection of said at least one latch after a final stage of the relative movement between said housing and said slider, and the connector has an electrically interconnected state only when in the final stage.
46. The connector of claim 45, wherein said at least one trippable structure of said slider comprises at least one trippable beam, said slider further including at least one blocking structure that is positioned to prevent said at least one latch from flexing inward when the connector is in the final stage.
47. The connector of claim 45, wherein said at least one trippable structure of said slider comprises a plurality of trippable structures and a single one of said at least one tripping structure of said housing is configured to interoperate with a plurality of said trippable structures.

48. The connector of claim 45, wherein said housing includes a protuberance that houses said at least one terminal and extends in the mating direction.
49. The connector of claim 48, wherein said at least one tripping structure of said housing is situated on said protuberance.
50. The connector of claim 49, wherein said at least one tripping structure of said housing defines an operative planar surface that engages said at least one trippable structure of said slider, said operative surface being situated in a plane that does not pass through an axis of said protuberance.
51. The connector of claim 49, wherein said at least one terminal consists of two terminals, said protuberance housing said two terminals.
52. The connector of claim 48, wherein said housing further includes a support extending in the mating direction spaced apart from said protuberance, said at least one tripping structure of said housing being situated on said support.
53. The connector of claim 52, wherein said at least one terminal consists of two terminals, said protuberance housing said two terminals, said at least one tripping structure of said housing consisting of two tripping structures arranged on opposite sides of said support.
54. The connector of claim 48, wherein said at least one tripping structure comprises at least one stud extending outward from said protuberance.
55. The connector of claim 54, wherein said at least one terminal comprises a plurality of terminals and said at least one stud comprises a number of studs equal in number to said terminals, each of said studs being situated alongside a respective one of said terminals.
56. The connector of claim 45, wherein said at least one trippable structure of said slider terminates at an end as a styloid having an end face perpendicular to said mating direction, said styloid being radially inward of a respective one of said at least one latch, and wherein a distance from a mating axis to said styloid of said at least one trippable

structure of said slider is less than a distance from the mating axis to the respective one of said at least one latch interacting with each of said at least one trippable structure of said slider.

57. The connector of claim 45, wherein said at least one latch comprises a pair of spaced apart cantilever sections bridged at their tips by a unitary latching structure.

58. The connector of claim 45, wherein said at least one trippable structure is radially inward of a respective one of said at least one latch.

59. The connector of claim 45, wherein a portion of each of said at least one trippable structure that engages with a respective one of said at least one tripping structure is inward of a respective one of said at least one latch.

60. The connector of claim 45, wherein each of said at least one latch is entirely outward of a respective one of said at least one trippable structure.

61. The connector of claim 45, wherein each of said at least one trippable structure is interposed between a respective one of said at least one tripping structure and a respective one of said at least one latch with said respective one of said at least one tripping structure being inward of said trippable structure and said trippable structure being inward of said respective one of said at least one latch.

62. The connector of claim 45, wherein each of said at least one tripping structure is distanced from a respective one of said at least one latch and a space is provided between said tripping structure and said respective one of said at least one latch into which a respective one of said at least one trippable structure is movable.

63. The connector of claim 45, wherein each of said at least one tripping structure is situated on one side of a respective one of said at least one trippable structure and a respective one of said at least one latch is situated on an opposite side of said respective one of said at least one trippable structure.

64. The connector of claim 45, wherein each of said at least one tripping structure is configured to engage with a respective one of said at least one trippable structure to

urge said respective one of said at least one trippable structure toward a respective one of said at least one latch after the initial stage of movement.

65. A plug-in connector for connecting to a receptacle, the connector comprising:

a housing;

a pair of electrically conductive terminals defining a mating axis and a mating direction, said terminals being configured to electrically connect to a conductor of a cable or wire to be terminated by the connector;

a protuberance arranged in said housing and extending in the mating direction, said terminals being partly housing in said protuberance;

a pair of latches arranged in said housing;

a slider slidingly coupled to said housing and including a first set of trippable structures extending in the mating direction;

a second set of tripping structures arranged on said protuberance;

a third set of blocking structures arranged on said slider; and

a compressive member arranged to urge said slider outward away from said housing in the mating direction, and

wherein said first set of trippable structures and said second set of tripping structures engage with one another during an initial stage of relative movement between said housing and said slider against a bias of said compressive member while inward deflection of said latches is allowed, and

wherein said third set of blocking structures is configured to prevent inward deflection of said latches after a final stage of the relative movement between said housing and said slider, and the connector has an electrically interconnected state only when in the final stage.

66. The connector of claim 65, wherein said first set of trippable structures comprises a first set of trippable beams, said third set of blocking structures comprising at least one blocking beam separate from said first set of trippable beams.

67. The connector of claim 65, wherein each of said trippable structures in said first set of trippable structures terminates at an end as a styloid having an end face perpendicular to said mating direction, said styloid being radially inward of a respective one of said latches, and wherein a distance from a mating axis to said styloid of each of said trippable structures in said first set of trippable structures is less than a distance from the mating axis to the respective one of said latches interacting with each of said blocking structures in said third set of blocking structures.

68. The connector of claim 65, wherein said first set of trippable structures includes a plurality of trippable structures and said second set of tripping structures comprises a single tripping structure that is configured to interoperate with at least two of said trippable structures.

69. A method for securely coupling a plug-in connector to a receptacle, the connector including a housing including at least one tripping structure, at least one electrically conductive terminal at least partly situated in the housing and defining a mating axis and a mating direction, at least one latch arranged in the housing, a slider slidingly coupled to the housing and including at least one blocking structure and at least one trippable structure extending in the mating direction and that cooperates with the at least one tripping structure of the housing, and a compressive member arranged to urge the slider outward away from the housing in the mating direction, and the receptacle including a bulkhead surface, a cavity having at least one latch-receiving undercut site, and at least one electrical terminal adapted to mate with the at least one terminal of the connector, the method comprising:

engaging the connector with the receptacle while ensuring complete and proper connection by moving the housing into the receptacle, against bias of the compressive member, to cause the at least one trippable structure of the slider to abut against the bulkhead surface of the receptacle, then to cause the at least one tripping structure of

the housing to abut against the at least one trippable structure of the slider and the at least one latch to pass outward of the at least one trippable structure of the slider into engagement with the receptacle, and then to cause the at least one latch to pass into the at least one undercut site of the receptacle and cause the at least one tripping structure of the housing to urge the at least one trippable structure of the slider outward and enable the at least one blocking structure of the slider to be positioned inward of the at least one latch and prevent release of the at least one latch from the at least one undercut site of the receptacle; and

positioning the compressive member between the slider and the housing such that the compressive member causes separation of the connector from the receptacle during the movement of the housing until the at least one latch is situated in the at least one undercut site of the receptacle.

70. The method of claim 69, further comprising:

configuring the at least one trippable structure of the slider with a styloid; and

configuring the at least one tripping structure of the housing to engage a respective styloid and interact with the respective styloid such that movement of the housing into the receptacle initially causes the at least one tripping structure of the housing to contact the respective styloid and continued movement of the housing into the receptacle after such contact causes the at least one trippable structure of the housing to displace the respective styloid to move out of contact with the bulkhead surface of the receptacle.

71. The method of claim 69, further comprising:

configuring the slider to enable manual movement of the at least one blocking structure of the slider out of a position preventing release of the at least one latch from the at least one undercut site of the receptacle to thereby enable release of the at least one latch from the at least one undercut site of the receptacle and removal of the connector from the receptacle.

72. The method of claim 69, wherein the step of engaging the connector with the receptacle comprises performing a single act of relative motion of the connector with respect to the receptacle, with all directions of motion of the housing and slider remaining substantially parallel to the mating direction throughout the entirety of the single act of relative motion.

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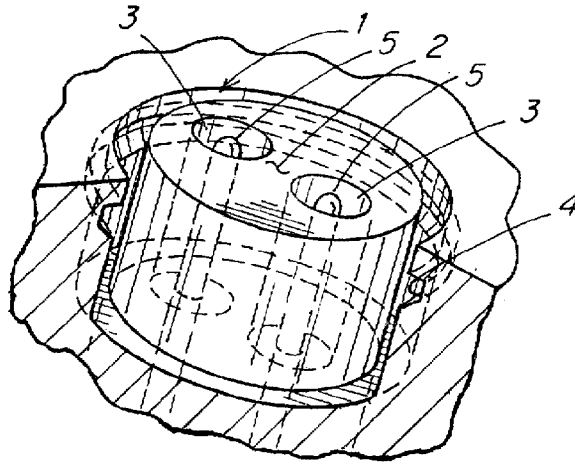


Fig. 1

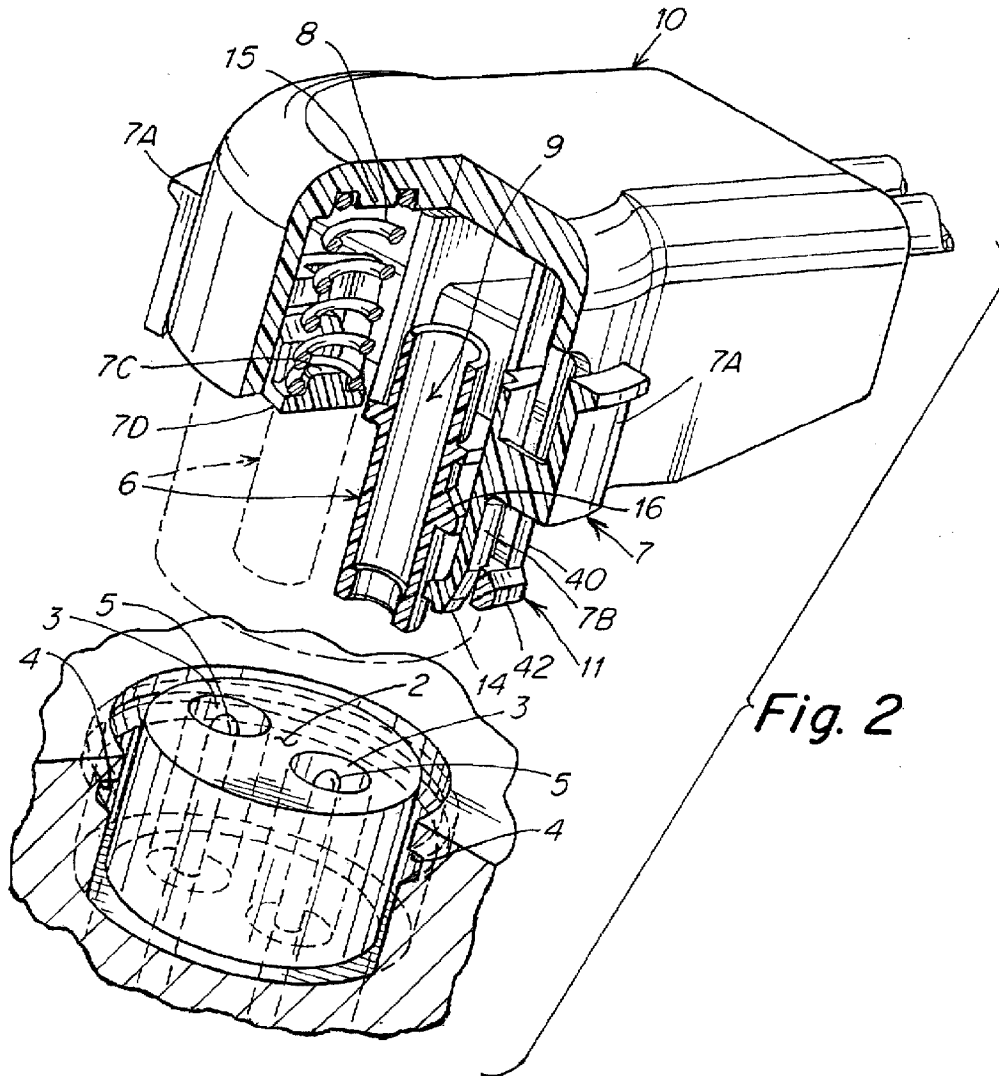


Fig. 2

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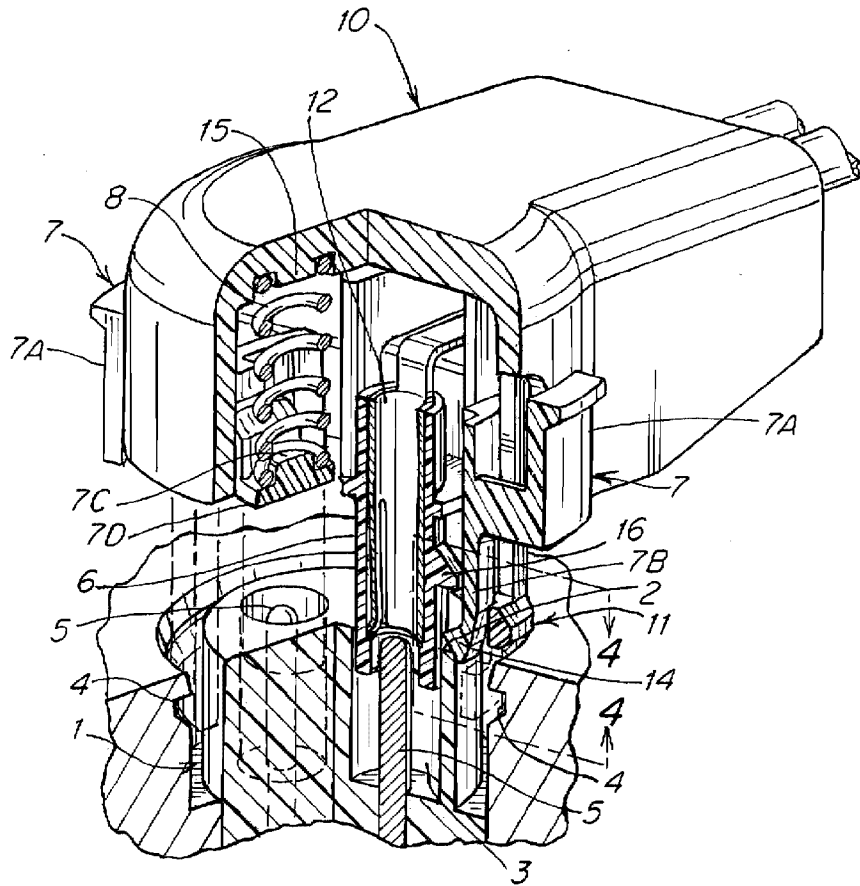


Fig. 3

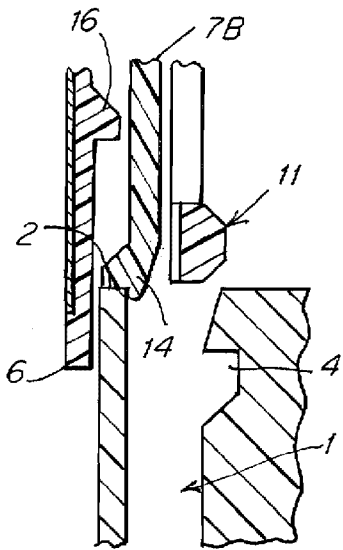


Fig. 4

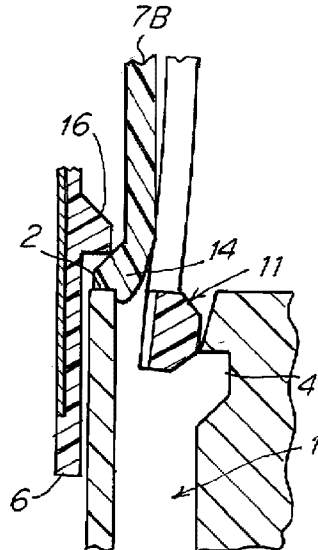


Fig. 5

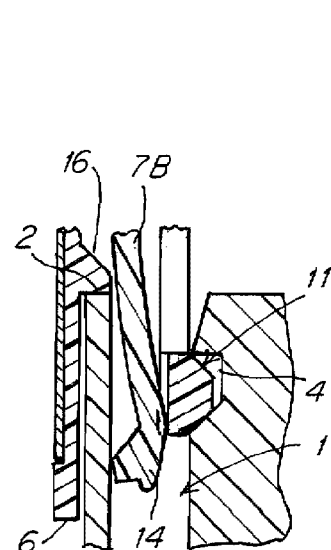


Fig. 6

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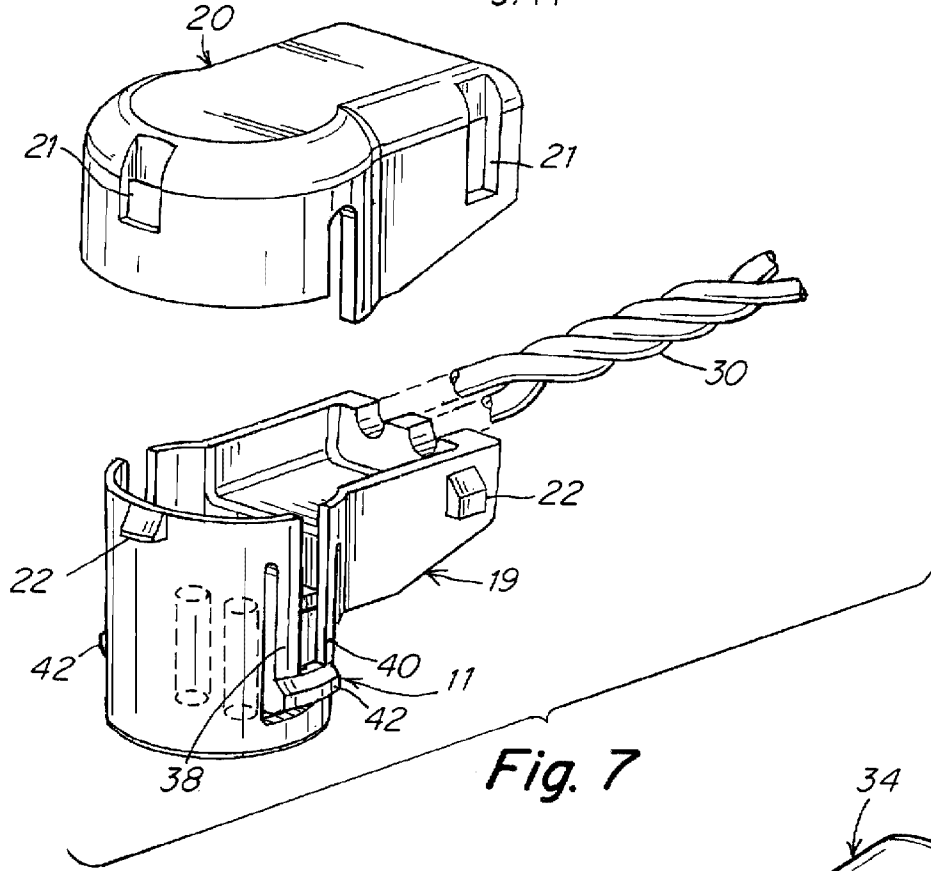


Fig. 7

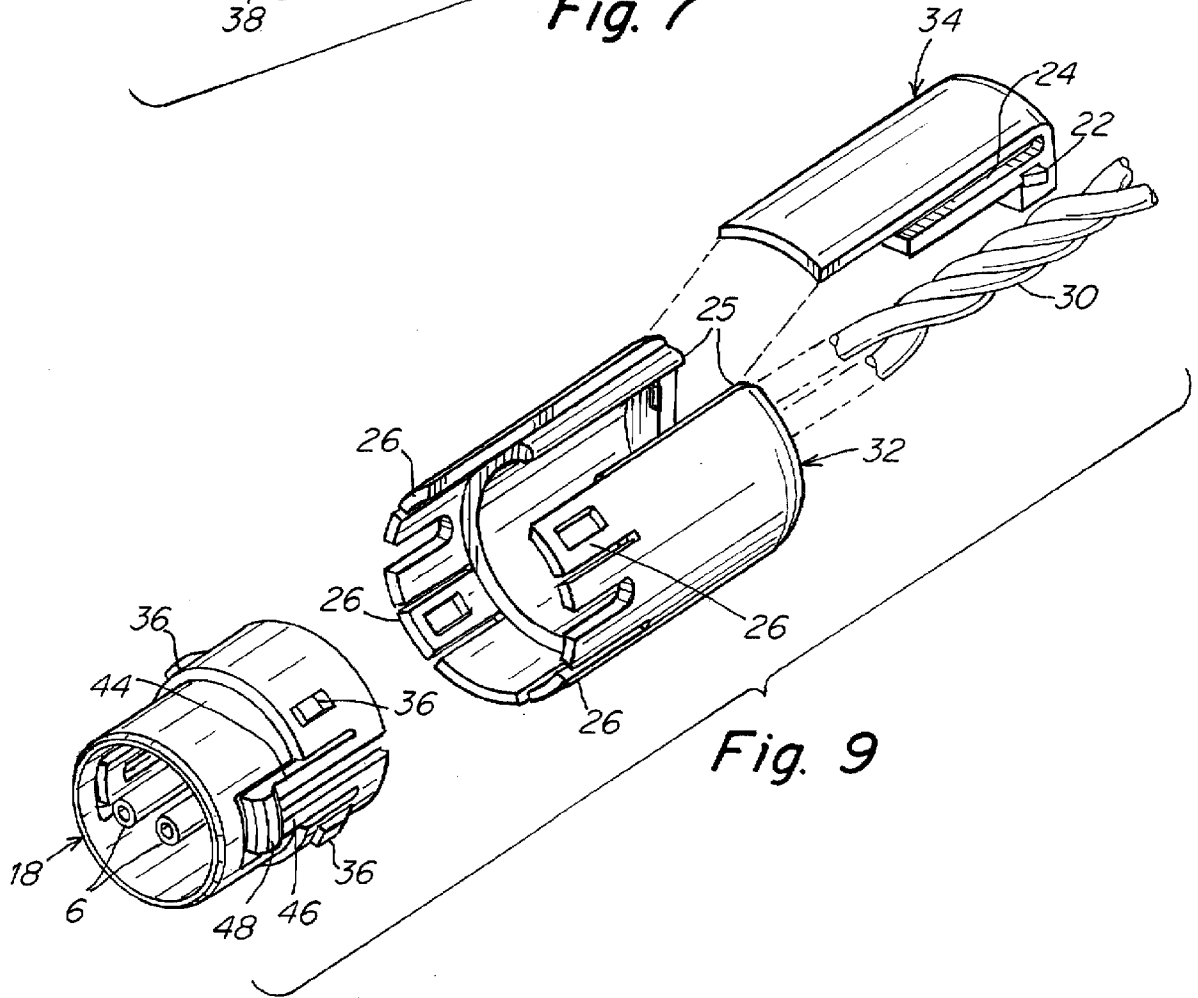


Fig. 9

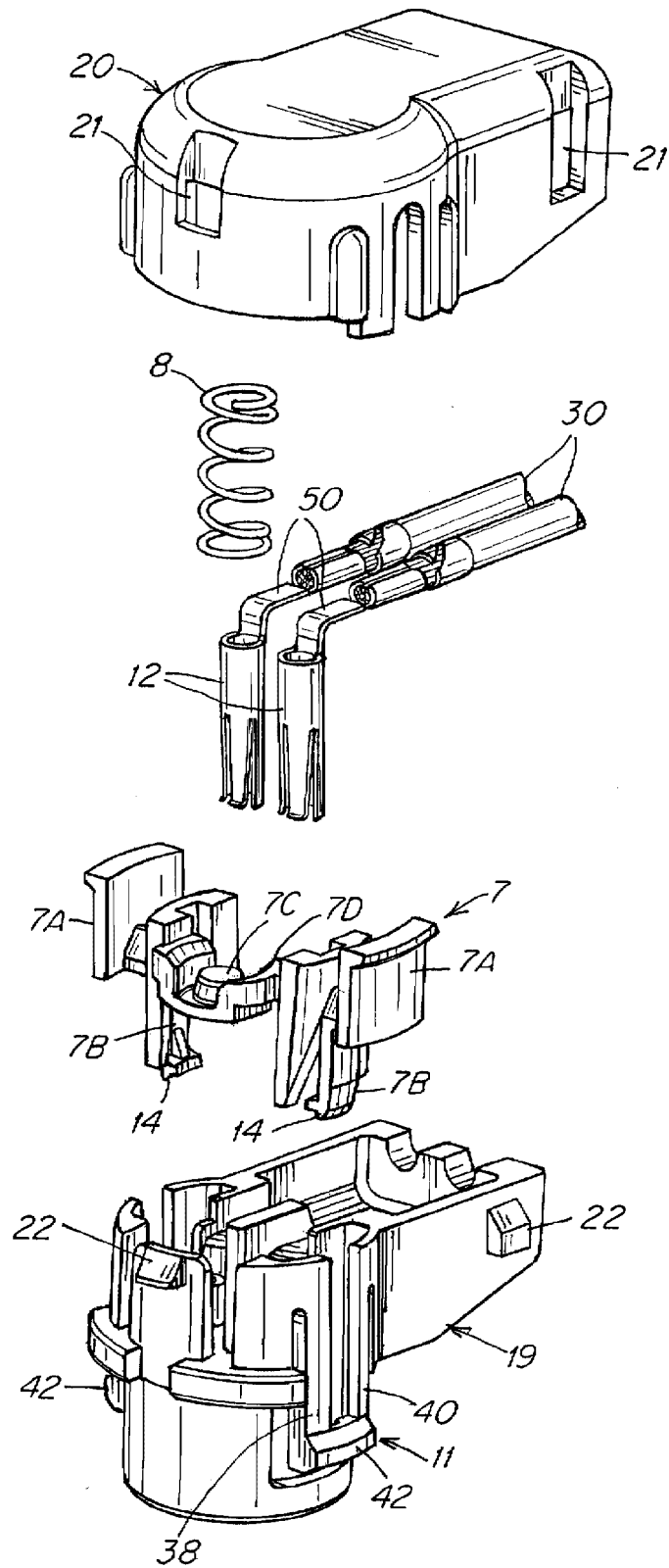


Fig. 8

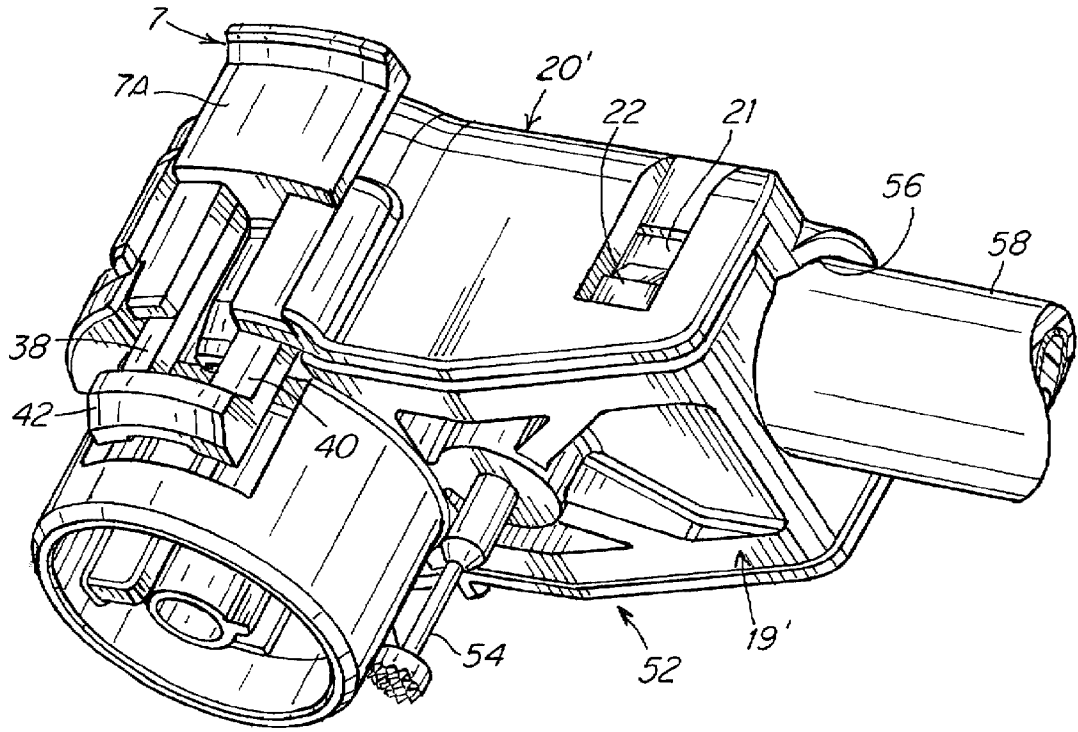


Fig. 10

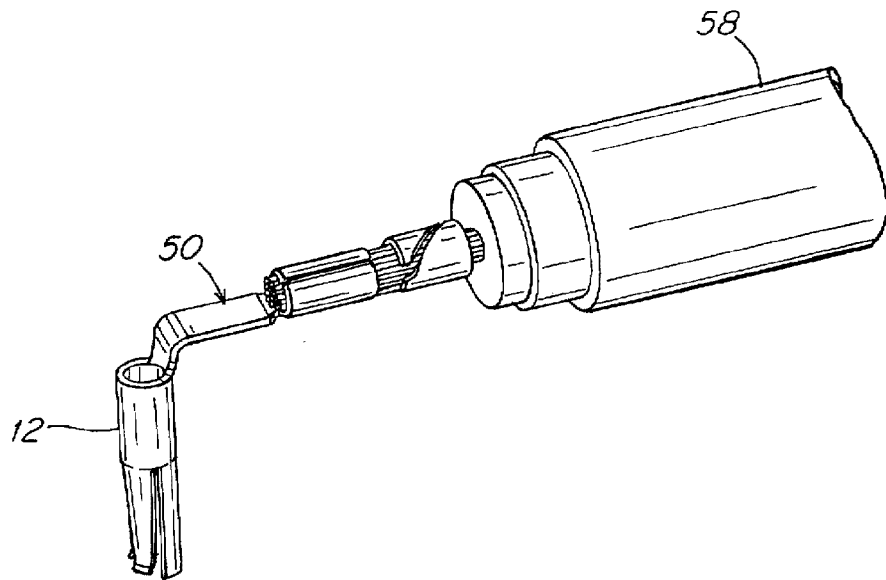


Fig. 11

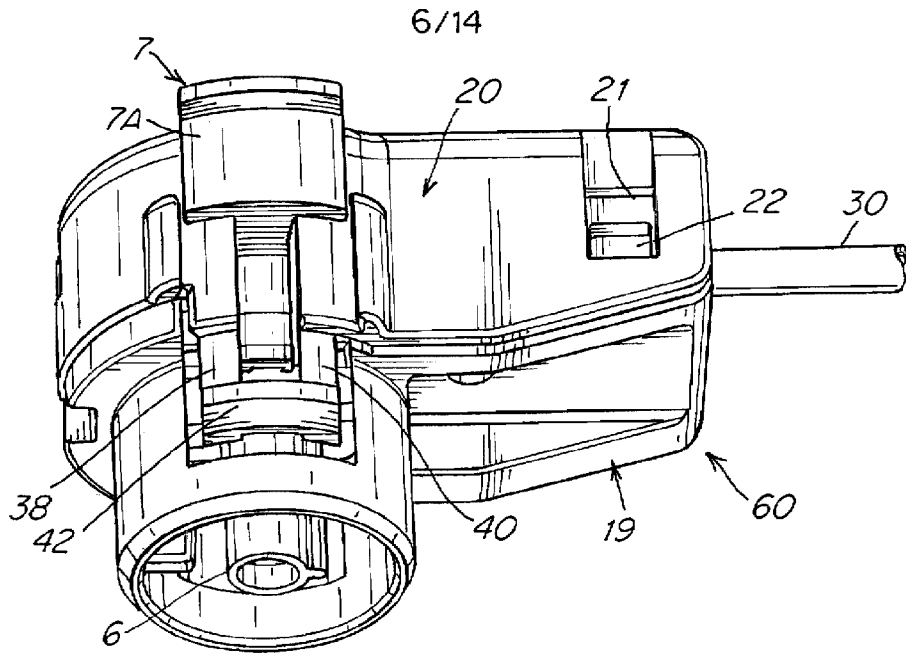


Fig. 12

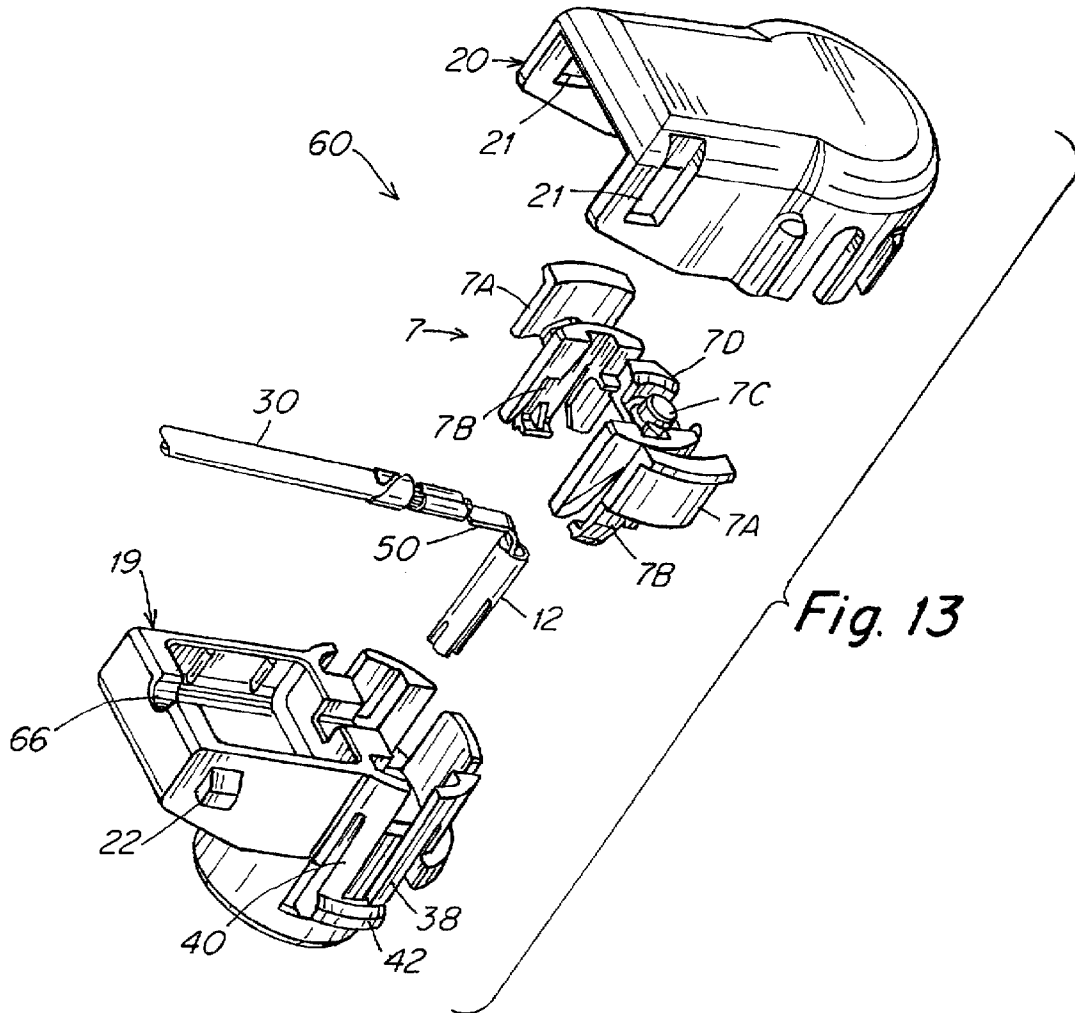


Fig. 13

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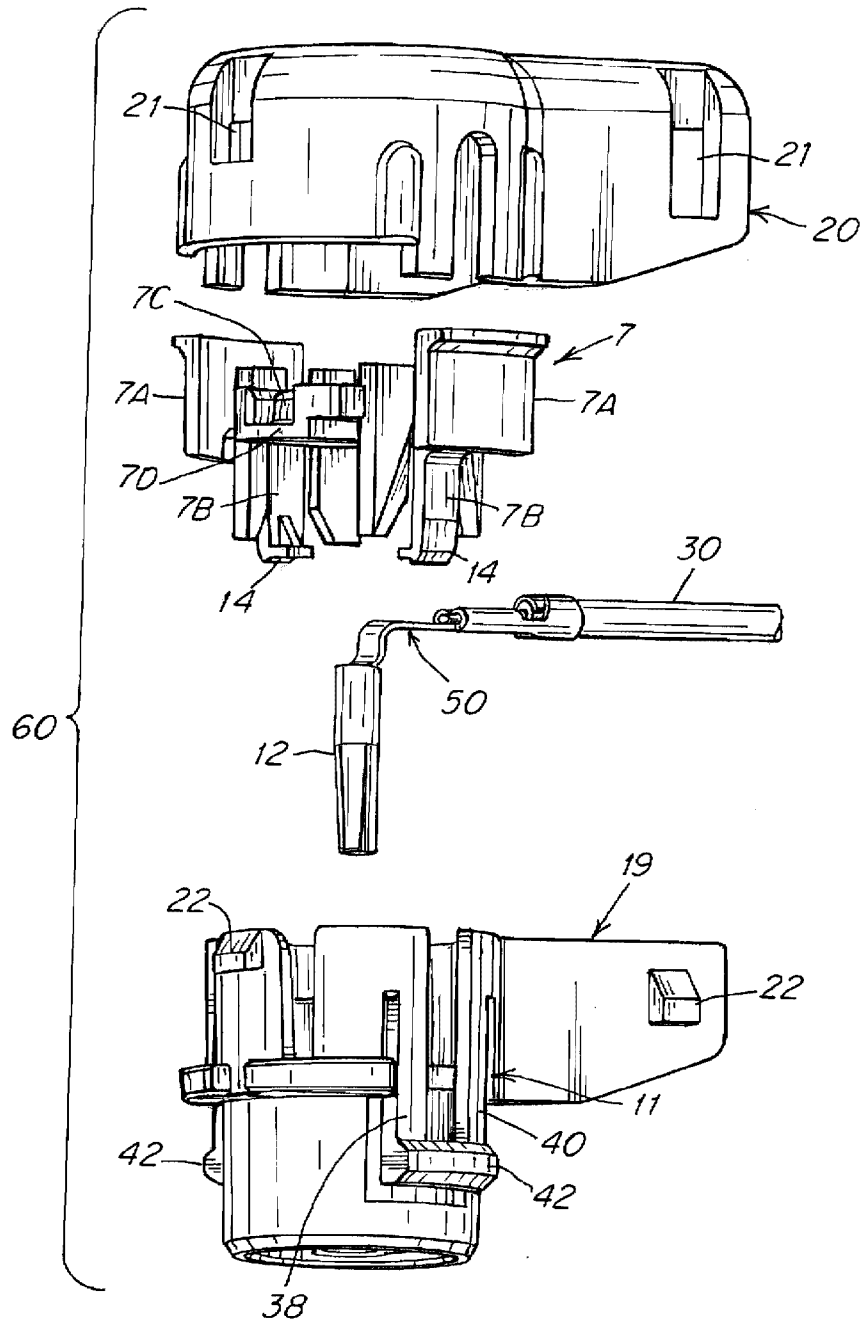


Fig. 14

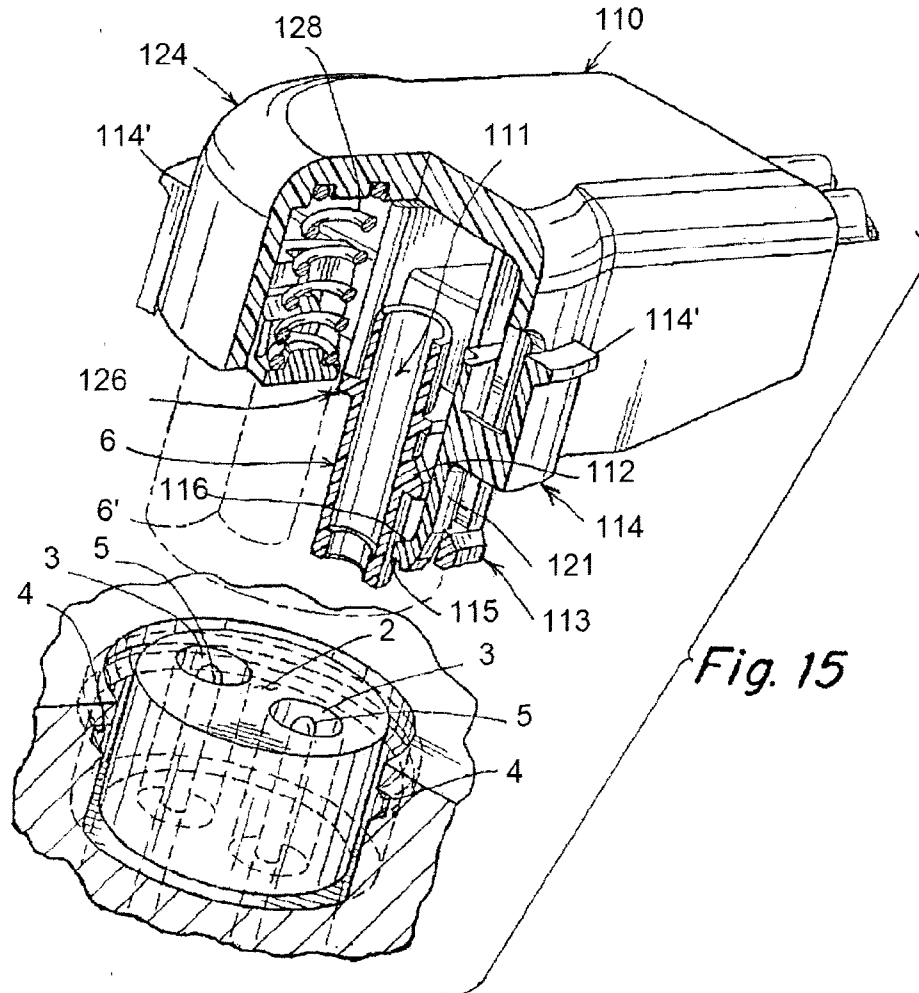


Fig. 15

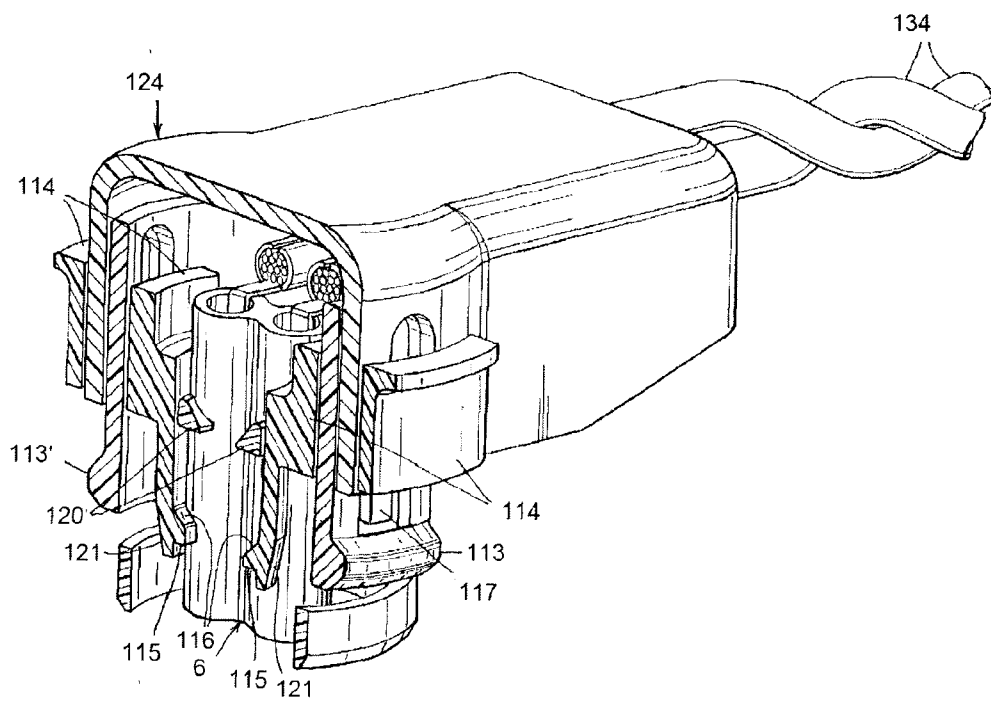


Fig. 16

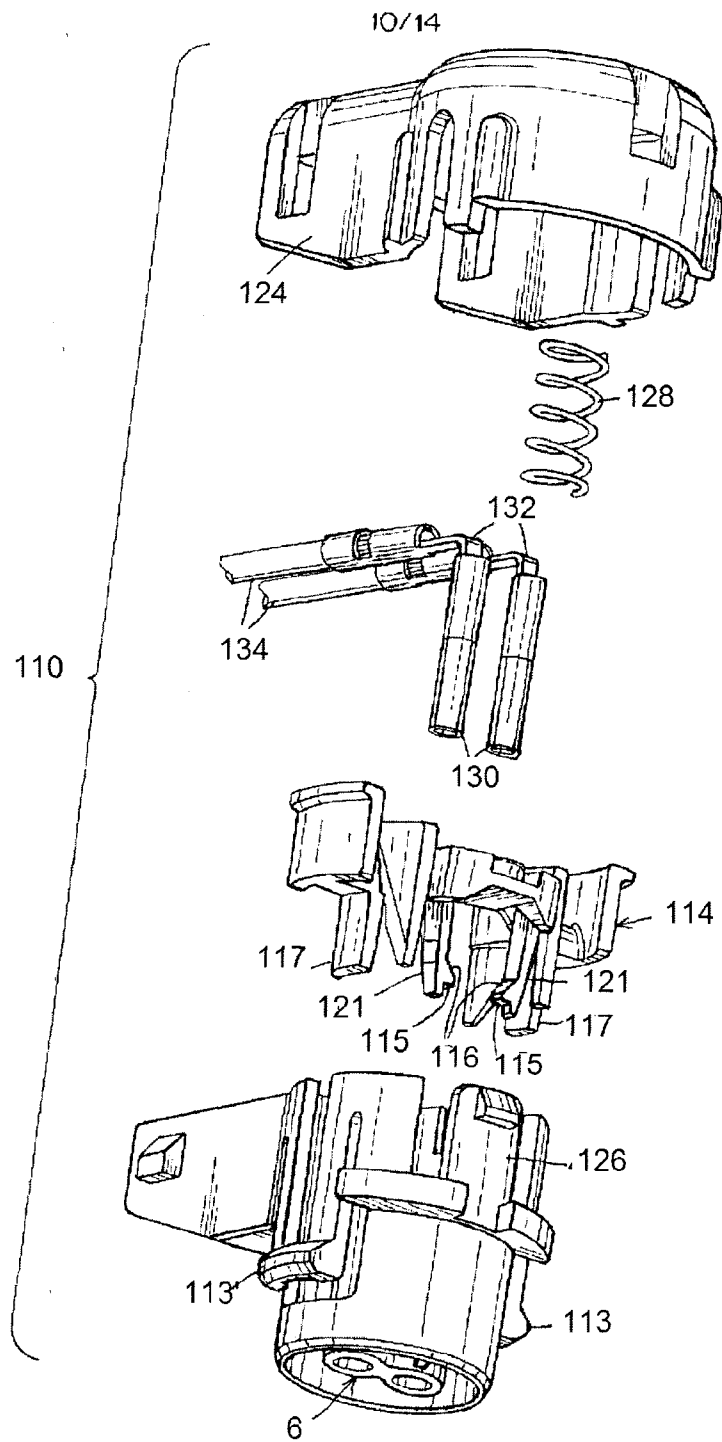


Fig. 17

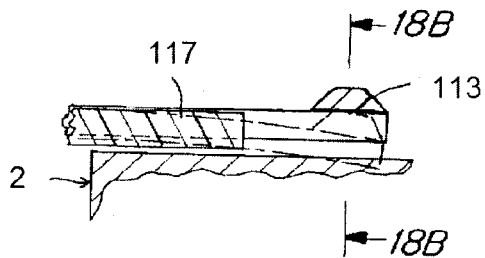


Fig. 18A

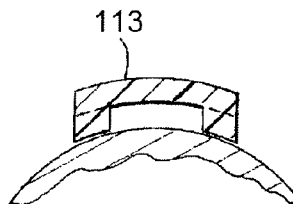


Fig. 18B

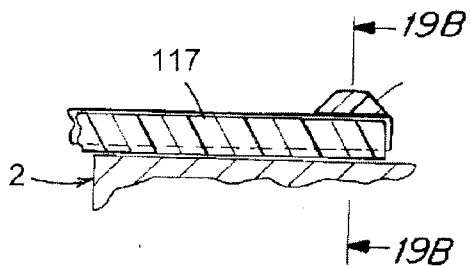


Fig. 19A

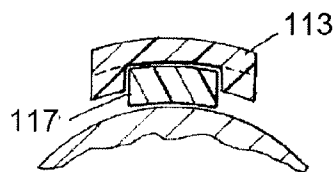


Fig. 19B

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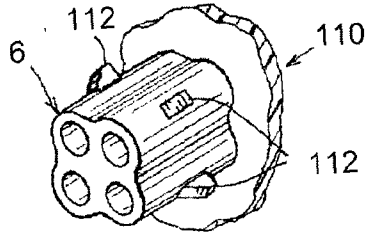


Fig. 20A

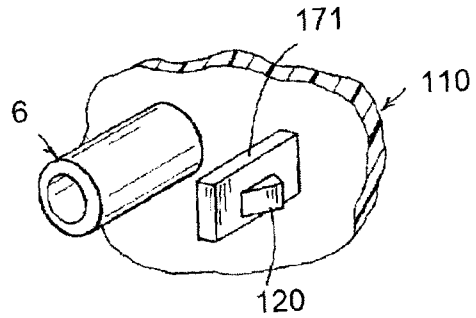


Fig. 20B

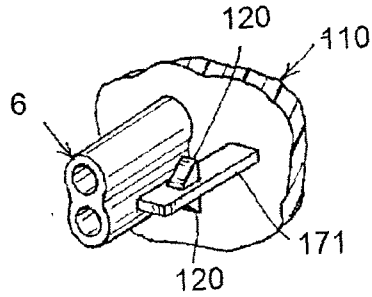


Fig. 20C

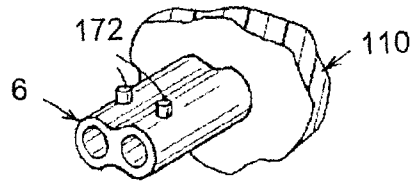


Fig. 20D

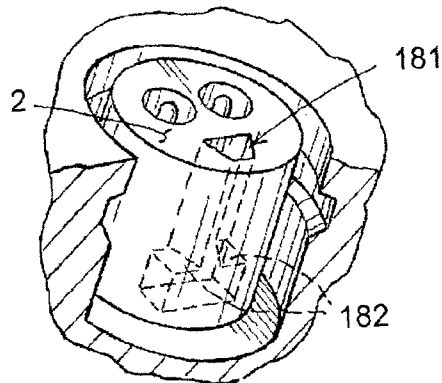


Fig. 21

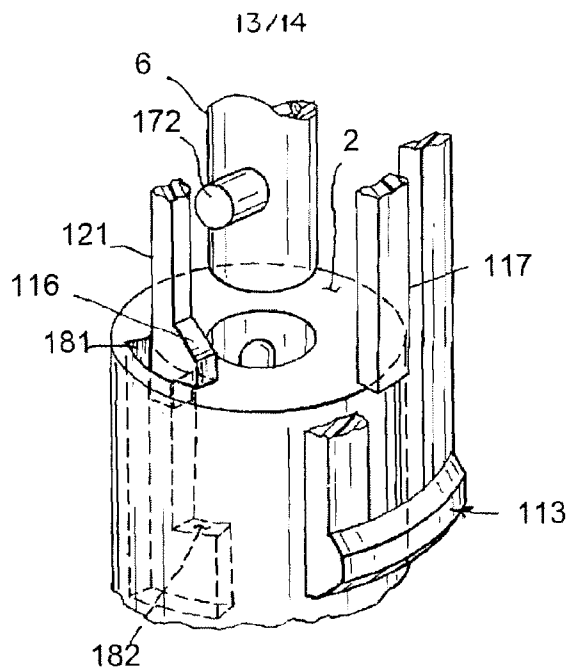


Fig. 22

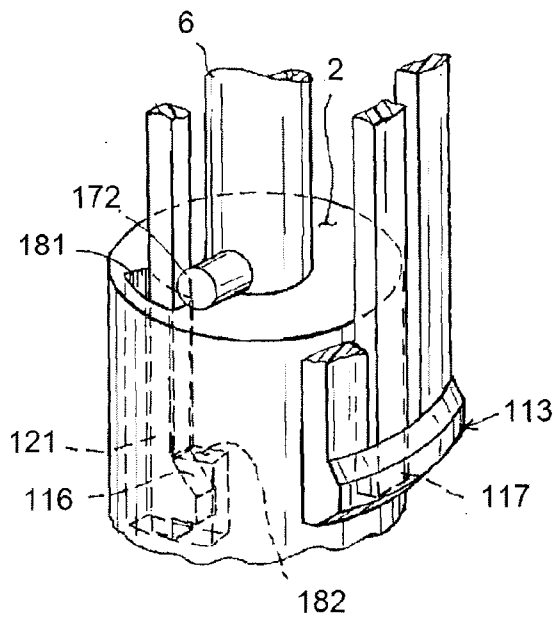


Fig. 23

