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# (54) COAXIAL CABLE CONNECTOR WITH INTEGRAL CONTINUITY CONTACTING PORTION

KOAXIALKABELSTECKER MIT INTEGRIERTEM KONTINUITÄTSKONTAKTTEIL

CONNECTEUR DE CÂBLE COAXIAL À PARTIE INTÉGRÉE DE CONTACT DE CONTINUITÉ

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## Description

### BACKGROUND

#### *Field of the Disclosure*

**[0001]** The disclosure relates generally to coaxial cable connectors, and particularly to a coaxial cable connector having an integral contacting portion that is monolithic with another coaxial cable connector component and provides for continuity between a coaxial cable and an appliance equipment connection port for radio frequency interference (RFI) and grounding shielding other than by a separate continuity member, regardless of the tightness of the coupling of the coaxial cable connector to the appliance equipment connection port, and without restricting the movement of the coupler of the coaxial cable connector when being attached to the appliance equipment connection.

#### *Technical Background*

**[0002]** Coaxial cable connectors, such as type F connectors, are used to attach coaxial cable to another object or appliance, e.g., a television set, DVD player, modem or other electronic communication device having a terminal adapted to engage the connector. The terminal of the appliance includes an inner conductor and a surrounding outer conductor.

**[0003]** Coaxial cable includes a center conductor for transmitting a signal. The center conductor is surrounded by a dielectric material, and the dielectric material is surrounded by an outer conductor. The outer conductor may be in the form of a conductive foil and/or braided sheath. The outer conductor is typically maintained at ground potential to shield the signal transmitted by the center conductor from stray noise, and to maintain a continuous, desired impedance over the signal path. The outer conductor is usually surrounded by a plastic cable jacket that electrically insulates, and mechanically protects, the outer conductor. Prior to installing a coaxial connector onto an end of the coaxial cable, the end of the coaxial cable is typically prepared by stripping off the end portion of the jacket to expose the end portion of the outer conductor. Similarly, it is common to strip off a portion of the dielectric to expose the end portion of the center conductor.

**[0004]** Coaxial cable connectors of the type known in the trade as "F connectors" often include a tubular post designed to slide over the dielectric material, and under the outer conductor of the coaxial cable, at the prepared end of the coaxial cable. If the outer conductor of the cable includes a braided sheath, then the exposed braided sheath is usually folded back over the cable jacket. The cable jacket and folded-back outer conductor extend generally around the outside of the tubular post and are typically received in an outer body of the connector. The outer body of the connector is often fixedly secured to the tubular post. A coupler is typically rotatably secured around the tubular post and includes an internally-threaded region for engaging external threads formed on the outer conductor of the appliance terminal. Alternatively or additionally, the coupler may friction fit, screw and/or latch on to the outer conductor of the appliance terminal.

**[0005]** When connecting the end of a coaxial cable to a terminal of a television set, equipment box, modem, computer or other appliance, it is important to achieve a reliable electrical connection between the outer conductor of the coaxial cable and the outer conductor of the appliance terminal. Typically, this goal is usually achieved by ensuring that the coupler of the connector is fully tightened over the connection port of the appliance. When fully tightened, the head of the tubular post of the connector directly engages the edge of the outer conductor of the appliance port, thereby making a direct electrical ground connection between the outer conductor of the appliance port and the tubular post. The tubular post is engaged with the outer conductor of the coaxial cable.

**[0006]** The increased use of self-install kits provided to home owners by some CATV system operators has resulted in customer complaints due to poor picture quality in video systems and/or poor data performance in computer/internet systems. Additionally, CATV system operators have found upstream data problems induced by entrance of unwanted RF signals into their systems. Complaints of this nature result in CATV system operators having to send a technician to address the issue. Frequently, it is reported by the technician that the cause of the problem is due to a loose F connector fitting, sometimes as a result of inadequate installation of the self-install kit by the homeowner. An improperly installed or loose connector may result in poor signal transfer because there are discontinuities along the electrical path between the devices, resulting in ingress of undesired radio frequency ("RF") signals where RF energy from an external source or sources may enter the connector/cable arrangement causing a signal to noise ratio problem resulting in an unacceptable picture or data performance. Many of the current state of the art F connectors rely on intimate contact between the F male connector interface and the F female connector interface. If, for some reason, the connector interfaces are allowed to pull apart from each other, such as in the case of a loose F male coupler, an interface "gap" may result. If not otherwise protected this gap can be a point of RF ingress as previously described.

**[0007]** As mentioned above, the coupler is typically rotatably secured about the head of the tubular post. The head of the tubular post usually includes an enlarged shoulder, and the coupler typically includes an inwardly-directed flange for extending over and around the shoulder of the tubular post. In order not to interfere with free rotation of the coupler, manufacturers of such F-style connectors routinely make the outer diameter of the shoulder (at the head of the tubular post) of smaller di-

mension than the inner diameter of the central bore of the coupler. Likewise, manufacturers routinely make the inner diameter of the inwardly-directed flange of the coupler of larger dimension than the outer diameter of the non-shoulder portion of the tubular post, again to avoid interference with rotation of the coupler relative to the tubular post. In a loose connection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, an alternate ground path may fortuitously result from contact between the coupler and the tubular post, particularly if the coupler is not centered over, and axially aligned with, the tubular post. However, this alternate ground path is not stable, and can be disrupted as a result of vibrations, movement of the appliance, movement of the cable, or the like.

**[0008]** Alternatively, there are some cases in which such an alternate ground path is provided by fortuitous contact between the coupler and the outer body of the coaxial connector, provided that the outer body is formed from conductive material. This alternate ground path is similarly unstable, and may be interrupted by relative movement between the appliance and the cable, or by vibrations. Moreover, this alternate ground path does not exist at all if the outer body of the coaxial connector is constructed of non-conductive material. Such unstable ground paths can give rise to intermittent failures that are costly and time-consuming to diagnose.

**[0009]** Coaxial cable connectors have attempted to address the above problems by incorporating a continuity member into the coaxial cable connector as a separate component. In this regard, **Figure 1** illustrates a connector **1000** in the prior art having a coupler **2000,** a separate post **3000,** a separate continuity member **4000,** and a body **5000.** In connector **1000** the separate continuity member **4000** is captured between post **3000** and body **5000** and contacts at least a portion of coupler **2000.** Coupler **2000** is preferably made of metal such as brass and plated with a conductive material such as nickel. Post **3000** is preferably made of metal such as brass and plated with a conductive material such as tin. Separate conductive member **4000** is preferably made of metal such as phosphor bronze and plated with a conductive material such as tin. Body **5000** is preferably made of metal such as brass and plated with a conductive material such as nickel.

**[0010]** US 7 371 113 B2 and US 8 075 338 B1 disclose coaxial cable connectors according to the prior art.

## SUMMARY OF THE DETAILED DESCRIPTION

**[0011]** The present invention provides a coaxial cable connector according to claim 1.

**[0012]** Embodiments disclosed herein include a coaxial cable connector for coupling an end of a coaxial cable to a terminal. The connector has a coupler adapted to couple the connector to a terminal, a body assembled with the coupler and a post assembled with the coupler and the body. The post is adapted to receive an end of a coaxial cable. The coupler, the body or the post has an integral contacting portion. The contacting portion is monolithic with at least a portion of at least one of the coupler, the body, and the post. When the connector is coupled to the terminal and a coaxial cable is received by the body, the contacting portion provides for electrical continuity from an outer conductor of the coaxial cable through the connector to the terminal regardless of the tightness of the coupling of the connector to the terminal. Electrical continuity means a DC contact resistance from the outer conductor of the coaxial cable to the equipment port through the connector of less than about 3000 milliohms. Additionally, electrical continuity from an outer conductor of the coaxial cable through the connector to the terminal may be provided other than by a separate continuity component. The contacting portion is constructed of a material having an elastic/plastic property allowing it to maintain electrical and mechanical contact notwithstanding any interstice between components of the connector when assembled. The contacting portion is formable and forms to a contour of at least one of the body and the coupler when the body at least partially assembles with the coupler. The contacting portion may form to at least a partially arcuate shape.

**[0013]** Additional features and advantages are set out in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the embodiments as described herein, including the detailed description, the claims, as well as the appended drawings.

**[0014]** It is to be understood that both the foregoing general description and the following detailed description are merely exemplary, and are intended to provide an overview or framework to understanding the nature and character of the claims. The accompanying drawings are included to provide a further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate one or more embodiment(s), and together with the description serve to explain principles and operation of the various embodiments.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0015]**

**Figure 1** is a side cross sectional view of a coaxial cable connector in the prior art;

**Figure 2** is a side, cross sectional view of an exemplary embodiment of a coaxial connector comprising a post with a contacting portion providing an integral RFI and grounding shield;

**Figure 3A** is side, cross-sectional view of the coaxial cable connector of **Figure 2** in a state of partial assembly;

**Figure 3B** is a partial, cross-sectional detail view of the post of the coaxial cable connector of **Figure 2** in a state of further assembly than as illustrated in **Figure 3A,** and illustrating the contacting portion of

the post beginning to form to a contour of the coupler;

**Figure 3C** is a partial, cross-sectional detail view of the post of the coaxial cable connector of **Figure 2** in a state of further assembly than as illustrated in **Figures 3A** and **3B,** and illustrating the contacting portion of the post continuing to form to a contour of the coupler;

**Figure 3D** is a partial, cross-sectional detail view of the post of the coaxial cable connector of **Figure 2** in a state of further assembly than as illustrated in **Figures 3A, 3B** and **3C** and illustrating the contacting portion of the post forming to a contour of the coupler;

**Figure 4A** is a partial, cross-sectional view of the post of the coaxial cable connector of **Figure 2** in which the post is partially inserted into a forming tool;

**Figure 4B** is a partial, cross-sectional detail view of the post of the coaxial cable connector of **Figure 2** in which the post is inserted into the forming tool further than as illustrated in **Figure 4A** using a forming tool and illustrating the contacting portion of the post beginning to form to a contour of the forming tool;

**Figure 4C** is a partial cross-sectional detail view of the post of the coaxial cable connector of **Figure 2** in in which the post is inserted into the forming tool further than as illustrated in **Figures 4A** and **4B** illustrating the contacting portion of the post continuing to form to the contour of the forming tool;

**Figure 4D** is a partial cross-sectional detail view of the post of the coaxial cable connector of **Figure 2** in which the post is fully inserted into the forming tool and illustrating the contacting portion of the post forming to the contour of the forming tool;

**Figures 5A** through **5H** are front and side schematic views of exemplary embodiments of the contacting portions of the post;

**Figure 6** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector comprising an integral pin, in the state of assembly with body having a contacting portion forming to a contour of the coupler;

**Figure 6A** is a cross-sectional view of the coaxial cable connector illustrated in **Figure 6** in a partial state of assembly illustrating the contacting portion of the body and adapted to form to a contour of the coupler;

**Figure 7** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector comprising an integral pin, wherein the coupler rotates about a body instead of a post and the contacting portion is part of a component press fit into the body and forming to a contour of the coupler;

**Figure 8** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector in a partial state of assembly and comprising an integral pin, wherein the coupler rotates about a body instead of a post and the contacting portion is part of a component press position in the body and forming to a contour of the coupler;

**Figure 8A** is a front and side detail view of the component having the contacting portion of the coaxial cable connector of **Figure 8;**

**Figure 9** is a cross sectional view of an exemplary embodiment of a coaxial cable connector comprising a post-less configuration, and a body having a contacting portion forming to a contour of the coupler;

**Figure 10** is a cross sectional view of an exemplary embodiment of a coaxial cable connector comprising a hex crimp body and a post having a contacting portion forming to a contour of the coupler;

**Figure 11** is an isometric, schematic view of the post of the coaxial cable connector of **Figure 2** wherein the post has a contacting portion in a formed state;

**Figure 12** is an isometric, cross-sectional view of the post and the coupler of the coaxial cable connector of **Figure 2** illustrating the contacting portion of the post forming to a contour of the coupler;

**Figure 13** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector having a coupler with a contacting portion forming to a contour of the post;

**Figure 14** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector having a post with a contacting portion forming to a contour of the coupler;

**Figure 15** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector having a post with a contacting portion forming to a contour behind a lip in the coupler toward the rear of the coaxial cable connector;

**Figure 16** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector having a post with a contacting portion forming to a contour behind a lip in the coupler toward the rear of the coaxial cable connector;

**Figure 17** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector having a body with a contacting portion forming to a contour behind a lip in the coupler toward the rear of the coaxial cable connector;

**Figure 18** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector having a post with a contacting portion forming to a contour of a coupler with an undercut;

**Figure 18A** is a partial, cross-sectional view of an exemplary embodiment of a coaxial cable connector having a post with a contacting portion forming to a contour of a coupler with an undercut having a prepared coaxial cable inserted in the coaxial cable connector;

**Figure 19** is a partial, cross-sectional view of an exemplary embodiment of a coaxial cable connector having a moveable post with a contacting portion wherein the post is in a forward position; and

**Figure 20** is a partial cross sectional view of the co-

axial cable connector of **Figure 19** with the movable post in a rearward position and the contacting portion of the movable post forming to a contour of the coupler.

## DETAILED DESCRIPTION

**[0016]** Reference will now be made in detail to the embodiments, examples of which are illustrated in the accompanying drawings, in which some, but not all embodiments are shown. Indeed, the concepts may be embodied in many different forms and should not be construed as limiting herein. Rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Whenever possible, like reference numbers will be used to refer to like components or parts.

**[0017]** Coaxial cable connectors are used to couple a prepared end of a coaxial cable to a threaded female equipment connection port of an appliance. The coaxial cable connector may have a post, a moveable post or be postless. In each case though, in addition to providing an electrical and mechanical connection between the conductor of the coaxial connector and the conductor of the female equipment connection port, the coaxial cable connector provides a ground path from an outer conductor of the coaxial cable to the equipment connection port. The outer conductor may be, as examples, a conductive foil or a braided sheath. Maintaining a stable ground path protects against the ingress of undesired radio frequency ("RF") signals which may degrade performance of the appliance. This is especially applicable when the coaxial cable connector is not fully tightened to the equipment connection port, either due to not being tightened upon initial installation or due to becoming loose after installation.

**[0018]** For purposes of this description, the term "forward" will be used to refer to a direction toward the portion of the coaxial cable connector that attaches to a terminal, such as an appliance equipment port. The term "rearward" will be used to refer to a direction that is toward the portion of the coaxial cable connector that receives the coaxial cable. The term "terminal" will be used to refer to any type of connection medium to which the coaxial cable connector may be coupled, as examples, an appliance equipment port, any other type of connection port, or an intermediate termination device. Additionally, for purposes herein, electrical continuity shall mean DC contact resistance from the outer conductor of the coaxial cable to the equipment port of less than about 3000 milliohms. Accordingly, a DC contact resistance of more than about 3000 milliohms shall be considered as indicating electrical discontinuity or an open in the path between the outer conductor of the coaxial cable and the equipment port.

**[0019]** Embodiments relate to a coaxial cable connector for coupling an end of a coaxial cable to a terminal. The connector has a coupler adapted to couple the connector to a terminal and a body assembled with the coupler and adapted to receive an end of a coaxial cable. The coaxial cable connector may also have a post. A contacting portion may be integral to one or more of the coupler, the body and/or the post. Moreover, the contacting portion may be integral with a component, that as non-limiting examples, may be one or more of the coupler, the body or the post, either individually or in combination. Additionally, the contacting portion may be of monolithic construction, being formed or constructed in a unitary fashion from a single piece of material, with that component or a portion of that component. In other words, and as a non-limiting example, if the contacting portion is of monolithic construction with the post, the contacting portion may be constructed from a single piece of material with the post or a portion of the post. Additionally, the contacting portion may have or be any shape, including shapes that may be flush or aligned with other portions of the coupler, the body, the post, or another component of the coaxial cable connector, or may protrude from the coupler, the body, the post, or another component of the coaxial cable connector.

**[0020]** Any portion of the coupler, body or post may be formed from any electrically conductive material, either a metal or a non-metal, provided that electrical continuity is maintained from the outer conductor of the coaxial cable through the connector to the equipment port. Further, a non-conductive material, as a non-limiting example, a polymer, with an electrically conductive coating or plating on a portion thereof may be used. Moreover, the body may be completely non-conductive, and electrical continuity from the outer conductor of the coaxial cable through the connector to the equipment port may be maintained through one or more of the other components of the coaxial cable connector.

**[0021]** The contacting portion may have any number of configurations, as non-limiting examples, partially or completely circular, single-cornered, or multi-cornered. When the coaxial cable connector is assembled, coupled to the terminal and a coaxial cable is received by the body, the contacting portion provides for electrical continuity from an outer conductor of the coaxial cable through the connector to the terminal other than by a separate component and regardless of the tightness or adequacy of the coupling of the connector to the terminal. The contacting portion may, but does not have to be at least partially radially projecting. The contacting portion may be formable and form to a contour of at least one of the body and the coupler. The contacting portion may form to at least a partially arcuate shape. Additionally and/or alternatively, the contacting portion may form in response to a forming tool. Further, a lubricant or grease, in particular a conductive lubricant or grease, may be applied to the contacting portion.

**[0022]** Embodiments also relate to a method of providing uninterrupted electrical continuity in a coaxial cable connector. The method includes providing components of a coaxial cable connector. At least one of the components has a formable electrical continuity portion. The

method also includes assembling the components to provide a coaxial cable connector. The assembling forms the electrical continuity portion to a contour of one of the other components. The components may be comprised from the group consisting of a coupler, a body, and a post. The method further includes receiving by one of the components a coaxial cable, and coupling by one of the components the coaxial cable connector to a terminal. The contacting portion provides for electrical continuity from an outer conductor of the coaxial cable through the connector to the terminal other than by a separate component, and is regardless of the tightness or adequacy of the coupling of the connector to the terminal.

**[0023]** Referring now to **Figure 2,** there is illustrated an exemplary embodiment of a coaxial cable connector **100.** The coaxial cable connector **100** has a front end **105,** a back end **195,** a coupler **200,** a post **300,** a body **500, a** shell **600** and a gripping member **700.** The coupler **200** at least partially comprises a front end **205,** a back end **295,** a central passage **210,** a lip **215** with a forward facing surface **216** and a rearward facing surface **217,** a through-bore **220** formed by the lip **215,** and a bore **230.** Coupler **200** is preferably made of metal such as brass and plated with a conductive material such as nickel. Alternately or additionally, selected surfaces of the coupler **200** may be coated with conductive or non-conductive coatings or lubricants, or a combinations thereof. Post **300,** may be tubular, at least partially comprises a front end **305,** a back end **395,** and a contacting portion **310.** In **Figure 2,** Contacting portion **310** is shown as a protrusion integrally formed and monolithic with post **300.** Contacting portion **310** may, but does not have to be, radially projecting. Post **300** may also comprise an enlarged shoulder **340,** a collar portion **320,** a through-bore **325,** a rearward facing annular surface **330,** and a barbed portion **335** proximate the back end **395.** The post **300** is preferably made of metal such as brass and plated with a conductive material such as tin. Additionally, the material, in an exemplary embodiment, may have a suitable spring characteristic permitting contacting portion **310** to be flexible, as described below. Alternately or additionally, selected surfaces of post **300** may be coated with conductive or non-conductive coatings or lubricants or a combination thereof Contacting portion **310,** as noted above, is monolithic with post **300** and provides for electrical continuity through the connector **100** to an equipment port (not shown in **Figure 2**) to which connector **100** may be coupled. In this manner, post **300** provides for a stable ground path through the connector **100,** and, thereby, electromagnetic shielding to protect against the ingress and egress of RF signals. Body **500** at least partially comprises a front end **505,** a back end **595,** and a central passage **525.** Body **500** is preferably made of metal such as brass and plated with a conductive material such as nickel. Shell **600** at least partially comprises a front end **605,** a back end **695,** and a central passage **625.** Shell **600** is preferably made of metal such as brass and plated with a conductive material such as nickel. Gripping member **700** at least partially comprises a front end **705,** a back end **795,** and a central passage **725.** Gripping member **700** is preferably made of a suitable polymer material such as acetal or nylon. The resin can be selected from thermoplastics characterized by good fatigue life, low moisture sensitivity, high resistance to solvents and chemicals, and good electrical properties.

**[0024]** In **Figure 2,** coaxial cable connector **100** is shown in an unattached, uncompressed state, without a coaxial cable inserted therein. Coaxial cable connector **100** couples a prepared end of a coaxial cable to a terminal, such as a threaded female equipment appliance connection port (not shown in **Figure 2**). This will be discussed in more detail with reference to **Figure 18A.** Shell **600** slideably attaches to body **500** at back end **595** of body **500.** Coupler **200** attaches to coaxial cable connector **100** at back end **295** of coupler **200.** Coupler **200** may rotatably attach to front end **305** of post **300** while engaging body **500** by means of a press-fit. Front end **305** of post **300** positions in central passage **210** of coupler **200** and has a back end **395** which is adapted to extend into a coaxial cable. Proximate back end **395,** post **300** has a barbed portion **335** extending radially outwardly from post **300.** An enlarged shoulder **340** at front end **305** extends inside the coupler **200.** Enlarged shoulder **340** comprises a collar portion **320** and a rearward facing annular surface **330.** Collar portion **320** allows coupler **200** to rotate by means of a clearance fit with through-bore **220** of coupler **200.** Rearward facing annular surface **330** limits forward axial movement of the coupler **200** by engaging forward facing surface **216** of lip **215.** Coaxial cable connector **100** may also include a sealing ring **800** seated within coupler **200** to form a seal between coupler **200** and body **500.**

**[0025]** Contacting portion **310** may be monolithic with or a unitized portion of post **300.** As such, contacting portion **310** and post **300** or a portion of post **300** may be constructed from a single piece of material. The contacting portion **310** may contact coupler **200** at a position that is forward of forward facing surface **216** of lip **215.** In this way, contacting portion **310** of post **300** provides an electrically conductive path between post **300,** coupler **200** and body **500.** This enables an electrically conductive path from coaxial cable through coaxial cable connector **100** to terminal providing an electrical ground and a shield against RF ingress and egress. Contacting portion **310** is formable such that as the coaxial cable connector **100** is assembled, contacting portion **310** may form to a contour of coupler **200.** In other words, coupler **200** forms or shapes contacting portion **310** of post **300.** The forming and shaping of the contacting portion **310** may have certain elastic/plastic properties based on the material of contacting portion **310.** Contacting portion **310** deforms , upon assembly of the components of coaxial cable connector **100,** or, alternatively contacting portion **310** of post **300** may be pre-formed, or partially preformed to electrically contactedly fit with coupler **200** as explained in greater detail with reference to **Figure 4A**

through **Figure 4D,** below. In this manner, post **300** is secured within coaxial cable connector **100,** and contacting portion **310** establishes an electrically conductive path between body **500** and coupler **200.** Further, the electrically conductive path remains established regardless of the tightness of the coaxial cable connector **100** on the terminal due to the elastic/plastic properties of contacting portion **310.** This is due to contacting portion **310** maintaining mechanical and electrical contact between components, in this case, post **300** and coupler **200,** notwithstanding the size of any interstice between the components of the coaxial cable connector **100.** In other words, contacting portion **310** is integral to and maintains the electrically conductive path established between post **300** and coupler **200** even when the coaxial cable connector **100** is loosened and/or partially disconnected from the terminal, provided there is some contact of coupler **200** with equipment port. Although coaxial connector **100** in **Figure 2** is an axial-compression type coaxial connector having a post **300,** contacting portion **310** may be integral to and monolithic with any type of coaxial cable connector and any other component of a coaxial cable connector, examples of which will be discussed herein with reference to the embodiments. However, in all such exemplary embodiments, contacting portion **310** provides for electrical continuity from an outer conductor of a coaxial cable received by coaxial cable connector **100** through coaxial cable connector **100** to a terminal, without the need for a separate component. Additionally, the contacting portion **310** provides for electrical continuity regardless of how tight or loose the coupler is to the terminal. In other words, contacting portion **310** provides for electrical continuity from the outer conductor of the coaxial cable to the terminal regardless and/or irrespective of the tightness or adequacy of the coupling of the coaxial cable connector **100** to the terminal. It is only necessary that the coupler **200** be in contact with the terminal.

**[0026]** Referring now to **Figures 3A, 3B 3C** and **3D,** post **300** is illustrated in different states of assembly with coupler **200** and body **500.** In **Figure 3A,** post **300** is illustrated partially assembled with coupler **200** and body **500** with contacting portion **310** of post **300,** shown as a protrusion, outside and forward of coupler **200.** Contacting portion **310** may, but does not have to be, radially projecting. In **Figure 3B,** contacting portion **310** has begun to advance into coupler **200** and contacting portion **310** is beginning to form to a contour of coupler **200.** As illustrated in **Figure 3B,** contacting portion **310** is forming to an arcuate or, at least, a partially arcuate shape. As post **300** is further advanced into coupler **200** as shown in **Figure 3C,** contacting portion **310** continues to form to the contour of coupler **200.** When assembled as shown in **Figure 3D,** contacting portion **310** is forming to the contour of coupler **200** and is contactedly engaged with bore **230** accommodating tolerance variations with bore **230.** In **Figure 3D** coupler **200** has a face portion **202** that tapers. The face portion **202** guides the contacting portion **310** to its formed state during assembly in a manner that does not compromise its structural integrity, and, thereby, its elastic/plastic property. Face portion **202** may be or have other structural features, as a non-limiting example, a curved edge, to guide the contacting portion **310.** The flexible or resilient nature of the contacting portion **310** in the formed state as described above, permits coupler **200** to be easily rotated and yet maintain a reliable electrically conductive path. It should be understood, that contacting portion **310** is formable and, as such, may exist in an unformed and a formed state based on the elastic/plastic property of the material of contacting portion **310.** As the coaxial cable connector **100** assembles contacting portion **310** transition from an unformed state to a formed state.

**[0027]** Referring now to **Figures 4A, 4B, 4C** and **4D** the post **300** is illustrated in different states of insertion into a forming tool **900.** In **Figure 4A,** post **300** is illustrated partially inserted in forming tool **900** with contacting portion **310** of post **300** shown as a protrusion. Protrusion may, but does not have to be radially projecting. In **Figure 4B,** contacting portion **310** has begun to advance into forming tool **900.** As contacting portion **310** is advanced into forming tool **900,** contact portion **310** begins flexibly forming to a contour of the interior of forming tool **900.** As illustrated in **Figure 4B,** contacting portion **310** is forming to an arcuate or, at least, a partially arcuate shape. As post **300** is further advanced into forming tool **900** as shown in Figure **4C,** contacting portion **310** continues forming to the contour of the interior of forming tool **900.** At a final stage of insertion as shown in Figure **4C** contacting portion **310** is fully formed to the contour of forming tool **900,** and has experienced deformation in the forming process but retains spring or resilient characteristics based on the elastic/plastic property of the material of contacting portion **310.** Upon completion or partial completion of the forming of contacting portion **310,** post **300** is removed from forming tool **900** and may be subsequently installed in the connector **100** or other types of coaxial cable connectors. This manner of forming or shaping contacting portion **310** to the contour of forming tool **900** may be useful to aid in handling of post **300** in subsequent manufacturing processes, such as plating for example. Additionally, use of this method makes it possible to achieve various configurations of contacting portion **310** formation as illustrated in **Figures 5A** through **5H. Figure 5A** is a side schematic view of an exemplary embodiment of post **300** where contacting portion **310** is a radially projecting protrusion that completely circumscribes post **300.** In this view, contacting portion **310** is formable but has not yet been formed to reflect a contour of coaxial cable connector or forming tool. Figure **5B** is a front schematic view of the post **300** of Figure **5. Figure 5C** is a side schematic view of an exemplary embodiment of post **300** where contacting portion **310** has a multi-cornered configuration. Contacting portion **310** may be a protrusion and may, but does not have to be, radially projecting. Although in **Figure 5C** contacting portion **310**

is shown as tri-cornered, contacting portion **310** can have any number of corner configurations, as non-limiting examples, two, three, four, or more. In **Figure 5C,** contacting portion **310** may be formable but has not yet been formed to reflect a contour of coaxial cable connector or forming tool. **Figure 5D** is a front schematic view of post **300** of **Figure 5C.** Figure **5E** is a side schematic view of post **300** where contacting portion **310** has a tri-cornered configuration. In this view, contacting portion **310** is shown as being formed to a shape in which contacting portion 310 cants or slants toward the front end **305** of post **300.** Figure **5F** is a front schematic view of post **300** of **Figure 5E. Figure 5G** is a side schematic view of an exemplary embodiment of post **300** where contacting portion **310** has a tri-cornered configuration. In this view contacting portion **310** is formed in a manner differing from **Figure 5E** in that indentations **311** in contacting portion **310** result in a segmented or reduced arcuate shape **313. Figure 5H** is a front schematic view of post **300** of **Figure 5G.**

**[0028]** It will be apparent to those skilled in the art that contacting portion **310** as illustrated in **Figures 2-5H** may be integral to and monolithic with post **300.** Additionally, contacting portion **310** may have or be any shape, including shapes that may be flush or aligned with other portions of post **300,** or may have any number of configurations, as non-limiting examples, configurations ranging from completely circular to multi-cornered geometries, and still perform its function of providing electrical continuity. Further, contacting portion **310** may be formable and formed to any shape or in any direction.

**[0029]** **Figure 6** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector **110** comprising an integral pin **805,** wherein coupler **200** rotates about body **500** instead of post **300** and contacting portion **510** is a protrusion from, integral to and monolithic with body **500** instead of post **300.** In this regard, contacting portion **510** may be a unitized portion of body **500.** As such, contacting portion **510** may be constructed with body **500** or a portion of body **500** from a single piece of material. Coaxial cable connector **110** is configured to accept a coaxial cable. Contacting portion **510** may be formed to a contour of coupler **200** as coupler **200** is assembled with body **500** as illustrated in **Figure 6A. Figure 6A** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector **110** in a state of partial assembly. Contacting portion **510** has not been formed to a contour of the coupler **200.** Assembling the coupler **200** with the body **500** forms the contacting portion **510** in a rearward facing manner as opposed to a forward facing manner as is illustrated with the contacting portion **310.** However, as with contacting portion **310,** the material of contacting portion **510** has certain elastic/plastic property which, as contacting portion **510** is formed provides that contacting portion **510** will press against the contour of the coupler **200** and maintain mechanical and electrical contact with coupler **200.** Contacting portion **510** provides for electrical continuity from the outer conductor of the coaxial cable to the terminal regardless of the tightness or adequacy of the coupling of the coaxial cable connector **100** to the terminal, and regardless of the tightness of the coaxial cable connector **100** on the terminal in the same way as previously described with respect to contacting portion **310.** Additionally or alternatively, contacting portion **310** may be cantilevered or attached at only one end of a segment.

**[0030]** **Figure 7** is a cross-sectional view of an exemplary embodiment of a coaxial cable connector **111** comprising an integral pin **805,** and a conductive component **400.** Coupler **200** rotates about body **500** instead of about a post, which is not present in coaxial cable connector **111.** Contacting portion **410** is shown as a protrusion and may be integral to, monolithically with and radially projecting from a conductive component **400** which is press fit into body **500.** Contacting portion **410** may be a unitized portion of conductive component **400.** As such, the contacting portion **410** may be constructed from a single piece of material with conductive component **400** or a portion of conductive component **400.** As with contacting portion **310,** the material of contacting portion **410** has certain elastic/plastic property which, as contacting portion **410** is formed provides that contacting portion **410** will press against the contour of the coupler **200** and maintain mechanical and electrical contact with coupler **200** as conductive component **400** inserts in coupler **200** when assembling body **500** with coupler **200** as previously described.

**[0031]** **Figure 8** is a cross-sectional view of another exemplary embodiment of the coaxial cable connector **111** comprising an integral pin **805,** and a retaining ring **402.** The coupler **200** rotates about body **500** instead of a post. Contacting portion **410** may be integral with and radially projecting from a retaining ring **402** which fits into a groove formed in body **500.** The contacting portion **410** may be a unitized portion of the retaining ring **402.** As such, the contacting portion **410** may be constructed from a single piece of material with the retaining ring **402** or a portion of the retaining ring **402.** In this regard, **Figure 8A** illustrates front and side views of the retaining ring **402.** In **Figure 8A,** contacting portion **410** is shown as three protrusions integral with and radially projecting from retaining ring **402.** As discussed above, the material of contacting portion **410** has certain elastic/plastic property which, as contacting portion **410** is formed provides that contacting portion **410** will press against the contour of the coupler **200** and maintain mechanical and electrical contact with coupler **200** as retaining ring **402** inserts in coupler **200** when assembling body **500** with coupler **200** as previously described.

**[0032]** It will be apparent to those skilled in the art that the contacting portion **410** as illustrated in **Figures 6-8A** may be integral to the body **500** or may be attached to or be part of another component **400, 402.** Additionally, the contacting portion **410** may have or be any shape, including shapes that may be flush or aligned with other portions of the body **500** and/or another component **400,**

**402,** or may have any number of configurations, as non-limiting examples, configurations ranging from completely circular to multi-cornered geometries.

**[0033]** **Figure 9** is a cross-sectional view of an embodiment of a coaxial cable connector **112** that is a compression type of connector with no post. In other words, having a post-less configuration. The coupler **200** rotates about body **500** instead of a post. The body **500** comprises contacting portion **510.** The contacting portion **510** is integral with the body **500.** As such, the contacting portion **510** may be constructed from a single piece of material with the body **500** or a portion of the body **500.** The contacting portion **510** forms to a contour of the coupler **200** when the coupler **200** is assembled with the body **500.**

**[0034]** **Figure 10** is a cross-sectional view of an embodiment of a coaxial cable connector **113** that is a hex-crimp type connector. The coaxial cable connector **113** comprises a coupler **200,** a post **300** with a contacting portion **310** and a body **500.** The contacting portion **310** is integral to and monolithic with post **300.** Contacting portion **310** may be unitized with post **300.** As such, contacting portion **310** may be constructed from a single piece of material with post **300** or a portion of post **300.** Contacting portion **310** forms to a contour of coupler **200** when coupler **200** is assembled with body **500** and post **300.** The coaxial cable connector **113** attaches to a coaxial cable by means radially compressing body **500** with a tool or tools known in the industry.

**[0035]** **Figure 11** is an isometric schematic view of post **300** of coaxial cable connector **100** in **Figure 2** with the contacting portion **310** formed to a position of a contour of a coupler (not shown).

**[0036]** **Figure 12** is an isometric cross sectional view of post **300** and coupler **200** of connector **100** in **Figure 2** illustrated assembled with the post **300.** The contacting portion **310** is formed to a contour of the coupler **200.**

**[0037]** **Figure 13** is a cross-sectional view of an embodiment of a coaxial cable connector **114** comprising a post **300** and a coupler **200** having a contacting portion **310.** Contacting portion **310** is shown as an inwardly directed protrusion. Contacting portion **310** is integral to and monolithic with coupler **200** and forms to a contour of post **300** when post **300** assembles with coupler **200.** Contacting portion **310** may be unitized with coupler **200.** As such, contacting portion **310** may be constructed from a single piece of material with coupler **200** or a portion of coupler **200.** Contacting portion **310** provides for electrical continuity from the outer conductor of the coaxial cable to the terminal regardless of the tightness or adequacy of the coupling of the coaxial cable connector **114** to the terminal, and regardless of the tightness of coaxial cable connector **114** on the terminal.

Contacting portion **310** may have or be any shape, including shapes that may be flush or aligned with other portions of coupler **200,** or may have and/or be formed to any number of configurations, as non-limiting examples, configurations ranging from completely circular to multi-cornered geometries.

**[0038]** **Figures 14, 15** and **16** are cross-sectional views of embodiments of coaxial cable connectors **115** with a post similar to post **300** comprising a contacting portion **310** as described above such that the contacting portion **310** is shown as outwardly radially projecting, which forms to a contour of the coupler **200** at different locations of the coupler **200.** Additionally, the contacting portion **310** may contact the coupler **200** rearward of the lip **215,** for example as shown in **Figures 15** and **16,**, which may be at the rearward facing surface **217** of the lip **215,** for example as shown in **Figure 15.**

**[0039]** **Figure 17** is a cross-sectional view of an embodiment of a coaxial cable connector **116** with a body **500** comprising a contacting portion **310,** wherein the contacting portion **310** is shown as an outwardly directed protrusion from body **500** that forms to the coupler **200.**

**[0040]** **Figure 18** is a cross-sectional view of an embodiment of a coaxial cable connector **117** having a post **300** with an integral contacting portion **310** and a coupler **200** with an undercut **231.** The contacting portion **310** is shown as a protrusion that forms to the contours of coupler **200** at the position of undercut **231. Figure 18A** is a cross-sectional view of the coaxial cable connector **117** as shown in **Figure 18** having a prepared coaxial cable inserted in the coaxial cable connector **117.** The body **500** and the post **300** receive the coaxial cable (**Figure 18A**). The post **300** at the back end **395** is inserted between an outer conductor and a dielectric layer of the coaxial cable.

**[0041]** **Figure 19** is a partial, cross-sectional view of an embodiment of a coaxial cable connector **118** having a post **301** comprising an integral contacting portion **310.** The movable post **301** is shown in a forward position with the contacting portion **310** not formed by a contour of the coupler **200. Figure 20** is a partial, cross-sectional view of the coaxial cable connector **118** shown in **Figure 19** with the post **301** in a rearward position and the contacting portion **310** forming to a contour of the coupler **200.**

**[0042]** Many modifications and other embodiments set forth herein will come to mind to one skilled in the art to which the embodiments pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the description and claims are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. It is intended that the embodiments cover the modifications and variations of the embodiments provided they come within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

## Claims

1. A coaxial cable connector (100) for coupling an end of a coaxial cable to a terminal, the coaxial cable

comprising an inner conductor, a dielectric surrounding the inner conductor, an outer conductor surrounding the dielectric, and a jacket surrounding the outer conductor, the connector comprising:

a coupler (200) adapted to couple the connector to a terminal,
a body (500) assembled with the coupler (200), and
a post (300) assembled with the coupler (200) and the body (500), wherein the post (300) is adapted to receive an end of a coaxial cable,
wherein at least one of the coupler (200), the body (500) and the post (300) comprises an integral contacting portion (310, 510), and wherein the contacting portion (310, 510) is monolithic with at least a portion of the at least one of the coupler (200), the body (500) and the post (200), and wherein when the connector is coupled to the terminal and a coaxial cable is received by the body (500), the contacting portion provides for electrical continuity from an outer conductor of the coaxial cable through the connector to the terminal regardless of the tightness of the coupling of the connector to the terminal,
**characterized in that**
the coupler (200) comprises a lip (215) extending into a central passage defined by the coupler (200);
the post (300) comprises a shoulder (340) disposed at a front end (305) of the post (300);
the integral contacting portion (310, 510) is disposed between the shoulder (340) of the post (300) and the lip (215) of the coupler (200), the integral contacting portion (310, 510) extending between the coupler (200) and post (300).

**2.** The connector of claim 1, wherein electrical continuity from an outer conductor of the coaxial cable through the connector to the terminal is provided other than by a separate continuity component.

**3.** The connector of claim 1 or 2, wherein the contacting portion (310, 510) is constructed of a material having an elastic/plastic property allowing it to maintain electrical and mechanical contact notwithstanding any interstice between components of the connector when assembled.

**4.** The connector of any of claims 1-3, wherein the contacting portion (310, 510) is formable.

**5.** The connector of claim 4, wherein the contacting portion (310, 510) forms to a contour of at least one of the coupler (200) and the post when the post (300) is at least partially assembled with the coupler (200).

**6.** The connector of claim 4, wherein the contacting portion (310, 510) forms (to a contour of at least one of the body (500) and the post (300) when the post (300) is at least partially assembled with the body (500).

**7.** The connector of any of claims 4-6, wherein the contacting portion (310, 510) forms to at least a partially arcuate shape.

**Patentansprüche**

**1.** Koaxialkabelstecker (100) zum Koppeln eines Endes eines Koaxialkabels mit einem Anschluss, wobei das Koaxialkabel einen Innenleiter, ein den Innenleiter umgebendes Dielektrikum, einen das Dielektrikum umgebenden Außenleiter und einen den Außenleiter umgebenden Mantel aufweist, wobei der Stecker aufweist:

ein Verbindungsstück (200), das dazu ausgebildet ist, den Stecker mit einem Anschluss zu koppeln,
einen Körper (500), der mit dem Verbindungsstück (200) zusammengefügt ist, und
einen Stab (300), der mit dem Verbindungsstück (200) und dem Körper (500) zusammengefügt ist, wobei der Stab (300) dazu ausgebildet ist, ein Ende eines Koaxialkabels aufzunehmen,
wobei mindestens eines des Verbindungsstücks (200), des Körpers (500) und des Stabs (300) einen integrierten Kontaktteil (310, 510) umfasst, und wobei der Kontaktteil (310, 510) monolithisch mit mindestens einem Teil des mindestens einen des Verbindungsstücks (200), des Körpers (500) und des Stabs (200) ausgebildet ist, und wobei, wenn der Stecker mit dem Anschluss gekoppelt ist und ein Koaxialkabel von dem Körper (500) aufgenommen wird, der Kontaktteil elektrische Durchgängigkeit von einem Außenleiter des Koaxialkabels durch den Stecker zu dem Anschluss ungeachtet der Festigkeit der Kopplung des Steckers mit dem Anschluss gewährleistet,
**dadurch gekennzeichnet, dass**
das Verbindungsstück (200) eine Lippe (215) aufweist, die sich in einen durch das Verbindungsstück (200) definierten zentralen Durchgang erstreckt;
der Stab (300) eine Schulter (340) aufweist, die an einem vorderen Ende (305) des Stabs (300) angeordnet ist;
der integrierte Kontaktteil (310, 510) zwischen der Schulter (340) des Stabs (300) und der Lippe (215) des Verbindungsstücks (200) angeordnet ist, wobei sich der integrierte Kontaktteil (310, 510) zwischen dem Verbindungsstück (200) und dem Stab (300) erstreckt.

2. Stecker nach Anspruch 1, wobei elektrische Durchgängigkeit von einem Außenleiter des Koaxialkabels durch den Stecker zu dem Anschluss auf andere Weise als durch ein separates Kontinuitätsbauteil bereitgestellt wird.

3. Stecker nach Anspruch 1 oder 2, wobei der Kontaktteil (310, 510) aus einem Material hergestellt ist, das eine elastische/plastische Eigenschaft aufweist, die ermöglicht, dass elektrischer und mechanischer Kontakt ungeachtet jeglichen Zwischenraums zwischen Bauteilen des Steckers, wenn zusammengefügt, aufrechterhalten wird.

4. Stecker nach einem der Ansprüche 1-3, wobei der Kontaktteil (310, 510) verformbar ist.

5. Stecker nach Anspruch 4, wobei sich der Kontaktteil (310, 510) entsprechend einer Kontur des Verbindungsstücks (200) und/oder des Stabs formt, wenn der Stab (300) mindestens teilweise mit dem Verbindungsstück (200) zusammengefügt ist.

6. Stecker nach Anspruch 4, wobei sich der Kontaktteil (310, 510) entsprechend einer Kontur des Körpers (500) und/oder des Stabs (300) formt, wenn der Stab (300) zumindest teilweise mit dem Körper (500) zusammengefügt ist.

7. Stecker nach einem der Ansprüche 4-6, wobei sich der Kontaktteil (310, 510) entsprechend mindestens einer teilweise gebogenen Gestalt formt.

**Revendications**

1. Connecteur de câble coaxial (100) pour coupler une extrémité d'un câble coaxial à une borne, ce câble coaxial comprenant un conducteur intérieur, un diélectrique entourant le conducteur intérieur, un conducteur extérieur entourant le diélectrique, et une gaine entourant le conducteur extérieur, ce connecteur comprenant :

   un coupleur (200) adapté de façon à coupler le connecteur à une borne,
   un corps (500) assemblé avec le coupleur (200), et
   une poteau (300) assemblé avec le coupleur (200) et le corps (500), ce poteau (300) étant adapté de façon à recevoir une extrémité d'un câble coaxial,
   dans lequel soit le coupleur (200), soit le corps (500), soit le poteau (300) comporte une partie d'entrée en contact solidaire (310, 510), et dans lequel cette partie d'entrée en contact (310, 510) est monolithique avec au moins une partie d'au moins soit le coupleur (200), soit le corps (500), soit le poteau (200), et dans lequel, lorsque le connecteur est couplé à la borne et qu'un câble coaxial est reçu par le corps (500), la partie d'entrée en contact fournit la continuité électrique depuis un conducteur extérieur du câble coaxial à travers le connecteur jusqu'à la borne quel que soit le serrage du couplage du connecteur à la borne,
   **caractérisé en ce que**
   le coupeur (200) comporte une lèvre (215) s'étendant dans un passage central défini par le coupleur (200) ;
   le poteau (300) comporte un épaulement (340) disposé à une extrémité avant (305) du poteau (300) ;
   la partie d'entrée en contact solidaire (310, 510) est disposée entre l'épaulement (340) du poteau (300) et la lèvre (215) du coupleur (200), la partie d'entrée en contact solidaire (310, 510) s'étendant entre le coupleur (200) et le poteau (300).

2. Connecteur selon la revendication 1, dans lequel la continuité électrique depuis un conducteur extérieur du câble coaxial à travers le connecteur jusqu'à la borne est fournie autrement que par un composant de continuité séparé.

3. Connecteur selon la revendication 1 ou 2, dans lequel la partie d'entrée en contact (310, 510) est construite d'un matériau ayant une propriété élastique/plastique lui permettant de maintenir un contact électrique et mécanique malgré n'importe quel interstice entre les composants du connecteur lorsqu'il est assemblé.

4. Connecteur selon l'une quelconque des revendications 1 à 3, dans lequel la partie d'entrée en contact (310, 510) est déformable.

5. Connecteur selon la revendication 4, dans lequel la partie d'entrée en contact (310, 510) forme un contour d'au moins soit le coupleur (200), soit le poteau lorsque le poteau (300) est au moins partiellement assemblé avec le coupleur (200).

6. Connecteur selon la revendication 4, dans lequel la partie d'entrée en contact (310, 510) se déforme selon un contour d'au moins soit le corps (200), soit le poteau (300) lorsque le poteau (300) est au moins partiellement assemblé avec le corps (500).

7. Connecteur selon l'une quelconque des revendications 4 à 6, dans lequel la partie d'entrée en contact (310, 510) se déforme selon une forme au moins partiellement arquée.

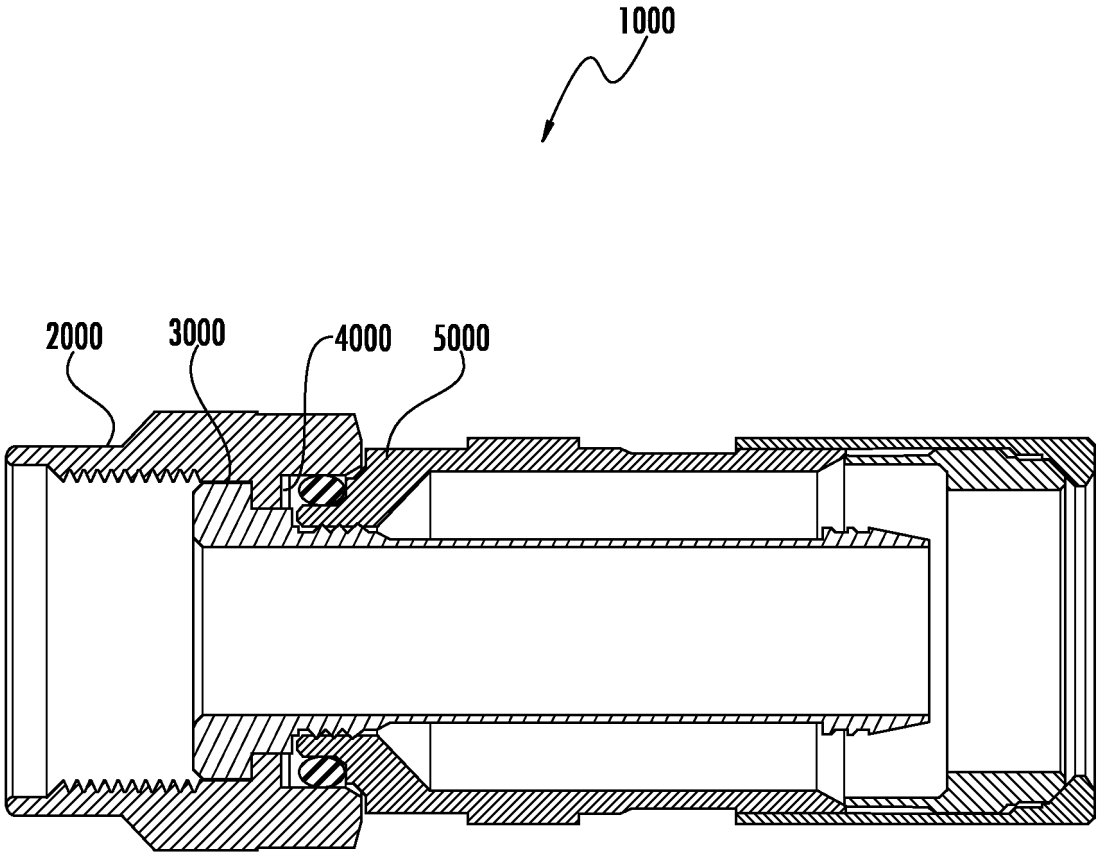



FIG. 1
(PRIOR ART)

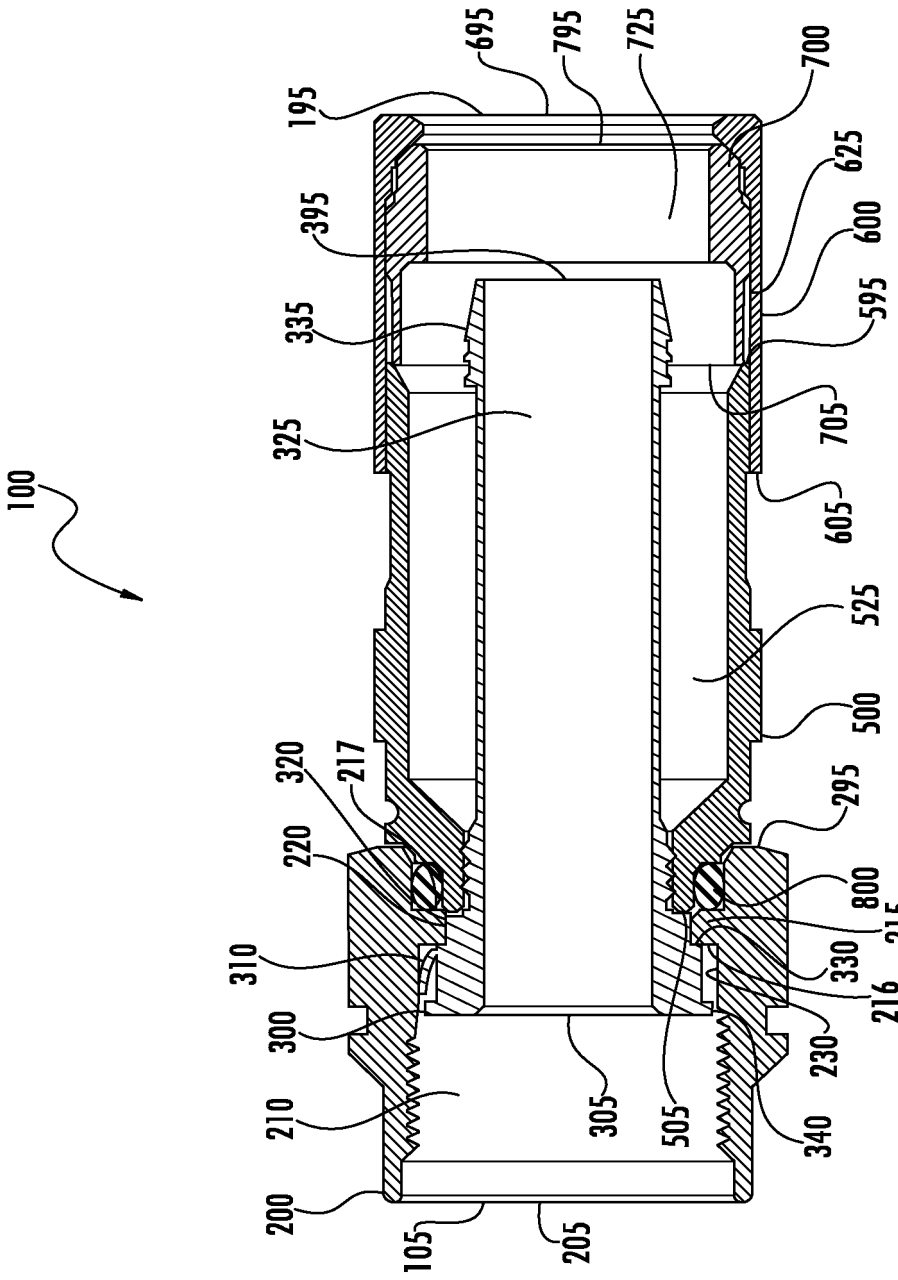

100
195
695
795
725
700
625
600
595
395
335
325
705
605
525
500
320
217
220
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800
215
310
330
216
300
230
210
305
505
340
200
105
205

FIG. 2

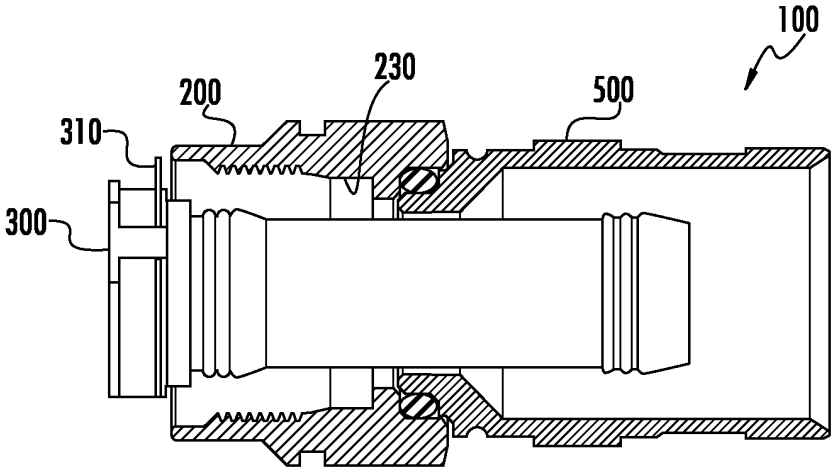



FIG. 3A

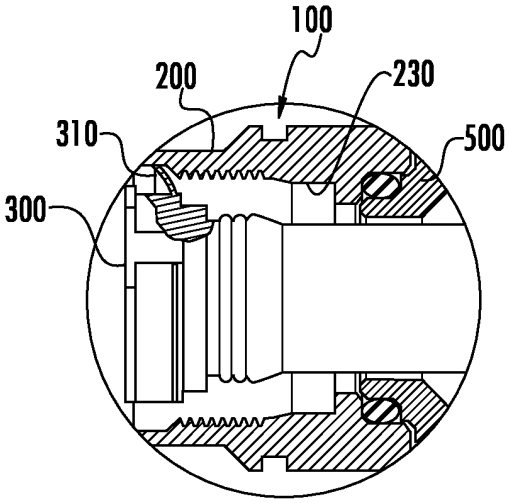



FIG. 3B

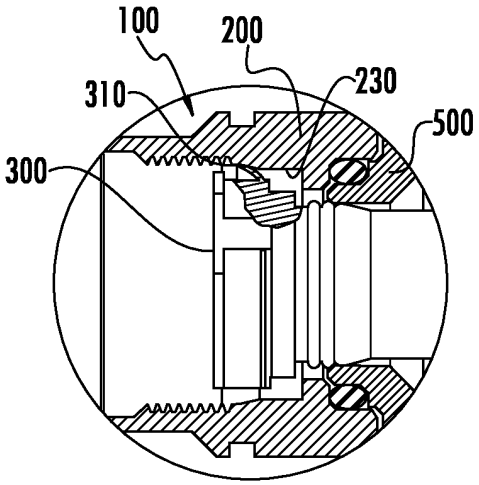



FIG. 3C

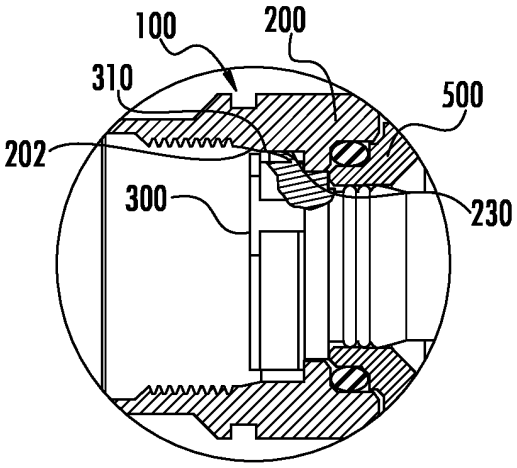



FIG. 3D

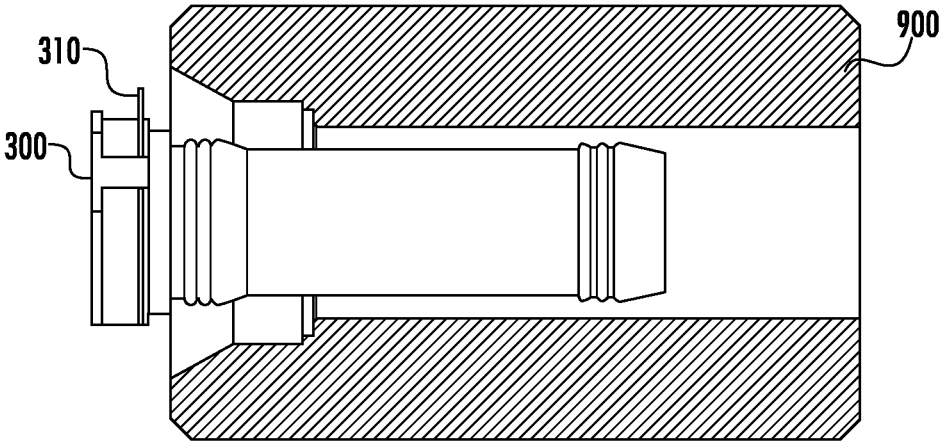



FIG. 4A

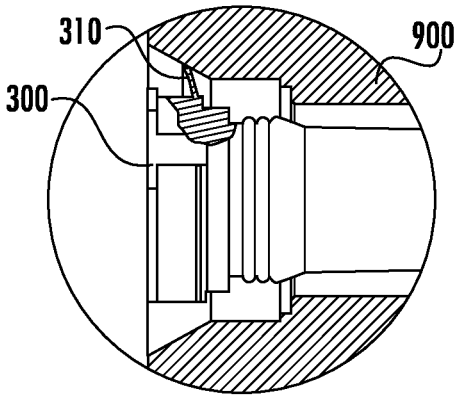



FIG. 4B

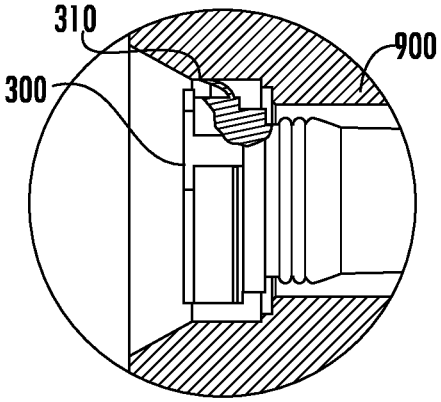



FIG. 4C

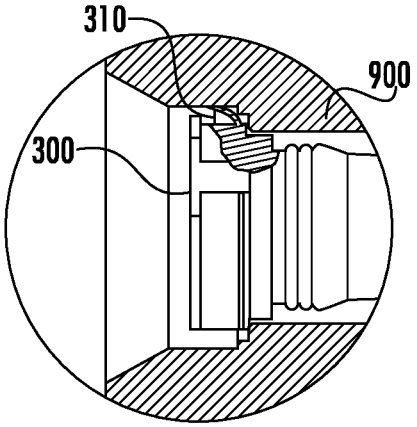



FIG. 4D

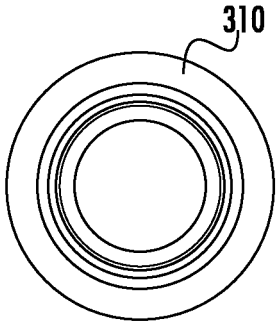



FIG. 5B

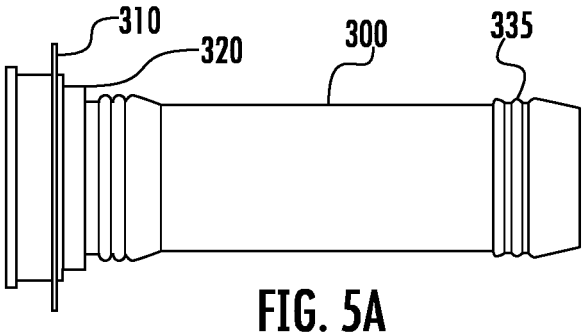



FIG. 5A

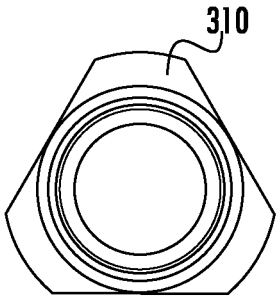



FIG. 5D

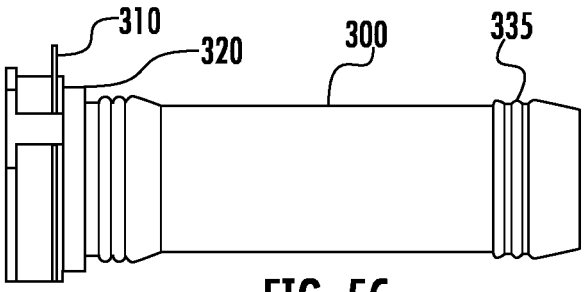



FIG. 5C

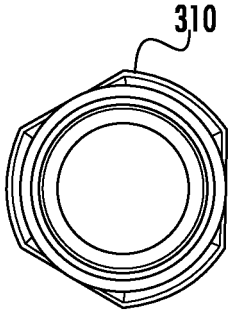



FIG. 5F

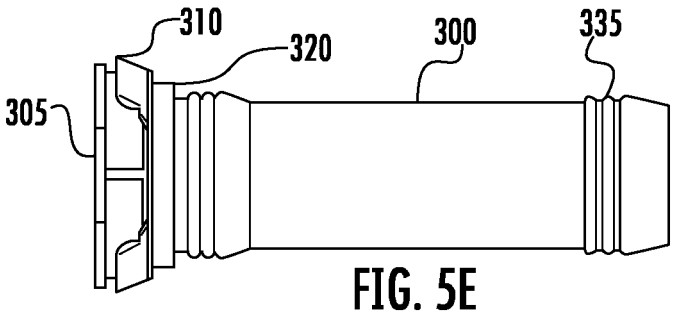



FIG. 5E

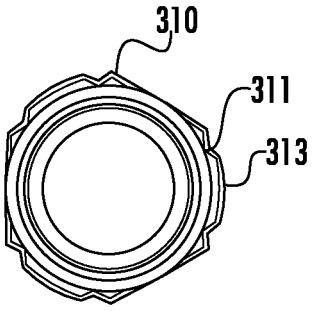



FIG. 5H

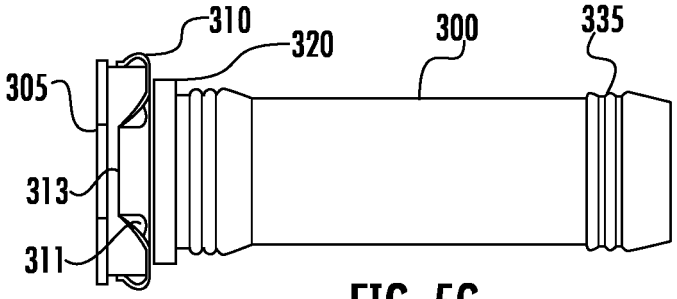



FIG. 5G

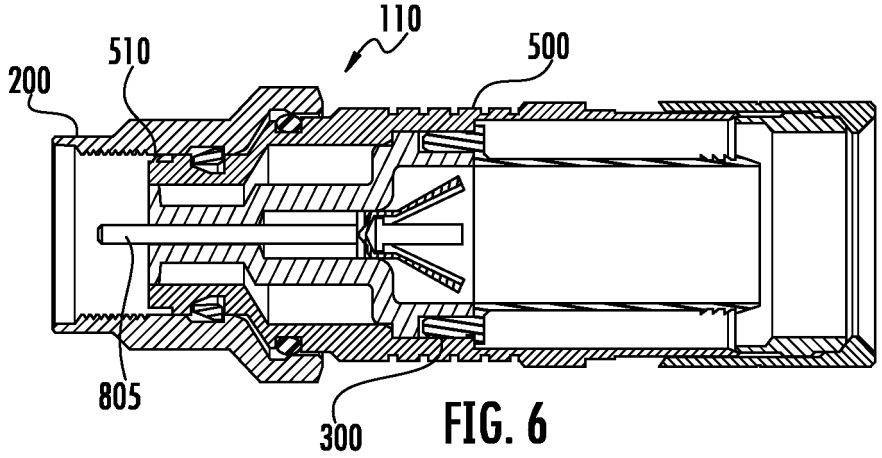



FIG. 6

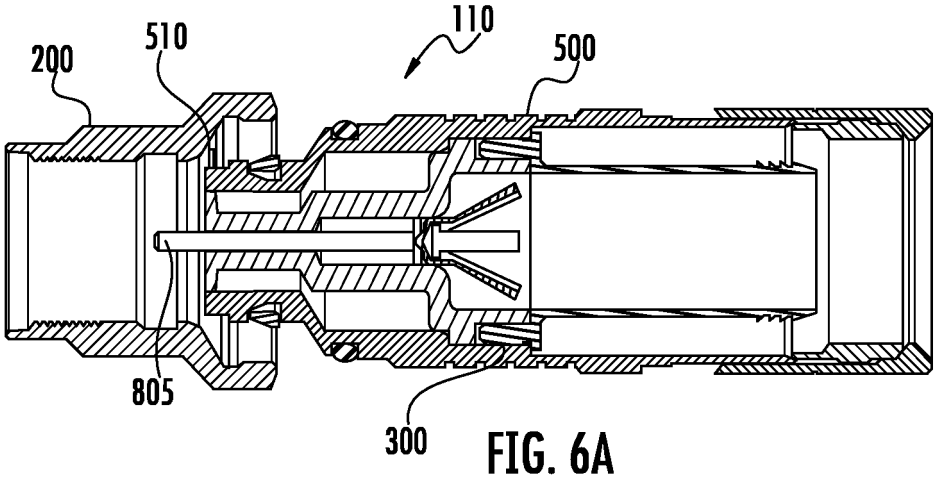



FIG. 6A

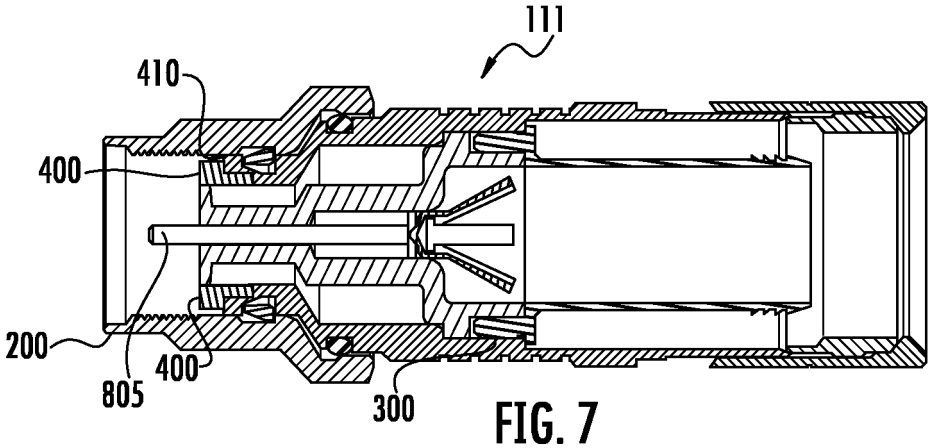



FIG. 7

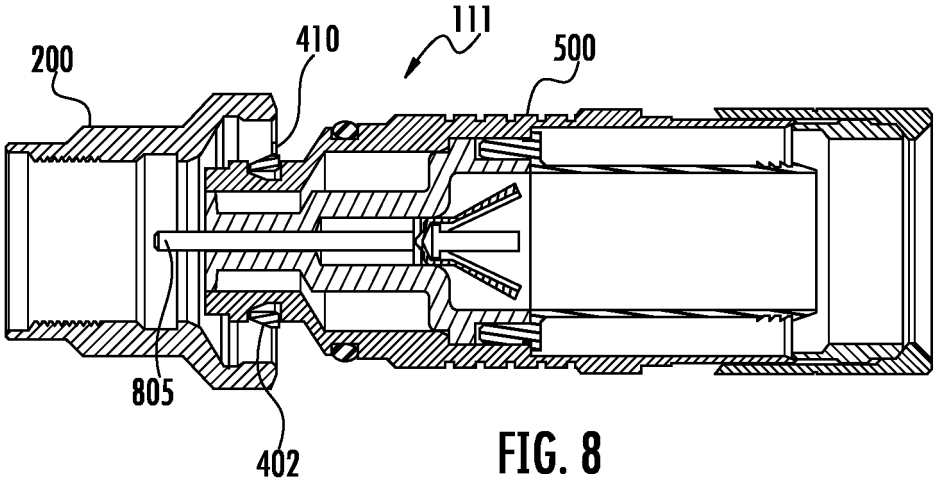



FIG. 8

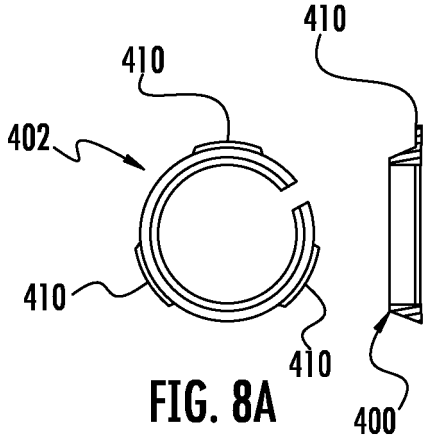



FIG. 8A

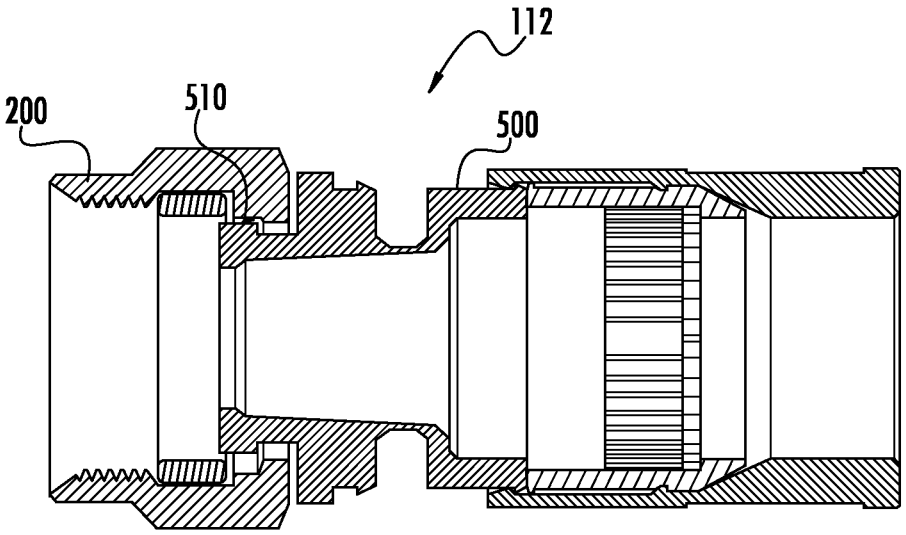



FIG. 9

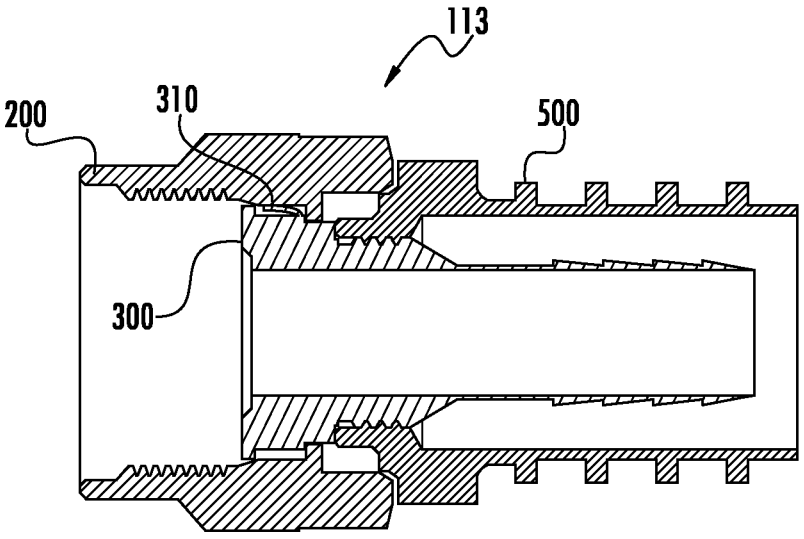



FIG. 10

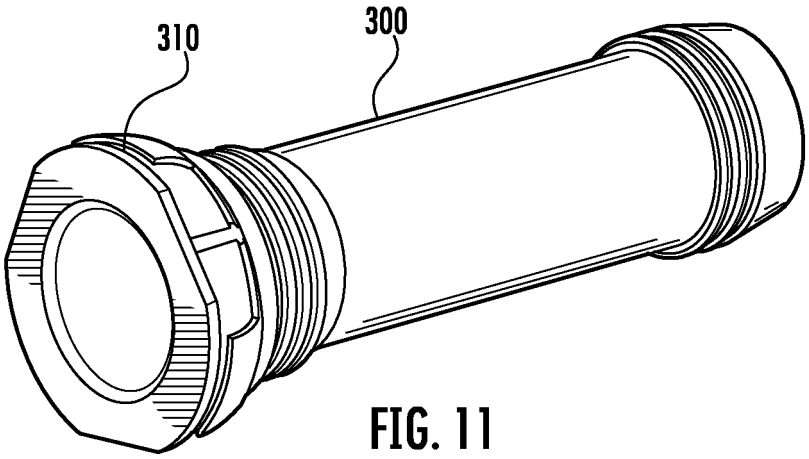



FIG. 11

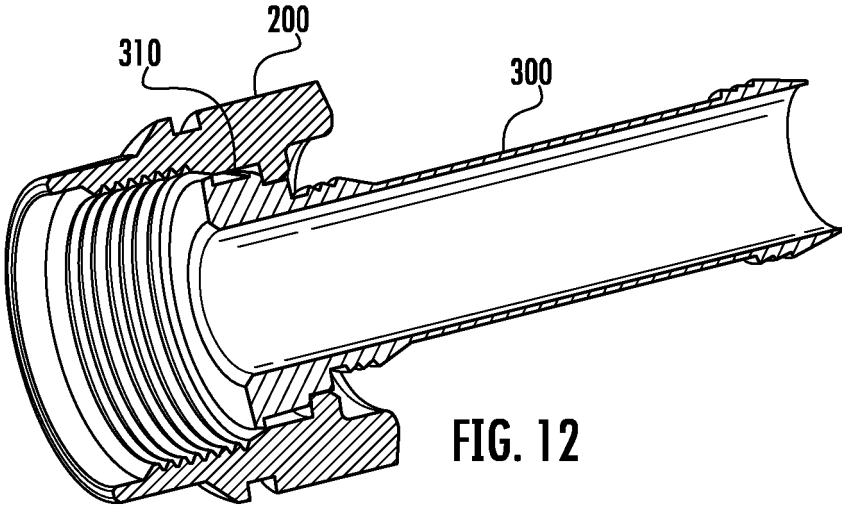



FIG. 12

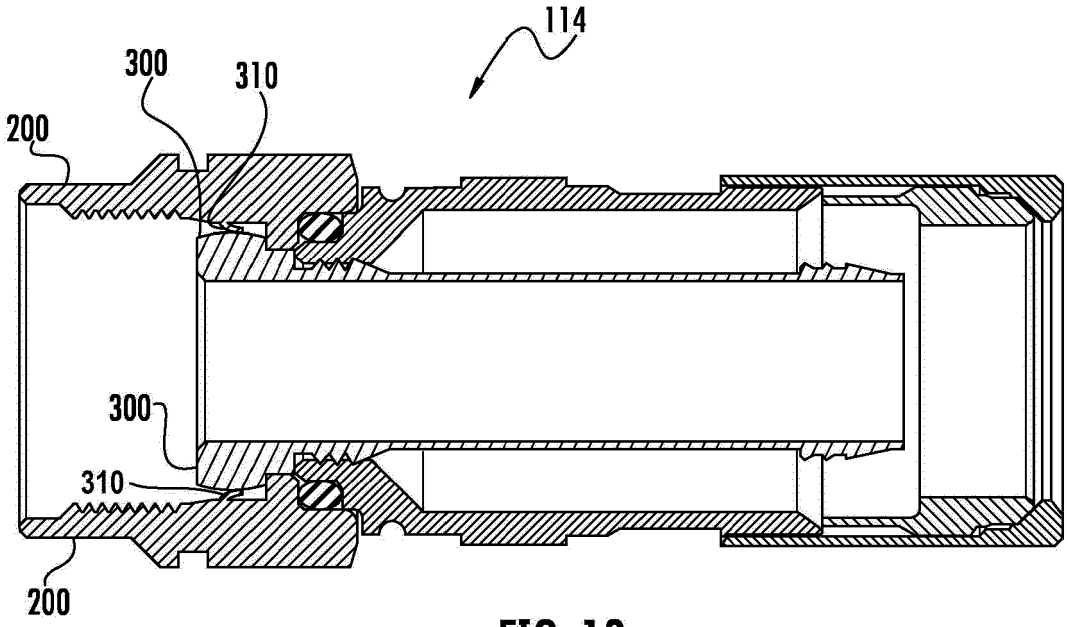



FIG. 13

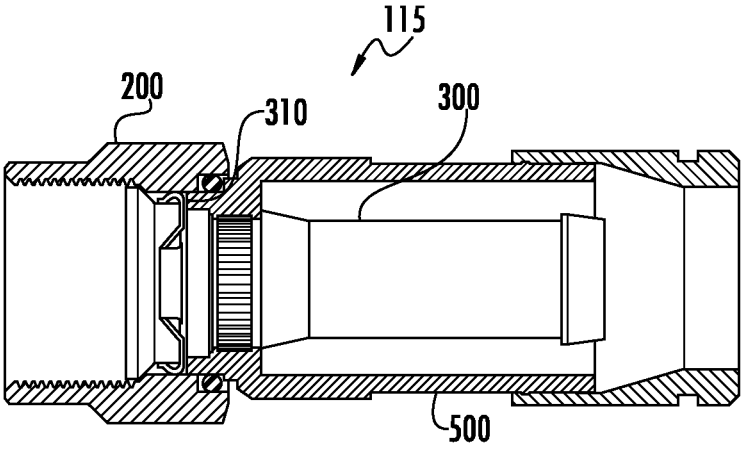



FIG. 14

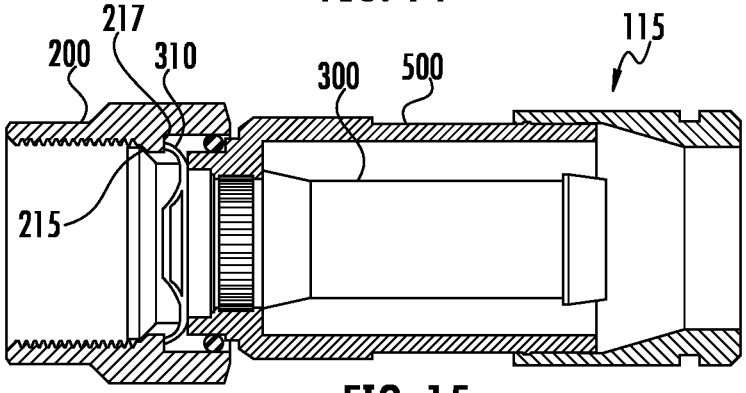



FIG. 15

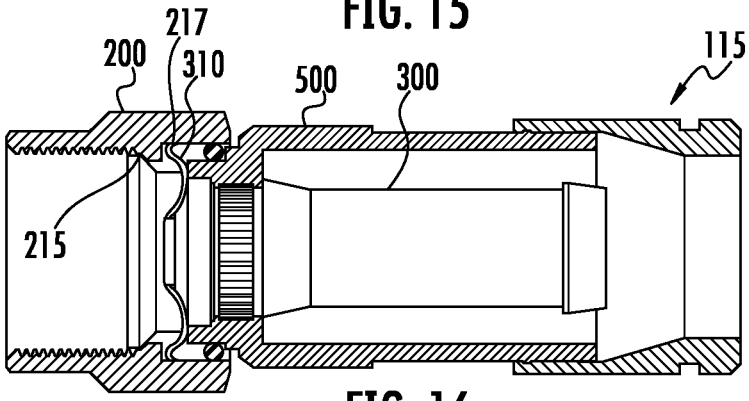



FIG. 16

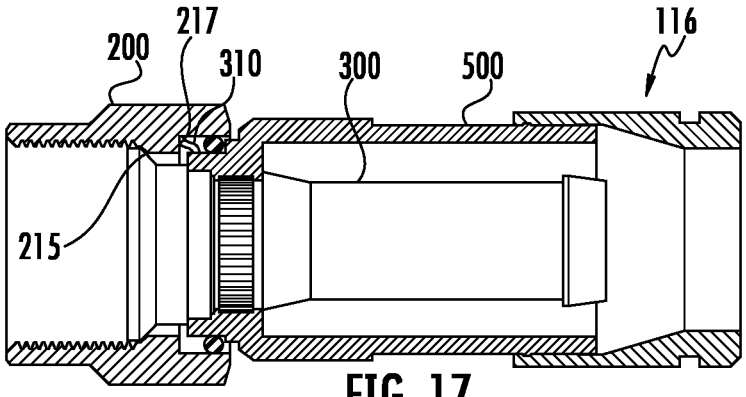



FIG. 17

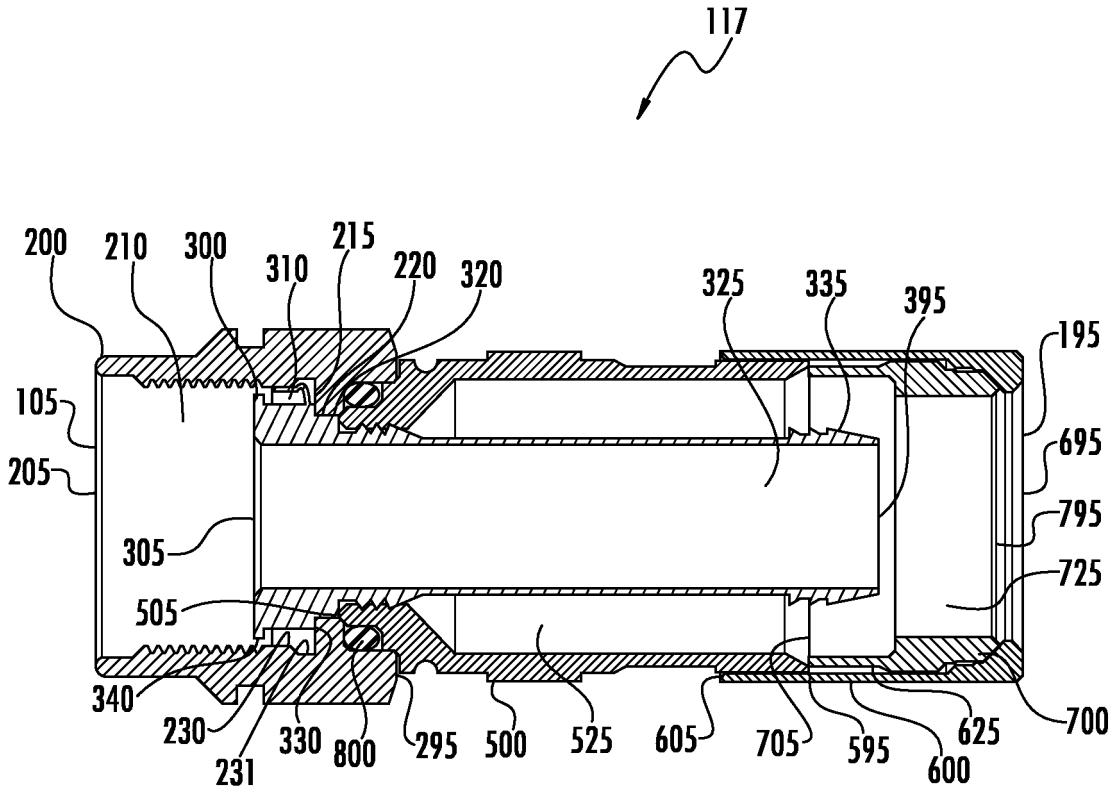

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FIG. 18

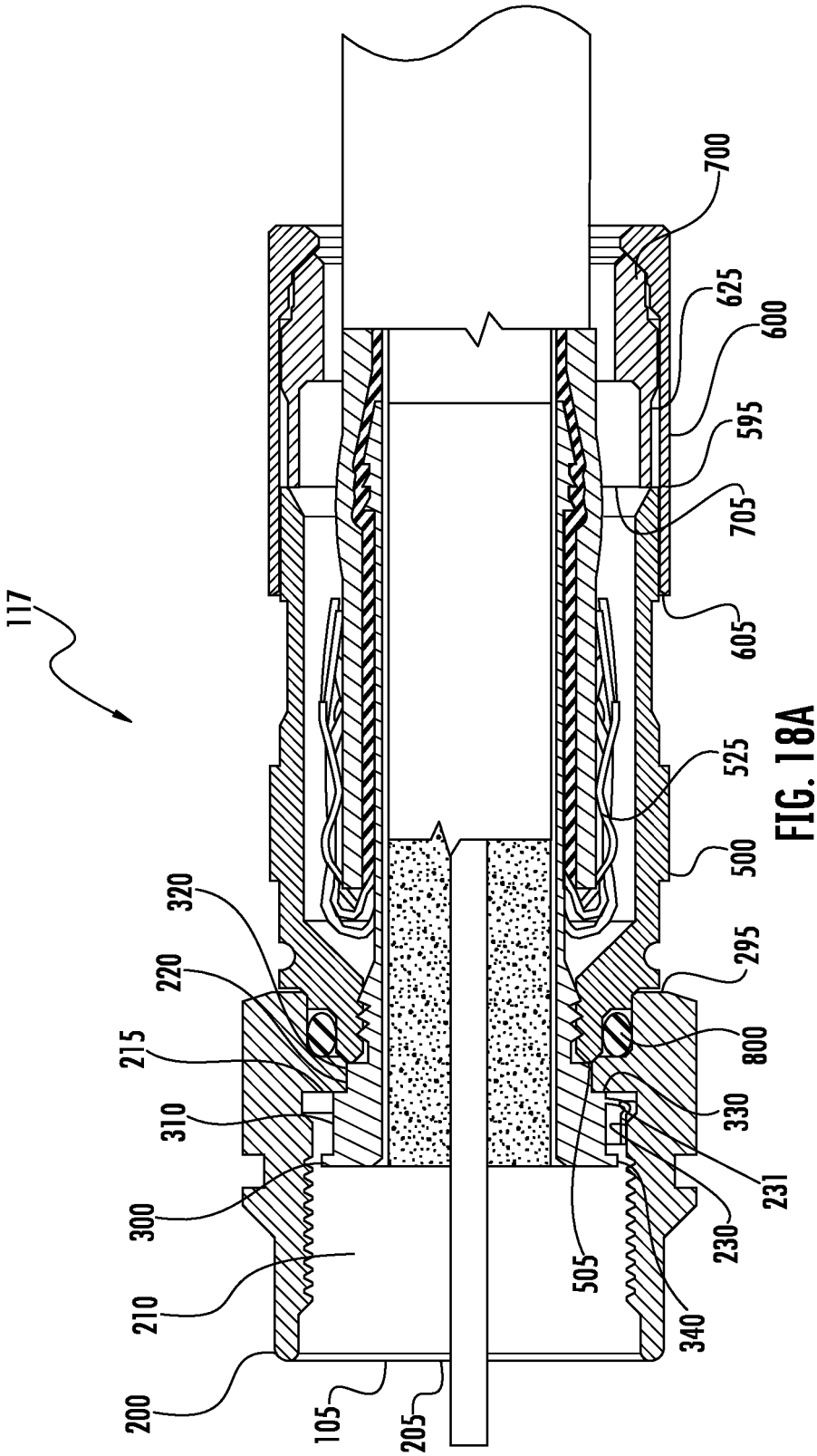

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FIG. 18A

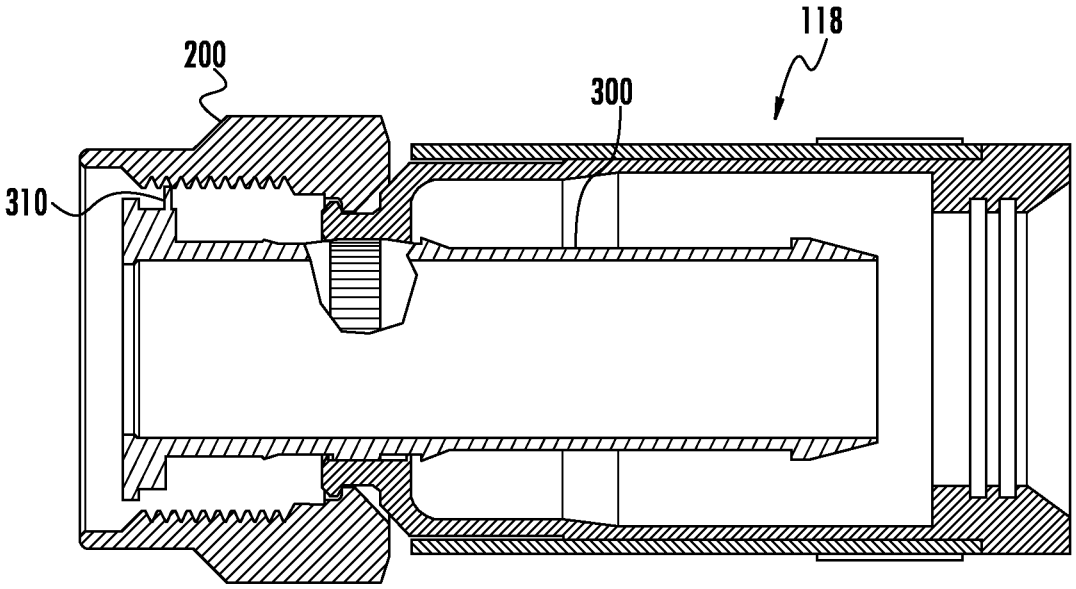



FIG. 19

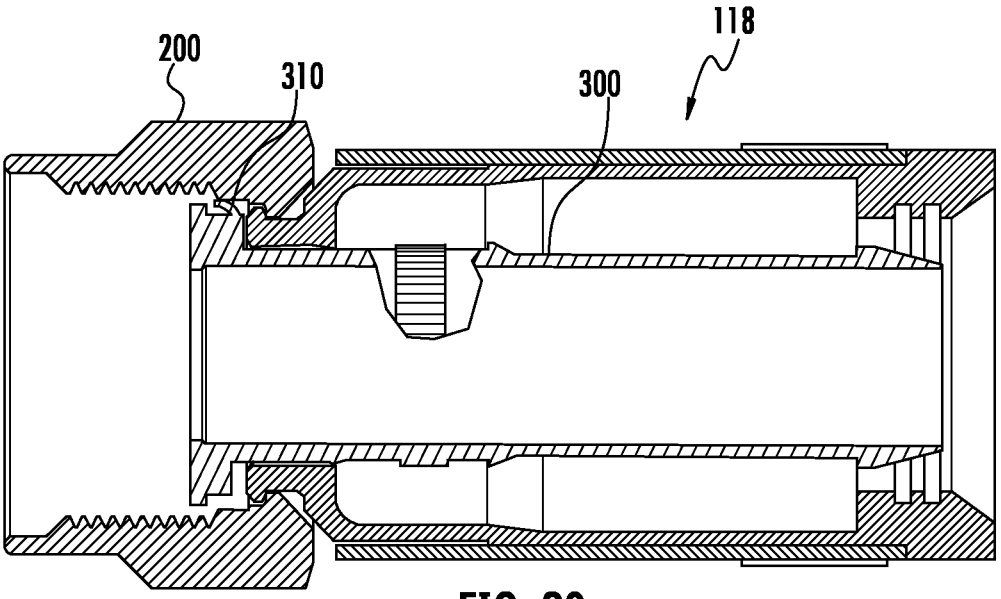



FIG. 20

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- US 7371113 B2 **[0010]**
- US 8075338 B1 **[0010]**