IN THE UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF ARKANSAS CENTRAL DIVISION



FEB 18 2022

TAMMY H. DOWNS, CLERK

PPC BROADBAND, INC.

Plaintiff.

v.

Case No.: <u>4:22-CV-163</u>-LPR

PERFECTVISION MANUFACTURING, INC.

Defendant.

This case assigned to District Judge Rudofsky and to Magistrate Judge Ray

COMPLAINT

PPC Broadband, Inc. ("PPC"), by its attorneys, Mitchell, Williams, Selig, Gates & Woodyard, P.L.L.C. and Barclay Damon LLP, files the following Complaint against Defendant PerfectVision Manufacturing, Inc. ("PerfectVision"), and alleges as follows:

Nature of Action

1. This action for patent infringement, brought under the Patent Laws of the United States, 35 U.S.C. § 1 *et seq.*, seeks relief arising out of PerfectVision's willful infringement of U.S. Patent Nos. 7,114,990 (the "'990 Patent"), 7,479,035 (the "'035 Patent"), 7,955,126 (the "'126 Patent"), 8,172,612 (the "'612 Patent"), and 10,756,455 (the "'455 Patent") (collectively, the "Patents-in-Suit").

2. PPC is the owner of the Patents-in-Suit by assignment, including the right to sue for past infringement.

3. PPC asserts infringement of all of the Patents-in-Suits against PerfectVision for its unauthorized making, using, offering to sell, selling, and/or importing of coaxial cable

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connector products marked as enhanced continuity connectors, including at least such connectors sold using PerfectVision's SignaLoc[®] tradename (the "Accused Products").

The Parties

4. PPC is a corporation organized and existing under the laws of the State of Delaware, with its principal place of business at 6176 East Molloy Road, East Syracuse, New York.

5. PerfectVision, is a corporation organized and existing under the laws of the State of Arkansas and has its principal place of business at 16101 La Grande Drive, Little Rock, Arkansas.

Jurisdiction and Venue

This Court has subject matter jurisdiction over the asserted claims pursuant to
 28 U.S.C. §§ 1331 and 1338, and 35 U.S.C. § 281.

7. This Court has personal jurisdiction over PerfectVision because PerfectVision is an Arkansas corporation, because PerfectVision has its principal place of business in Arkansas, and/or because Arkansas has been conducting and/or is presently conducting business in the Eastern District of Arkansas on a regular basis.

8. In addition, this Court has personal jurisdiction over PerfectVision because it has knowingly and actively engaged in acts that have infringed and will infringe the claims of the Patents-in-Suit in the Eastern District of Arkansas.

9. Venue is proper in the Eastern District of Arkansas pursuant to 28 U.S.C. § 1400. PerfectVision is incorporated in Arkansas and has its principal place of business in the Eastern District of Arkansas, and therefore reside in Arkansas and/or the Eastern District of Arkansas for the purposes of the statute. ۲

Factual Allegations

Background

10. PPC is a worldwide leader in the design and manufacture of products for the cable and telecommunication industries. PPC invests a substantial amount of capital in product development and improvement to maintain its position as a leading producer of innovative connective technology products. As a result of this investment, PPC has hundreds of issued patents, and has an established track record of strictly enforcing its patents against competitors, including against PerfectVision.

11. PerfectVision uses, imports, offers for sale, and/or sells the Accused Products in Arkansas and elsewhere in the United States. Such use, importation, offers for sale, and/or sale of the Accused Products is in direct competition with PPC's coaxial connector products, including its best-in-class SignalTight® continuity coaxial connectors.

Patents-in-Suit

12. The Patents-in-Suit claim priority to U.S. patent application Serial No. 11/043,844, filed on January 25, 2005, which was published as U.S. Patent Application Publication No. US2006/0166552 on July 27, 2006.

The '990 Patent was filed on January 25, 2005, and issued on October 3, 2006.
 The '990 Patent is attached hereto as Exhibit A.

14. The '035 Patent was filed on October 2, 2006, and issued on January 20, 2009.The '035 Patent is attached hereto as Exhibit B.

15. The '126 Patent was filed on December 11, 2008, and issued on June 7, 2011.The '126 Patent is attached hereto as Exhibit C.

16. The '612 Patent was filed on May 27, 2011, and issued on May 8, 2012. The'612 Patent is attached hereto as Exhibit D.

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17. The '455 Patent was filed on January 28, 2014, and issued on August 25, 2020.The '455 Patent is attached hereto as Exhibit E.

18. The Patents-in-Suit are directed to a problem in the cable and telecommunications industries. A significant cost driver for cable television and high-speed internet service providers is the cost of having to send technicians to customers' homes and businesses to address service interruptions. One of the most common problems these technicians find once on site is that the coaxial cable connectors are loose. When connectors are loose the ground path through the metal components of the connector to the outer conductor of the coaxial cable can become broken or unstable as the components can separate as the cable or the equipment is moved. When this happens, service is degraded or lost altogether, thus necessitating a service call by a technician.

19. As the Patents-in-Suit explain in their respective specifications: "When connecting the end of a coaxial cable to a terminal of a television set, equipment box, 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. 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; in turn, the tubular post is engaged with the outer conductor of the coaxial cable. However, in many cases, it is difficult for an installer to reach the connection ports of the appliance with a wrench, and in some instances, it is even difficult for the installer to reach such connection ports with his or her fingers. As a result, it can often happen that type F connectors are not fully

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tightened to the appliance port. In such a loose connection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, a gap exists between the outer conductor of the appliance port and the tubular post of the connector. Unless an alternate ground path exists, poor signal quality, and RFI leakage, will result It is therefore an object of the present invention to provide a coaxial cable connector for connecting a coaxial cable to a connection port of an appliance, the coaxial cable connector being of the type that includes a tubular post and a coupler, such as a rotatable coupler, which ensures a reliable ground connection between the tubular post of the connector and an outer conductor of the appliance port, even if the coupler is not fully tightened onto the appliance port." (*E.g.*, '990 Patent, Col. 1, line 47 to Col. 2, line 49.)

20. Although the specific scope of the invention is delineated by the various elements in the claims, as illustrated in the exemplary annotated patent figures below, the Patents-in-Suit accomplish this objective by placing a grounding member (red) in between the tubular post (blue) and the coupler (green) that creates an electrical pathway between those two components even when the connector is not fully tightened onto the appliance port.



Accused Products

21. The following annotated figures from PerfectVision's own patent application (filed almost seven years *after* the Patents-in-Suit) illustrate the nearly identical internal construction of PerfectVision's accused SignaLoc[®] coaxial cable connector design, including, but not limited to, PerfectVision's model PV6USLP connectors. Indeed, as indicated PerfectVision's accused SignaLoc[®] places a grounding member (red) in between the tubular post (blue) and the coupler (green) that creates an electrical pathway between those two components even when the connector is not fully tightened onto the appliance port.



PerfectVision's Knowledge of the Patents-in-Suit

22. On information and belief. PerfectVision is a sophisticated company in the industry that keep appraised of relevant patents (either alone or through the actions of its related companies).

23. PerfectVision has been aware of one or more of the Patents-in-Suit since at least November 30, 2011, when PerfectVision filed a patent application on the design of its accused SignaLoc[®] connector. In that application (U.S. Patent Application No. 13/373.782) PerfectVision's then Chief Executive Officer is listed as the first named inventor. PerfectVision

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is listed as assignee, and PerfectVision included a recitation of what was disclosed in the asserted '990 and '035 Patents. That recitation is incomplete and misleading (likely so that PerfectVision would be able to argue that its supposed invention was new and novel despite coming almost seven years *after* the invention in the Patents-in-Suit), but, in any event, leaves no room for doubt that PerfectVision was aware of the asserted '990 and '035 Patents at least by 2011, if not earlier.

24. Further, at least by 2016 (when all of the Patents-in-Suit other than the '455 Patent had already issued) it is believed that PerfectVision either hired or retained as a consultant William Lutz, one of the named inventors on the Patents-in-Suit. It is believed Mr. Lutz assisted with design improvements to PerfectVision's SignaLoc[®] connector, even appearing as the first named inventor on a continuation-in-part application filed by PerfectVision in the family of patents PerfectVision was seeking on its SignaLoc[®] connector design (U.S. Patent Application No. 15/201,232). Certainly Mr. Lutz was fully aware of his earlier invention in the Patents-in-Suit at that time, and that patent application also included recitation of what was disclosed in the '990 and '035 Patents, misleading as it was.

25. Upon information and belief, based on its prior knowledge of the '990 and '035 Patents, and based on its work with Mr. Lutz, who as noted above is one of the named inventors on the Patents-in-Suit, PerfectVision knew or should have known of the asserted '126, '612, and '455 Patents on or about the date each such patent issued, and knew or should have known that its manufacture, use, importation, offer for sale, and/or sale of the Accused Products infringed each of the Patents-in-Suit on or about the time each of the Patents-in-Suit issued and/or on or about the time the PerfectVision made, used, imported, offered for sale and/or sold the Accused Products.

26. Moreover, on January 27, 2022, PPC sent PerfectVision a cease-and-desist letter explaining in detail how PerfectVision's SignaLoc^R connector infringed the Patents-in-Suit and demanding that it stop infringing. That letter is attached hereto as Exhibit F. On information and belief, PerfectVision has continued to infringe the Patents-in-Suit as alleged herein.

<u>COUNT I</u> (Infringement of '990 Patent)

27. PPC repeats and reasserts all of the foregoing allegations as if they were stated in full herein.

28. As illustrated in the representative chart below. PerfectVision has directly infringed and continues to directly infringe at least Claim 6 of the '990 Patent, within the meaning of 35 U.S.C. § 271(a) and either literally or under the doctrine of equivalents, by using, selling, offering for sale, and or importing the Accused Products in the United States, without license or authorization by PPC.

SignaLoc [®] Connector
gnaLoc [®] line of coaxial cable connectors are cable tors for coupling a coaxial cable to an equipment he coaxial cable including a center conductor ided by a dielectric material, the dielectric material urrounded by an outer conductor. (<i>See</i> https://www. evision.com/WebSupport/webstore/spec-sheets/PV6 PDF.) nter conductor dielectric outer conductor





6. The coaxial cable connector recited by claim 5 wherein the tubular post includes an enlarged shoulder at the second end thereof extending inside the coupler, and wherein the annular recess and said grounding member surround the enlarged shoulder of the tubular post when the coaxial cable connector is assembled onto the prepared end of the coaxial cable.



29. The Accused Products include each of the elements of at least Claim 6 of the '990 Patent and PerfectVision's manufacture, importation, use, offer for sale and/or sale of such products in the United States constitutes infringement of the '990 Patent.

30. PerfectVision's infringement has caused and continues to cause PPC irreparable harm and damages in an amount to be proven at trial.

31. Upon information and belief, PerfectVision's unlawful infringing activity will continue unless and until it is enjoined by this Court from further infringement, and, at least since the commencement of this suit, such infringement has been willful, egregious, deliberate, and/or intentional. PerfectVision's continuing infringement since the commencement of this suit will cause PPC further irreparable harm and damages, and entitle it to recover, among other things, treble damages, attorney's fees, and costs.

<u>COUNT II</u> (Infringement of '035 Patent)

32. PPC repeats and reasserts all of the foregoing allegations as if they were stated in full herein.

33. As illustrated in the representative chart below, PerfectVision has directly infringed and continue to directly infringe at least Claim 11 of the '035 Patent, within the

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meaning of 35 U.S.C. § 271(a) and either literally or under the doctrine of equivalents, by using, selling, offering for sale, and or importing the Accused Products in the United States, without license or authorization by PPC.

'035 Patent, Claim 11	SignaLoc [®] Connector
1. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising:	The SignaLoc [*] line of coaxial cable connectors are cable connectors for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor. (<i>See</i> https://www. perfect-vision.com/WebSupport/webstore/spec-sheets/PV6 USLP.PDF.) center conductor dielectric outer conductor
a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof	tubular post

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34. The Accused Products include each of the elements of at least Claim 11 of the '035 Patent and PerfectVision's manufacture, importation, use, offer for sale and/or sale of such products in the United States constitutes infringement of the '035 Patent.

35. PerfectVision's infringement has caused and continues to cause PPC irreparable harm and damages in an amount to be proven at trial.

36. Upon information and belief, PerfectVision's unlawful infringing activity will continue unless and until it is enjoined by this Court from further infringement, and, at least since the commencement of this suit, such infringement has been willful, egregious, deliberate, and/or intentional. PerfectVision's continuing infringement since the commencement of this suit will cause PPC further irreparable harm and damages, and entitle it to recover, among other things, treble damages, attorney's fees, and costs.

<u>COUNT III</u> (Infringement of '126 Patent)

37. PPC repeats and reasserts all of the foregoing allegations as if they were stated in full herein.

38. As illustrated in the representative chart below, PerfectVision has directly infringed and continue to directly infringe at least Claim 6 of the '126 Patent, within the meaning of 35 U.S.C. § 271(a) and either literally or under the doctrine of equivalents, by using, selling, offering for sale, and or importing the Accused Products in the United States, without license or authorization by PPC.

'126 Patent, Claim 6	SignaLoc [®] Connector
6. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:	The SignaLoc [®] line of coaxial cable connectors are cable connectors for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor. (<i>See</i> https://www. perfect-vision.com/WebSupport/webstore/spec-sheets/PV6 USLP.PDF.) center conductor dielectric outer conductor
a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof;	tubular post
b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port;	a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port





39. The Accused Products include each of the elements of at least Claim 6 of the 126 Patent and PerfectVision's manufacture, importation, use, offer for sale and/or sale of such products in the United States constitutes infringement of the 126 Patent.

40. PerfectVision's infringement has caused and continues to cause PPC irreparable harm and damages in an amount to be proven at trial.

41. Upon information and belief. PerfectVision's unlawful infringing activity will continue unless and until it is enjoined by this Court from further infringement, and, at least since the commencement of this suit, such infringement has been willful, egregious, deliberate, and/or intentional. PerfectVision's continuing infringement since the commencement of this suit will cause PPC further irreparable harm and damages, and entitle it to recover, among other things, treble damages, attorney's fees, and costs.

<u>COUNT IV</u> (Infringement of '612 Patent)

42. PPC repeats and reasserts all of the foregoing allegations as if they were stated in full herein.

43. As illustrated in the representative chart below. PerfectVision has directly infringed and continue to directly infringe at least Claim 23 of the '612 Patent, within the

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meaning of 35 U.S.C. § 271(a) and either literally or under the doctrine of equivalents, by using, selling, offering for sale, and or importing the Accused Products in the United States, without license or authorization by PPC.

'612 Patent, Claim 23	SignaLoc [®] Connector
9. A grounding member for a coaxial cable connector having a post and a nut, comprising a generally arcuate shaped member, composed at least partially of electrically conductive material, and a contact portion of the generally arcuate shaped member, wherein:	The SignaLoc [®] line of coaxial cable connectors include a grounding member for a coaxial cable connector having a post and a nut, comprising a generally arcuate shaped member, composed at least partially of electrically conductive material, and a contact portion of the generally arcuate shaped member.
the at least one contact portion provides for an electrically- conductive path through the post and the nut;	a contact portion provides for an electrically- conductive path through the post and the nut





44. The Accused Products include each of the elements of at least Claim 23 of the '612 Patent and PerfectVision's manufacture, importation, use, offer for sale and/or sale of such products in the United States constitutes infringement of the '612 Patent.

45. PerfectVision's infringement has caused and continues to cause PPC irreparable harm and damages in an amount to be proven at trial.

46. Upon information and belief, PerfectVision's unlawful infringing activity will continue unless and until it is enjoined by this Court from further infringement, and, at least since the commencement of this suit, such infringement has been willful, egregious, deliberate, and/or intentional. PerfectVision's continuing infringement since the commencement of this suit will cause PPC further irreparable harm and damages, and entitle it to recover, among other things, treble damages, attorney's fees, and costs.

<u>COUNT V</u> (Infringement of '455 Patent)

47. PPC repeats and reasserts all of the foregoing allegations as if they were stated in full herein.

48. As illustrated in the representative chart below, PerfectVision has directly infringed and continue to directly infringe at least Claim 5 of the '455 Patent, within the meaning of 35 U.S.C. § 271(a) and either literally or under the doctrine of equivalents, by using, selling, offering for sale, and or importing the Accused Products in the United States, without license or authorization by PPC.



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a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:	a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port
a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable: and	body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable
an electrically-conductive grounding component disposed between the tubular post and the coupler:	electrically-conductive grounding member between the tubular post and the coupler



49. The Accused Products include each of the elements of at least Claim 5 of the '455 Patent and PerfectVision's manufacture, importation, use, offer for sale and/or sale of such products in the United States constitutes infringement of the '455 Patent.

50. PerfectVision's infringement has caused and continues to cause PPC irreparable harm and damages in an amount to be proven at trial.

51. Upon information and belief, PerfectVision's unlawful infringing activity will continue unless and until it is enjoined by this Court from further infringement, and, at least since the commencement of this suit, such infringement has been willful, egregious, deliberate, and/or intentional. PerfectVision's continuing infringement since the commencement of this suit will cause PPC further irreparable harm and damages, and entitle it to recover, among other things, treble damages, attorney's fees, and costs.

Prayer for Relief

WHEREFORE. PPC prays for judgment in its favor and against PerfectVision, as follows:

- A. Entry of judgment that PerfectVision infringed one or more claims of the Patents-in-Suit;
- B. Entry of judgment that preliminarily and/or permanently enjoins the PerfectVision and its representatives, assigns or successors, or any subsidiaries, parents, divisions, agents, servants, employees thereof, and/or those in privity with PerfectVision from infringing the Patents-in-Suit;
- C. An award of compensatory damages for PPC as a result of infringement, as provided in 35 U.S.C. § 284, the extent of which will be determined at trial, but in no event less than a reasonable royalty, together with interest and costs;
- D. A determination that PerfectVision's acts of infringement of one or more claims of the Patents-in-Suit have been, and continue to be, egregious and/or willful, and that PPC is entitled to an award of enhanced damages of up to three times the amount of actual damages pursuant to 35 U.S.C. § 284;

- E. A determination that, pursuant to 35 U.S.C. § 285, this is an exceptional case and that PPC be awarded its reasonable attorney's fees;
- F. An award of interest on any judgment rendered in this action:
- G. An award of PPC's costs in this action; and
- H. Such other and further relief as is just and proper.

Jury Demand

PPC demands a trial by jury on all issues so triable.

Dated: February 18, 2022.

John Keeling Baker, ABA 97024 MITCHELL, WILLIAMS, SELIG, GATES & WOODYARD, P.L.L.C. 425 W. Capitol Avenue, Suite 1800 Little Rock, Arkansas 72201 Tel: 501.688.8800 Facsimile: 501.688-8807 jbaker@mwlaw.com

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US007114990B2

(12) United States Patent

Bence et al.

(54) COAXIAL CABLE CONNECTOR WITH GROUNDING MEMBER

- (75) Inventors: Bruce D. Bence, Glendale, AZ (US);
 Donald A. Burris, Peoria, AZ (US);
 Brian L. Kisling, Phoenix, AZ (US);
 John A. Kooiman, Mesa, AZ (US);
 William B. Lutz, Glendale, AZ (US);
 William F. McDade, Glendale, AZ (US);
 William F. McDade, Glendale, AZ (US);
 US); Thomas D. Miller, Peoria, AZ (US);
 Lee Yung Chuan, Sanchong (TW)
- (73) Assignee: Corning Gilbert Incorporated. Glendale, AZ (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: 11/043,844
- (22) Filed: Jan. 25, 2005 (Under 37 CFR 1.47)

(65) Prior Publication Data

US 2006/0166552 A1 Jul. 27, 2006

- (51) Int. Cl. *H01R 9/05* (2006.01)
- (52) U.S. Cl. 439/583; 439/322

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(45) **Date of Patent: Oct. 3, 2006**

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(Continued)

Assistant Examiner Vladimir Imas

(74) Attorney, Agent. or Firm—Joseph M. Homa; Marvin A. Glazer

(57) ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.

34 Claims, 8 Drawing Sheets





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U.S. Patent

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COAXIAL CABLE CONNECTOR WITH GROUNDING MEMBER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to electrical connectors. and more particularly to coaxial cable connectors capable of being connected to a terminal.

2. Description of the Related Art

Coaxial cable connectors, such as type F connectors, are used to attach coaxial cable to another object or appliance. e.g., a television set or VCR having a terminal adapted to engage the connector. The terminal of the appliance includes an inner conductor and a surrounding outer conductor.

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: this outer conductor may be in the form of a conductive foil and/or braided sheath. The outer conductor 20 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 mechani-25 cally 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 bare the end portion of the outer conductor. Similarly, it is common to strip off a portion of 30 the dielectric to expose the end portion of the center conductor.

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 con- 35 ductor 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 40 tubular post and are typically received in an outer body of the connector: this outer body of the connector is usually fixedly secured to the tubular post. A coupler is rotatably secured around the tubular post and includes an internallythreaded region for engaging external threads formed on the 45 outer conductor of the appliance terminal.

When connecting the end of a coaxial cable to a terminal of a television set, equipment box, or other appliance, it is important to achieve a reliable electrical connection between the outer conductor of the coaxial cable and the outer 50 conductor of the appliance terminal. 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 55 of the appliance port, thereby making a direct electrical ground connection between the outer conductor of the appliance port and the tubular post: in turn, the tubular post is engaged with the outer conductor of the coaxial cable.

However, in many cases, it is difficult for an installer to 60 reach the connection ports of the appliance with a wrench. and in some instances, it is even difficult for the installer to reach such connection ports with his or her fingers. As a result, it can often happen that type F connectors are not fully tightened to the appliance port. In such a loose con- 65 nection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, a gap

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exists between the outer conductor of the appliance port and the tubular post of the connector. Unless an alternate ground path exists, poor signal quality, and RFI leakage, will result. As mentioned above, the coupler is 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 10 of such F-style connectors routinely make the outer diameter of the shoulder (at the head of the tubular post) of smaller dimension 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 15 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.

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 timeconsuming to diagnose.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a coaxial cable connector for connecting a coaxial cable to a connection port of an appliance, the coaxial cable connector being of the type that includes a tubular post and a coupler, such as a rotatable coupler, which ensures a reliable ground connection between the tubular post of the connector and an outer conductor of the appliance port, even if the coupler is not fully tightened onto the appliance port.

It is another object of the present invention to provide such a coaxial cable connector which maintains a reliable ground path between the coupler and the tubular post, at least following installation of such connector onto the end of a coaxial cable.

It is still another object of the present invention to provide such a coaxial connector that can be manufactured economically.

These and other objects of the present invention will become more apparent to those skilled in the art as the description thereof proceeds.

SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a coaxial cable connector comprising a tubular post, a coupler and a grounding means for providing an electrically conductive path between the post and the coupler. In accordance

with a preferred embodiment thereof, the present invention relates to a coaxial cable connector for coupling a prepared end of a coaxial cable to a threaded female equipment port, and including a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between 5 the dielectric material and the outer conductor thereof. A coupler is rotatably secured over the second end of the tubular post, and includes a central bore, at least a portion of which is threaded for engaging the female equipment port. An outer body is secured to the tubular post and extends 10 about the first end of the tubular post for receiving the outer conductor, and preferably the cable jacket, of the coaxial cable.

In a preferred embodiment of the present invention, a resilient, electrically-conductive grounding member is dis-15 posed between the tubular post and the coupler. This grounding member engages both the tubular post and the coupler for providing an electrically-conductive path therebetween, but without restricting rotation of the coupler relative to the tubular post. 20

For some preferred embodiments, the grounding member is generally arcuately shaped to extend around the tubular post over an arc of at least 225°, and may extend for a full 360°. This arcuately shaped grounding member may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member has a shape that is outof-round, and more preferably oblong, rather than circular. in order to ensure reliable electrical contact with both the coupler and the tubular post. In order to retain the grounding member inside the coupler, the inner bore of the coupler may include an annular recess proximate to the end of the coupler that encircles the tubular post; at least portions of the grounding member are engaged with the annular recess to prevent the grounding member from being axially displaced within the coupler.

As mentioned above, the tubular post may include an enlarged shoulder at the head thereof. In one preferred embodiment of the present invention, the grounding member 40 surrounds the enlarged shoulder of the tubular post, at least when the coaxial cable connector is assembled onto the prepared end of a coaxial cable, whereby at least portions of the grounding member engage the outer surface of such enlarged shoulder.

In one embodiment of the present invention, the grounding member is generally circular and includes a plurality of projections extending outwardly therefrom for engaging the coupler. In another embodiment of the present invention, the grounding member is generally circular and includes a 50 plurality of projections extending inwardly therefrom for engaging the tubular post.

In yet another embodiment of the present invention, the tubular post includes an enlarged shoulder extending inside the coupler, and including a first radial face that faces the 55 opposite end of the tubular post. The coupler includes a flange directed inwardly toward the tubular post; this inwardly directed flange including a second radial face that faces toward the connection port of the appliance to which the coaxial cable is to be connected. The grounding member 60 is disposed between the first radial face and the second radial face. In this embodiment, the grounding member is resilient relative to the longitudinal axis of the connector, and is compressed between the first radial face and the second radial face to maintain sliding electrical contact between the 65 shoulder of the tubular post (via its first radial face).

The coaxial connector of the present invention may also include a sealing ring seated within the coupler for rotatably engaging the body member to form a seal therebetween.

In an alternate embodiment of the present invention, conductive grease is substituted for a discrete grounding member. In this embodiment, an outer dimension of a portion of the tubular post is caused to be commensurate with an inner dimension of an adjacent portion of the coupler. While the gap between such adjacent portions, coupled with the lubrication provided by the conductive grease, is sufficient to permit rotation of the coupler relative to the tubular post, the conductive grease nonetheless functions to maintain reliable electrical coupling across such gap.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with greater specificity and clarity with reference to the following draw-20 ings. in which:

FIG. 1 is a perspective view of an F connector in accordance with the preferred embodiment of the invention, including a body and a coupling nut;

FIG. **2** is an exploded view of the F connector of FIG. **1**, including a preferred embodiment of a grounding member:

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member of FIG. 2:

FIG. 3 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3 3, and a side view of a prepared coaxial cable ready to be inserted into a back end of the F connector;

FIG. 3A is a cross-sectional view of the body of the F connector of FIG. 1 through cut-line 3 - 3;

FIG. 3B is a cross-sectional view of a tubular post of the F connector of FIG. 1, through cut-line 3-3;

FIG. 3C is a cross-sectional view of the coupling nut of the F connector of FIG. 1 through cut-line 3 - 3;

FIG. 4 is a cross-sectional view of the F connector of FIG. 1 through cut-line $3 \rightarrow 3$, and cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, prior to axial compression of the F connector:

FIG. 4A is an enlargement of a portion of FIG. 4:

FIG. 5 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3 3, and a cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, subsequent to axial compression of the F connector:

FIG. **5**A is an enlargement of a portion of FIG. **5**:

FIG. **6** is a partial cross-sectional view of a first alternate embodiment of an F connector having a first alternate grounding member:

FIG. 6A is an enlargement of a portion of FIG. 6:

FIG. **6**B is a slightly enlarged side view of the first alternate grounding member of FIG. **6**:

FIG. **6**C is a slightly enlarged plan view of the first alternate grounding member of FIG. **6**;

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of an F connector having a second alternate grounding member:

FIG. 7A is an enlargement of a portion of FIG. 7:

FIG. 7B is a slightly enlarged side view of the second alternate grounding member of FIG. 7:

FIG. 7C is a slightly enlarged plan view of the second alternate grounding member of FIG. 7:

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of an F connector having a third alternate grounding member:

FIG. 8A is a slightly enlarged side view of the third alternate grounding member of FIG. 8:

FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member of FIG. 8:

FIG. 9 is a partial cross-sectional view of a fourth 5 alternate embodiment of an F connector having one of a fourth alternate grounding member and a fifth alternate grounding member:

FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member of FIG. 9:

FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member of FIG. 9:

FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member of FIG. 9:

FIG. 9D is a slightly enlarged plan view of the fifth 15 alternate grounding member of FIG. 9:

FIG. 10 is a partial cross-sectional view of a fifth alternate embodiment of an F connector having conductive grease that acts as a grounding member:

FIG. 11 is a partial cross-sectional view of a front end of 20 a sixth alternate embodiment of an F connector having a sixth alternate grounding member:

FIG. 11A is an enlargement of a portion of FIG. 11:

FIG. **11**B is a side view of the sixth alternate grounding member of FIG. 11: 25

FIG. 11C is a plan view of the sixth alternate grounding member of FIG. 11: and

FIG. 11D is a perspective view of the sixth alternate grounding member of FIG. 11.

For simplicity and clarity of illustration, the drawing 30 figures illustrate the general manner of construction, and descriptions and details of well-known features and techniques are omitted to avoid unnecessarily obscuring the invention. Furthermore, elements in the drawing figures are not necessarily drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a perspective view of an F connector 100 in 40 accordance with the preferred embodiment of the invention. The F connector 100 (hereinafter. "connector") has a longitudinal axis 101. The connector has a front end 102 and a back end 103.

FIG. 2 is an exploded view of the connector 100. The 45 connector 100 includes tubular post 104. a coupling nut 105 rotatably secured over an end 106 of the tubular post for securing the connector to an appliance (not shown), and a body 108 secured to the tubular post. A shell 107 and a label 109 are secured to the body 108. Preferably, the body 108 is 50 made entirely of acetal plastic. Alternatively, the body 108 is made of brass, plated with nickel. The shell 107 adds strength to the plastic body 108 and protects the plastic body from ultraviolet light. The tubular post 104 is preferably metallic, and more preferably, made of brass, with a tin 55 plating: as tin is more conductive than nickel. The coupling nut 105 is preferably metallic, and more preferably, formed from brass, plated with nickel or with another non-corrosive material.

In the embodiment shown in the drawings, the coupling 60 nut 105 is rotatably secured over an end 106 of the tubular post 104 via a neck 111 of the body 108. Advantageously, an electrical grounding path is constantly maintained between the coupling nut 105 and the tubular post 104, including, in particular, when the coupling nut 105 of the connector 100 65 is not tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-con-

ductive grounding member 110 disposed between the tubular post 104 and the coupling nut 105.

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member 110. In the preferred embodiment of the present invention, the electrically-conductive grounding member 110 is disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 contacts both the tubular post 104 and the coupling nut 105 for providing an electrically-conductive path therebetween. but without restricting rotation of the coupling nut relative to the tubular post. A preferred embodiment of the grounding member 110 shown in FIG. 2A is a spring member, or circlip, disposed between the coupling nut 105 and the tubular post 104, which establishes a stable ground path between the coupling nut and the post, and which is preferably constructed of a wire-type material. The grounding member 110 is retained in the coupling nut 105 by an annular recess 343 (see FIG. 3C) in the coupling nut. The spring action of the grounding member 110 serves to form a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut 105 to rotate. The grounding member 110 is resilient and is generally arcuately shaped. The grounding member 110 extends around the tubular post 104 over an arc of at least 225°, and may extend for a full 360°. The arcuately shaped grounding member 110 may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member 110 is a C-shaped metal clip that has an arcuate curvature that is non-circular. The grounding member 110 has a minimum diameter 201 and a maximum diameter 203. Preferably, the grounding member 110 is made of stainless steel wire that has a wire diameter of between 0.010-inch and 0.020-inch: in a preferred embodiment, the wire diameter is about 0.016-inch. 35 Stainless steel is a preferred metal for the grounding member

110 because it need not be plated for corrosion resistance. FIG. 3 is a cross-sectional view of the connector 100 through cut-line 3-3 of FIG. 1, and a side view of a prepared coaxial cable 301 ready to be inserted into a back end 103 of the connector. The center conductor 302 of the coaxial cable 301 is surrounded by a dielectric material 303. and the dielectric material is surrounded by an outer conductor 304 that may be in the form of a conductive foil and/or braided sheath. The outer conductor 304 is usually surrounded by a plastic cable jacket 305 that electrically insulates, and mechanically protects, the outer conductor.

FIG. 3A is a cross-sectional view of the body 108 of FIG. 1 through cut-line 3—3. FIG. 3B is a cross-sectional view of the tubular post 104 of FIG. 1 through cut-line 3-3. FIG. 3C is a cross-sectional view of the coupling nut 105 of FIG. 1 through cut-line 3-3. Referring now to FIGS. 3, 3A, 3B and 3C, the body 108 has a lip 310 at a front end of the body. The lip 310 has an outer diameter 311 and an inner diameter 312. The coupling nut 105 is rotatably secured about a head 330 at the front end of the tubular post 104. The head 330 of the tubular post 104 usually includes an enlarged shoulder 332. The coupling nut 105 typically includes an inwardlydirected flange 340 that extends over and around the shoulder 332 of the tubular post 104. In order to retain the grounding member 110 inside the coupling nut 105, the inner. or central, bore 342 of the coupling nut 105 may include an annular recess 343 that is proximate to the end of the coupling nut that encircles the tubular post 104. At least portions of the grounding member 110 are engaged with the annular recess 343 to prevent the grounding member from being axially displaced within the coupling nut 105. The tubular post 104 may include an enlarged shoulder 332 at the

head 330 thereof. The shoulder 332 has a first radial face 333 that faces the back end of the tubular post 104. In one preferred embodiment of the present invention, the grounding member 110 surrounds the enlarged shoulder 332 of the tubular post 104. at least when the connector 100 is assembled onto the prepared end of a coaxial cable 301. At least portions of the grounding member 110 contact the outer surface 334 of such enlarged shoulder 332.

The coupling nut 105 has an inwardly-directed flange near the back end of the coupling nut. The coupling nut 105 has 1 an inner diameter 341 at a back end of the coupling nut. In order to retain the back end of the coupling nut 105 on the front end of the body 108, the inner diameter 341 of the coupling nut has a dimension less than the outer diameter of the lip 310 of the body 108. In order not to interfere with free 15 rotation of the coupling nut 105, the outer diameter 336 of the shoulder 332 (at the head 330 of the tubular post 104) is of smaller dimension than the inner diameter 344 of the central bore of the coupling nut 105. Likewise, the inner diameter 341 of the inwardly-directed flange 340 of the 20 coupling nut 105 is of larger dimension than the outer diameter 337 of the non-shoulder portion 338 of the tubular post 104. again to avoid interference with rotation of the coupling nut 105 relative to the tubular post.

FIG. 4 is a cross-sectional view of the connector 100 $_{25}$ through cut-line 3 $_{-3}$, and cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof, prior to axial compression of the connector. FIG. 4A is an enlargement of a portion of FIG. 4. Referring now to FIGS. 4 and 4A, the resilient, electrically-conductive 30 grounding member 110 is shown disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 is disposed in the annular recess 343 that encircles the tubular post 104.

FIG. 5 is a cross-sectional view of the connector 100 35 through cut-line 3 3, and a cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof, subsequent to axial compression of the connector. FIG. 5A is an enlargement of a portion of FIG. 5. Referring now to FIGS. 5 and 5A, as a result of axial 40 compression by a standard compression tool (not shown). the tubular post 104 slides (to the right in the drawings) relative to the other components of the connector 100 and relative to the cable 301, such that the shoulder 332 of the tubular post is radially inward of the grounding member 110. 45 At least a portion of the grounding member 110 engages the coupling nut 105 at the annular recess 343 of the coupling nut, and at least another portion of the grounding member engages tubular post 104 at the shoulder 332 of the tubular post. The tubular post 104 is in electrical contact with the 50 outer conductor 304 of the cable 301 along the back portion of the tubular post, and the coupling nut 105 may engage the outer conductor of an appliance port (not shown). Therefore, when the connector 100 is fastened to an appliance port. there is maintained an electrical grounding path between the 55 outer conductor 304 of the cable 301 and the outer conductor of the appliance port, whether or not the coupling nut 105 of the connector is tightly fastened to the appliance port.

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of a connector 600 having a first alternate 60 grounding member 601 (see FIGS. 6A 6C), shown subsequent to axial compression, FIG. 6A is an enlargement of a portion of the first alternate embodiment of the connector 600 showing a portion of the first alternate grounding member 601, FIG. 6B is a slightly enlarged side view of the 65 first alternate grounding member 601, FIG. 6C is a slightly enlarged plan view of the first alternate grounding member 8

601. Referring now to FIGS. 6. 6A. 6B and 6C, the first alternate grounding member 601 is a spring finger grounding member retained between the coupling nut 105 and the tubular post 104. The first alternate grounding member 601 is constructed of a thin cross section of material such bervllium copper. The first alternate grounding member 601 comprises a ring portion 602 and a plurality of fingers 603 that project at approximately a 30° angle from the plane of the ring. The spring action of the fingers 603 extend to, and make contact with, a radial surface 604 near the back end of the coupling nut 105 that faces the front end of the coupling nut, which serve to connect a ground path from the coupling nut to the tubular post while allowing the coupling nut to rotate. The first alternate grounding member 601 has optional internal lugs 605 that contact the outer diameter 337 of the non-shoulder portion of the tubular post.

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of a connector 700 having a second alternate grounding member 701 (see FIGS. 7.4 7C). FIG. 7A is an enlargement of a portion of the second alternate embodiment of the connector 700, showing a portion of the second alternate grounding member 701. FIG. 7B is a slightly enlarged side view of the second alternate grounding member 701. FIG. 7C is a slightly enlarged plan view of the second alternate grounding member 701. Referring now to FIGS. 7, 7A, 7B and 7C, the second alternate grounding member 701 is a radial grounding member retained between the coupling nut 105 and the tubular post 104. The second alternate grounding member 701 is constructed of a thin cross section of metallic material such as beryllium copper. The second alternate grounding member 701 comprises a ring portion 702 and a plurality of fingers 703 extending radially from the ring portion at about a 45° angle from the plane of the ring portion. The spring action of the fingers 703 extend to inner-diameter surfaces 705 of the coupling nut 105 and serve to connect a ground path from the coupling nut to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of a connector 800 having a third alternate grounding member 801 (see FIGS. 8A-8E). FIG. 8A is a slightly enlarged side view of the third alternate grounding member 801. FIGS. 8B 8E are slightly enlarged plan views of four styles of the third alternate grounding member 801. Referring now to FIG. 8 and FIGS. 8A 8E. the third alternate grounding member 801 is a conductive member retained between the coupling nut 105 and the tubular post 104. The third alternate grounding member 801 is constructed of a thin cross section of metallic material such as brass or beryllium copper. The third alternate grounding member 801 comprises a ring 802 with multiple points of contact, or internal lugs, 803 around the inner perimeter of the ring and with multiple external lugs 804 around the outer perimeter of the ring. The lugs 803 and 804 serve to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. FIGS. 8B 8E show four styles with regard to the shape of the lugs 803 and 804 and the position of the lugs on the ring 802. FIG. 8 also exhibits an alternate embodiment comprising a sealing ring 805 for forming a moisture seal between the coupling nut 105 and the body 108 of the connector 801. The sealing ring 805 is disposed between the back end of the coupling nut 105 and the body 108 for forming a seal therebetween. Preferably, the sealing ring 805 is made from ethylene propylene. Use of the sealing ring 805 is not limited to use in connectors having the third alternate grounding member

801. The third alternate grounding member **801** may also be used in connectors without the sealing ring **805**.

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of a connector 900 having one of a fourth alternate grounding member 901 and a fifth alternate grounding member 911 (see FIGS. 9A 9D). FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member 901. FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member 901. FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member 10 902. FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member 911. The fourth and fifth alternate embodiments of the grounding member 901 and 911. respectively, comprise a C-shaped ring between the coupling nut 105 and the tubular post 104. The C-shaped ring is 15 constructed of a thin cross section of metallic material such as beryllium copper or stainless steel. It is retained by a groove in the coupling nut. The spring action of the C-shaped ring serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the 20 coupling nut to rotate. The fourth alternate grounding member 901 includes a circumferential metallic band 902, which has a general circular shape and approximates a section of a hollow cylinder, that extends between first 903 and second 904 opposing ends. The band 902 has first 906 and second 25 907 opposing side edges extending along its length. The fourth alternate grounding member 901 includes a first generally radial wall 908 extending from the first side edge 906 of the band in a first radial direction, and a second generally radial wall 909 extending from the second side 30 edge 907 of the band generally in said first radial direction. The band 902 contacts a first one of the group of members that includes the coupling nut 105 and the tubular post 104. The first 908 and second 909 radial walls contact the second of the group of members that includes the coupling nut 105 35 and the tubular post 104. The fifth alternate grounding member 911 includes a metallic band 912 extending along its length between first 913 and second 914 opposing ends. and extending along its width between first 916 and second 917 side edges. The band 912 is formed along its length into 40 a generally circular shape. The band 912 is formed along its width into a generally concave shape with the side edges 916 and 917 projecting generally in a first radial direction. The fifth alternate grounding member 911 includes a plurality of projections 918 extending from the band 912 in a second 45 radial direction opposite to the first radial direction. The first 916 and second 917 side edges of the band 912 contact a first one of the group of members that includes the coupling nut and the tubular post. The plurality of projections 918 contact the second of the group of members that includes the 50 coupling nut 105 and the tubular post 104.

FIG. 10 is a partial cross-sectional view of a fifth alternate embodiment of a connector 1000 having conductive grease (not shown) that acts as a grounding member. The ground path is established by means of a close fit between the 55 coupling nut 105 and the tubular post 104. The conductive grease is disposed at a grease annular ring 1001 where mating portions of the tubular post 104 and coupling nut 105 have closely matching dimensions. Preferably, the conductive grease is a silver-loaded silicon lubricating material. ⁶⁰ The conductive grease serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector 1100 that 65 includes a body 1108, and which has a sixth alternate grounding member 1101. FIG. 11A is an enlargement of a 10

portion of FIG. 11. FIG. 11B is a side view of the sixth alternate grounding member 1101. FIG. 11C is a plan view of the sixth alternate grounding member 1101. FIG. 1D is a perspective view of the sixth alternate grounding member 1101. Referring now to FIG. 11 and FIGS. 11.4 11D, the sixth alternate grounding member 1101 includes a circumferential metallic band 1112 extending between first 1113 and second 1114 opposing ends. The band 1112 has a generally circular shape that approximates a section of a hollow cylinder. The first 1113 and second 1114 ends of the band 1112 are disposed generally proximate to each other and are directed generally toward one another. The band 1112 has first and second opposing side edges 1115 and 1116. respectively, extending along its length. The band generally defines a section of a cylindrical surface. The sixth alternate grounding member 1101 includes a plurality of projections 1101 extending from at least one of the first and second side edges 1115 and 1116 of the band 1112. The plurality of projections 1117 extend away from the cylindrical surface defined by the band 1112. The band 1112 contacts a first one of the group of members that includes the coupling nut 1105 and the tubular post 1104. The plurality of projections 1117 contact the second of the group of members that includes the coupling nut 1105 and the tubular post 1104.

In preferred embodiments, the present invention provides a coaxial cable connector that ensures a reliable grounding path without creating undue interference with free rotation of the coupler relative to the remaining components of the connector: however, the present invention can also provide a reliable grounding path between a post and a coupler that does not rotate. Advantageously, a connector in accordance with the invention works with standard installation tools and with standard compression tools. The present invention can be used with both axially-compressible connectors as well as with older-style crimp-ring connectors. In some embodiments, the present invention is compatible with the use of a sealing ring for forming a moisture seal between the coupler and the outer body of the connector.

While the present invention has been described with respect to preferred embodiments thereof, such description is for illustrative purposes only, and is not to be construed as limiting the scope of the invention. Various modifications and changes may be made to the described embodiments by those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims. For example, the grounding member can have a shape other than generally circular, such as square, hexagonal, octagonal, oval, etc.

We claim:

1. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof;
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving

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the outer conductor of the coaxial cable, wherein the body member contacts the coupler; and

d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween.

2. The coaxial cable connector recited by claim 1 wherein said grounding member is arcuately shaped to extend around the tubular post over at least 225 degrees.

3. The coaxial cable connector recited by claim **2** wherein said grounding member is configured to form a broken ring.

4. The coaxial cable connector recited by claim 2 wherein said grounding member is formed from metal wire.

5. The coaxial cable connector recited by claim **2** wherein ¹⁵ the central bore of the coupler includes an annular recess proximate to the first end of the coupler, and wherein at least portions of said grounding member are disposed within the annular recess.

6. The coaxial cable connector recited by claim **5** wherein 20 the tubular post includes an enlarged shoulder at the second end thereof extending inside the coupler, and wherein the annular recess and said grounding member surround the enlarged shoulder of the tubular post when the coaxial cable connector is assembled onto the prepared end of the coaxial 25 cable.

7. The coaxial cable connector recited by claim 1 wherein said grounding member is generally circular.

8. The coaxial cable connector recited by claim 7 wherein said grounding member has a plurality of projections extending radially outwardly therefrom for engaging the coupler.

9. The coaxial cable connector recited by claim **7** wherein said grounding member has a plurality of projections extending radially inwardly therefrom for engaging the tubular post.

10. The coaxial cable connector recited by claim **1** wherein the tubular post includes an enlarged shoulder at the second end thereof extending inside the coupler, the enlarged shoulder including a first radial face that faces the first end of the tubular post, the coupler including a radially inwardly directed flange proximate the first end thereof directed flange including a second radial face that faces the second end of the coupler, said grounding member being disposed between the first radial face and the second radial face for electrically coupling the tubular post to the coupler.

11. The coaxial cable connector recited by claim 10 wherein the grounding member includes a central, generally 50circular body member disposed generally within a plane, the grounding member including a plurality of resilient spring fingers extending out of said plane and being compressed between the first radial face of the tubular post and the second radial face of the coupler. 55

12. The coaxial cable connector recited by claim 11 wherein said plurality of spring fingers includes at least a first spring finger and a second spring finger. and wherein said first and second spring fingers extend out of said plane in opposing directions.

13. The coaxial cable connector recited by claim 1 wherein the grounding member includes:

a. a circumferential metallic band extending between first and second opposing ends, the band having a generally circular shape, and approximating a section of a hollow 65 cylinder, the first and second ends of the band being disposed generally proximate to each other and being 12

directed generally toward one another, the band having first and second opposing side edges extending along its length:

- b. a first generally radial wall extending from the first side edge of the band in a first radial direction; and
- c. a second generally radial wall extending from the second side edge of the band generally in said first radial direction;

wherein the band contacts a first one of the group of members that consists of the coupler and the tubular post, and wherein the first and second radial walls contact the second of the group of members that consists of the coupler and the tubular post.

14. The coaxial cable connector recited by claim 13 wherein the band has a plurality of apertures formed therein.

15. The coaxial cable connector recited by claim 13 wherein the band has dimples formed therein, the dimples extending away from the band in a second radial direction opposite to said first radial direction.

16. The coaxial cable connector recited by claim **1** wherein the grounding member includes:

- a. a metallic band extending along its length between first and second opposing ends, and extending along its width between first and second side edges, the band being formed along its length into a generally circular shape, the band being formed along its width into a generally concave shape with the side edges projecting generally in a first radial direction, the first and second ends of the band being disposed generally proximate to each other and being directed generally toward one another; and
- a plurality of projections extending from the band in a second radial direction opposite to the first radial direction;

wherein the first and second side edges of the band contact a first one of the group of members that includes the coupler and the tubular post, and wherein the plurality of projections contact the second of the group of members that includes the coupler and the tubular post.

17. The coaxial cable connector recited by claim 16 wherein the band has a plurality of apertures formed therein to create the plurality of projections.

18. The coaxial cable connector recited by claim **16** wherein the plurality of projections is dimples.

19. The coaxial cable connector recited by claim **1** wherein the grounding member includes:

- a. a circumferential metallic band extending between first and second opposing ends, the band having a generally circular shape, and approximating a section of a hollow cylinder, the first and second ends of the band being disposed generally proximate to each other and being directed generally toward one another, the band having first and second opposing side edges extending along its length, the band generally defining a section of a cylindrical surface; and
- a plurality of projections extending from at least one of the first and second side edges of the band, the plurality of projections extending away from the cylindrical surface defined by the band;

wherein the band contacts a first one of the group of members that includes the coupler and the tubular post, and wherein the plurality of projections contact the second of the group of members that includes the coupler and the tubular post.

20. The coaxial cable connector recited by claim 19 wherein the plurality of projections are formed by cutting

slots into the band from one of the first and second side edges of the band, and by displacing portions of the band lying between adjacent slots.

21. The coaxial cable connector recited by claim 2 further including a sealing ring disposed between the first end of the scoupler and the body member for forming a seal therebetween.

22. The coaxial cable connector recited by claim 2 wherein said grounding member is a C-shaped metal clip.

23. The coaxial cable connector recited by claim 22 10 wherein said C-shaped metal clip has an arcuate curvature that is non-circular to maximize contact with both the coupler and the tubular post.

24. The coaxial cable connector recited by claim 22 wherein said C-shaped metal clip is made of wire.

25. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof, the tubular post including a grounding path portion having an outer²⁵ surface of a predetermined outer diameter:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore 30 extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port, the coupler including a grounding path portion having an inner surface of a predetermined inner diameter, the grounding path portion of the coupler being disposed adjacent to the grounding path portion of the tubular post when the coaxial cable connector is installed onto the coaxial cable, and wherein the predetermined inner diameter closely approximates the predetermined outer diameter 40 while permitting rotation of the coupler relative to the tubular post:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable; and
- conductive grease disposed proximate to the respective grounding path portions of the tubular post and coupler for electrically coupling such grounding path portions.

26. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center 50 conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the 55 dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore ou extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving 65 the outer conductor of the coaxial cable, wherein the body member contacts the coupler; and

- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the tubular post, the body member, the grounding member, and the coupler are disposed about a common longitudinal axis:
- wherein the grounding member comprises a ring portion and a plurality of fingers extending from the ring portion.

27. The coaxial cable connector of claim 26 wherein the plurality of fingers extend radially from the ring portion.

28. The coaxial cable connector of claim **26** wherein the 15 plurality of fingers contacts the coupler.

29. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial 20 cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member contacts the coupler; and
- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the tubular post, the body member, the grounding member, and the coupler are disposed about a common longitudinal axis:
- wherein the grounding member comprises a spring projecting portion that extends away from a plane perpendicular to the longitudinal axis.

30. The coaxial cable connector of claim **29** wherein the spring projecting portion contacts the coupler.

31. The coaxial cable connector of claim **29** wherein the grounding member comprises first and second spring projecting portions that project from said plane in opposing longitudinal directions.

32. The coaxial cable connector of claim **29** wherein a substantial portion of the grounding member lies in the perpendicular plane.

33. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore

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proximate the second end of the coupler being adapted for engaging the equipment port:

- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable: and
- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the tubular post, the body member, the grounding member, and the coupler are disposed about a common longitudinal axis;

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wherein the grounding member comprises a central body portion, a first spring finger, and a second spring finger, wherein the central body portion is disposed generally within a plane perpendicular to the longitudinal axis, and wherein the first and second spring fingers extend from the central body portion and project from said plane in opposing directions.

34. The coaxial cable connector of claim **33** wherein a $_{10}$ substantial portion of the grounding member lies in the perpendicular plane.

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Case 4:22-cv-00163-LPR Docum



(12) EX PARTE REEXAMINATION CERTIFICATE (10124th) **United States Patent** (10) **Number:**

Bence et al.

US 7,114,990 C1 (45) Certificate Issued: Apr. 18, 2014

(54) COAXIAL CABLE CONNECTOR WITH **GROUNDING MEMBER**

- (75) Inventors: Bruce D. Bence, Glendale, AZ (US); Donald A. Burris, Peoria, AZ (US): Brian L. Kisling. Phoenix. AZ (US): John A. Kooiman. Mesa. AZ (US): William B. Lutz. Glendale. AZ (US): William F. McDade, Glendale, AZ (US): Thomas D. Miller, Peoria, AZ (US): Lee Yung Chuan. Sanchong (TW)
- (73) Assignee: Corning Incorporated. Corning. NY (US)

Reexamination Request: No. 90/012,749, Dec. 21, 2012

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- (52) U.S. Cl. USPC 439/583: 439/322

(58) Field of Classification Search None

See application file for complete search history.

(56)**References** Cited

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/012.749. please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner Linh M. Nguyen

(57)ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.



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EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

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THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [] appeared in the patent, but has been deleted and is no longer a part of the 10 patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION. IT HAS BEEN DETERMINED THAT:

The patentability of claims 1-5. 7-12. 22. 24 and 26-34 is confirmed.

New claims 35-38 are added and determined to be patentable.

Claims 6, 13-21, 23 and 25 were not reexamined.

35. The coaxial cable connector of claim 1 wherein the resilient, electrically conductive grounding member provides the electrically-conductive path between the coupler and the tubular post without restricting rotation of the coupler relative to the tubular post.

36. The coaxial cable connector of claim 26 wherein the resilient, electrically conductive grounding member provides the electrically-conductive path between the coupler and the tubular post without restricting rotation of the coupler relative to the tubular post.

37. The coaxial cable connector of claim 29 wherein the resilient, electrically conductive grounding member provides the electrically-conductive path between the coupler and the tubular post without restricting rotation of the coupler relative to the tubular post.

38. The coaxial cable connector of claim 33 wherein the resilient, electrically conductive grounding member provides the electrically-conductive path between the coupler and the tubular post without restricting rotation of the coupler rela-20 tive to the tubular post.

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Case 4:22-cv-00163-LPR Docum



(12) EX PARTE REEXAMINATION CERTIFICATE (11141st) **United States Patent** (10) **Number:**

Bence et al.

(54) COAXIAL CABLE CONNECTOR WITH **GROUNDING MEMBER**

(75) Inventors: Bruce D. Bence, Glendale, AZ (US): Donald A. Burris, Peoria, AZ (US): Brian L. Kisling, Phoenix, AZ (US): John A. Kooiman, Mesa, AZ (US): William B. Lutz, Glendale, AZ (US): William F. McDade, Glendale, AZ (US): Thomas D. Miller, Peoria, AZ (US): Lee Yung Chuan. Sanchong (**TW**)

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H01R 43/20	(2006.01)

US 7,114,990 C2 (45) Certificate Issued: Jun. 30, 2017

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(58) Field of Classification Search None

See application file for complete search history.

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To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/013.380, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner -- Christina Y Leung

(57) ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.



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EX PARTE REEXAMINATION CERTIFICATE

THE PATENT IS HEREBY AMENDED AS 5 INDICATED BELOW.

AS A RESULT OF REEXAMINATION. IT HAS BEEN DETERMINED THAT:

Claims 1-5, 7-12, 22, 24 and 26-34 are cancelled. ¹⁰ Claims 6, 13-21, 23, 25 and 35-38 were not reexamined.

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Case 4:22-cv-00163-LPR Docum

US007479035B2

(12) United States Patent

Bence et al.

(54) ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

- (75) Inventors: Bruce D. Bence, Glendale, AZ (US);
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 Lee Yung Chuan, Sanchong (TW)
- (73) Assignee: Corning Gilbert Inc., Glendale, AZ (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 32 days.
- (21) Appl. No.: 11/541,903
- (22) Filed: Oct. 2, 2006 (Under 37 CFR 1.47)

(65) Prior Publication Data

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Related U.S. Application Data

- (63) Continuation of application No. 11/043,844, filed on Jan. 25, 2005, now Pat. No. 7,114,990.
- (51) Int. Cl. *H01R 9/05*
- (52) U.S. CL 439/583

(2006.01)

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(45) Date of Patent: Jan. 20, 2009

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(57) ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.

17 Claims, 8 Drawing Sheets





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ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

This application claims the benefit of U.S. patent application Ser. No. 11/043,844, filed Jan. 25, 2005, now U.S. Pat. 5 No. 7,114,990 the benefit of priority is hereby claimed.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to electrical connectors, and more particularly to coaxial cable connectors capable of being connected to a terminal.

2. Description of the Related Art

Coaxial cable connectors, such as type F connectors, are 15 used to attach coaxial cable to another object or appliance, e.g., a television set or VCR having a terminal adapted to engage the connector. The terminal of the appliance includes an inner conductor and a surrounding outer conductor.

Coaxial cable includes a center conductor for transmitting 20 a signal. The center conductor is surrounded by a dielectric material, and the dielectric material is surrounded by an outer conductor; this 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 25 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 con- 30 nector 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 bare 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.

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, 40 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; this outer body of the connector is usually fixedly secured to 45 the tubular post. A coupler is 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.

When connecting the end of a coaxial cable to a terminal of 50 not fully tightened onto the appliance port. a television set, equipment box, 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. This goal is usually achieved by ensuring that the coupler of the connector is fully tightened 55 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; 60 in turn, the tubular post is engaged with the outer conductor of the coaxial cable.

However, in many cases, it is difficult for an installer to reach the connection ports of the appliance with a wrench, and in some instances, it is even difficult for the installer to 65 reach such connection ports with his or her fingers. As a result, it can often happen that type F connectors are not fully

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tightened to the appliance port. In such a loose connection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, a gap exists between the outer conductor of the appliance port and the tubular post of the connector. Unless an alternate ground path exists, poor signal quality, and RFI leakage, will result.

As mentioned above, the coupler is 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 dimension 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.

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 35 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.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a coaxial cable connector for connecting a coaxial cable to a connection port of an appliance, the coaxial cable connector being of the type that includes a tubular post and a coupler, such as a rotatable coupler, which ensures a reliable ground connection between the tubular post of the connector and an outer conductor of the appliance port, even if the coupler is

It is another object of the present invention to provide such a coaxial cable connector which maintains a reliable ground path between the coupler and the tubular post, at least following installation of such connector onto the end of a coaxial cable.

It is still another object of the present invention to provide such a coaxial connector that can be manufactured economically.

These and other objects of the present invention will become more apparent to those skilled in the art as the description thereof proceeds.

SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a coaxial cable connector comprising a tubular post, a coupler and a grounding means for providing an electrically conductive

path between the post and the coupler. In accordance with a preferred embodiment thereof, the present invention relates to a coaxial cable connector for coupling a prepared end of a coaxial cable to a threaded female equipment port, and including a tubular post having a first end adapted to be 5 inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor thereof. A coupler is rotatably secured over the second end of the tubular post, and includes a central bore, at least a portion of which is threaded for engaging the female equipment port. An outer 10 body is secured to the tubular post and extends about the first end of the tubular post for receiving the outer conductor, and preferably the cable jacket, of the coaxial cable.

In a preferred embodiment of the present invention, a resilient, electrically-conductive grounding member is disposed ¹⁵ between the tubular post and the coupler. This grounding member engages both the tubular post and the coupler for providing an electrically-conductive path therebetween, but without restricting rotation of the coupler relative to the tubular post. ²⁰

For some preferred embodiments, the grounding member is generally arcuately shaped to extend around the tubular post over an arc of at least 225°, and may extend for a full 360°. This arcuately shaped grounding member may be in the form of a generally circular broken ring, or C-shaped mem-²⁵ ber, as by bending a strip of metal wire into an arc. Preferably, the grounding member has a shape that is out-of-round, and more preferably oblong, rather than circular, in order to ensure reliable electrical contact with both the coupler and the 30 tubular post. In order to retain the grounding member inside the coupler, the inner bore of the coupler may include an annular recess proximate to the end of the coupler that encircles the tubular post; at least portions of the grounding member are engaged with the annular recess to prevent the 35 grounding member from being axially displaced within the coupler.

As mentioned above, the tubular post may include an enlarged shoulder at the head thereof. In one preferred embodiment of the present invention, the grounding member surrounds the enlarged shoulder of the tubular post, at least when the coaxial cable connector is assembled onto the prepared end of a coaxial cable, whereby at least portions of the grounding member engage the outer surface of such enlarged shoulder.

In one embodiment of the present invention, the grounding member is generally circular and includes a plurality of projections extending outwardly therefrom for engaging the coupler. In another embodiment of the present invention, the grounding member is generally circular and includes a plurality of projections extending inwardly therefrom for engaging the tubular post.

In yet another embodiment of the present invention, the tubular post includes an enlarged shoulder extending inside the coupler, and including a first radial face that faces the 55 opposite end of the tubular post. The coupler includes a flange directed inwardly toward the tubular post; this inwardly directed flange including a second radial face that faces toward the connection port of the appliance to which the coaxial cable is to be connected. The grounding member is 60 disposed between the first radial face and the second radial face. In this embodiment, the grounding member is resilient relative to the longitudinal axis of the connector, and is compressed between the first radial face and the second radial face to maintain sliding electrical contact between the shoulder of 65 the tubular post (via its first radial face) and the flange of the coupler (via its second radial face).

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The coaxial connector of the present invention may also include a sealing ring seated within the coupler for rotatably engaging the body member to form a seal therebetween.

In an alternate embodiment of the present invention, conductive grease is substituted for a discrete grounding member. In this embodiment, an outer dimension of a portion of the tubular post is caused to be commensurate with an inner dimension of an adjacent portion of the coupler. While the gap between such adjacent portions, coupled with the lubrication provided by the conductive grease, is sufficient to permit rotation of the coupler relative to the tubular post, the conductive grease nonetheless functions to maintain reliable electrical coupling across such gap.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with greater specificity and clarity with reference to the following drawings, in which:

FIG. 1 is a perspective view of an F connector in accordance with the preferred embodiment of the invention, including a body and a coupling nut;

FIG. 2 is an exploded view of the F connector of FIG. 1, including a preferred embodiment of a grounding member;

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member of FIG. 2;

FIG. 3 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and a side view of a prepared coaxial cable ready to be inserted into a back end of the F connector;

FIG. **3A** is a cross-sectional view of the body of the F connector of FIG. **1** through cut-line **3-3**;

FIG. 3B is a cross-sectional view of a tubular post of the F connector of FIG. 1, through cut-line 3-3;

FIG. 3C is a cross-sectional view of the coupling nut of the F connector of FIG. 1 through cut-line 3-3;

FIG. 4 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, prior to axial compression of the F connector;

FIG. 4A is an enlargement of a portion of FIG. 4;

FIG. 5 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, subsequent to axial compression of the F connector;

FIG. 5A is an enlargement of a portion of FIG. 5;

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of an F connector having a first alternate grounding member;

FIG. 6A is an enlargement of a portion of FIG. 6;

FIG. 6B is a slightly enlarged side view of the first alternate grounding member of FIG.6;

FIG. 6C is a slightly enlarged plan view of the first alternate grounding member of FIG. 6;

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of an F connector having a second alternate grounding member;

FIG. 7A is an enlargement of a portion of FIG. 7;

FIG. 7B is a slightly enlarged side view of the second alternate grounding member of FIG. 7;

FIG. 7C is a slightly enlarged plan view of the second alternate grounding member of FIG. 7;

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of an F connector having a third alternate grounding member;

FIG. 8A is a slightly enlarged side view of the third alternate grounding member of FIG. 8;

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FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member of FIG. 8;

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of an F connector having one of a fourth alternate grounding member and a fifth alternate grounding mem- 5 ber:

FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member of FIG. 9;

FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member of FIG. 9;

FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member of FIG. 9;

FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member of FIG. 9;

FIG. 10 is a partial cross-sectional view of a fifth alternate 15 embodiment of an F connector having conductive grease that acts as a grounding member;

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector having a sixth alternate grounding member;

FIG. 11 A is an enlargement of a portion of FIG. 11;

FIG. 11 B is a side view of the sixth alternate grounding member of FIG. 11;

FIG. 11C is a plan view of the sixth alternate grounding 25 member of FIG. 11; and

FIG. 11D is a perspective view of the sixth alternate grounding member of FIG. 11.

For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and 30 descriptions and details of well-known features and techniques are omitted to avoid unnecessarily obscuring the invention. Furthermore, elements in the drawing figures are not necessarily drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a perspective view of an F connector 100 in accordance with the preferred embodiment of the invention. 40 The F connector 100 (hereinafter, "connector") has a longitudinal axis 101. The connector has a front end 102 and a back end 103.

FIG. 2 is an exploded view of the connector 100. The connector 100 includes tubular post 104, a coupling nut 105 45 rotatably secured over an end 106 of the tubular post for securing the connector to an appliance (not shown), and a body 108 secured to the tubular post. A shell 107 and a label 109 are secured to the body 108. Preferably, the body 108 is made entirely of acetal plastic. Alternatively, the body 108 is 50 made of brass, plated with nickel. The shell 107 adds strength to the plastic body 108 and protects the plastic body from ultraviolet light. The tubular post 104 is preferably metallic, and more preferably, made of brass, with a tin plating; as tin is more conductive than nickel. The coupling nut 105 is 55 preferably metallic, and more preferably, formed from brass, plated with nickel or with another non-corrosive material.

In the embodiment shown in the drawings, the coupling nut 105 is rotatably secured over an end 106 of the tubular post 104 via a neck 111 of the body 108. Advantageously, an 60 electrical grounding path is constantly maintained between the coupling nut 105 and the tubular post 104, including, in particular, when the coupling nut 105 of the connector 100 is not tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive 65 grounding member 110 disposed between the tubular post 104 and the coupling nut 105.

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FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member 110. In the preferred embodiment of the present invention, the electrically-conductive grounding member 110 is disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 contacts both the tubular post 104 and the coupling nut 105 for providing an electrically-conductive path therebetween, but without restricting rotation of the coupling nut relative to the tubular post. A preferred embodiment of the grounding member 110 shown in FIG. 2A is a spring member, or circlip, disposed between the coupling nut 105 and the tubular post 104, which establishes a stable ground path between the coupling nut and the post, and which is preferably constructed of a wire-type material. The grounding member 110 is retained in the coupling nut 105 by an annular recess 343 (see FIG. 3C) in the coupling nut. The spring action of the grounding member 110 serves to form a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut 105 to rotate. The grounding member 110 is 20 resilient and is generally arcuately shaped. The grounding member 110 extends around the tubular post 104 over an arc of at least 225°, and may extend for a full 360°. The arcuately shaped grounding member 110 may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member 110 is a C-shaped metal clip that has an arcuate curvature that is non-circular. The grounding member 110 has a minimum diameter 201 and a maximum diameter 203. Preferably, the grounding member 110 is made of stainless steel wire that has a wire diameter of between 0.010-inch and 0.020-inch; in a preferred embodiment, the wire diameter is about 0.016-inch. Stainless steel is a preferred metal for the grounding member 110 because it need not be plated for corrosion resistance.

FIG. 3 is a cross-sectional view of the connector 100 through cut-line 3-3 of FIG. 1, and a side view of a prepared coaxial cable 301 ready to be inserted into a back end 103 of the connector. The center conductor 302 of the coaxial cable 301 is surrounded by a dielectric material 303, and the dielectric material is surrounded by an outer conductor 304 that may be in the form of a conductive foil and/or braided sheath. The outer conductor 304 is usually surrounded by a plastic cable jacket 305 that electrically insulates, and mechanically protects, the outer conductor.

FIG. 3A is a cross-sectional view of the body 108 of FIG. 1 through cut-line 3-3. FIG. 3B is a cross-sectional view of the tubular post 104 of FIG. 1 through cut-line 3-3. FIG. 3C is a cross-sectional view of the coupling nut 105 of FIG. 1 through cut-line 3-3. Referring now to FIGS. 3, 3A, 3B and 3C, the body 108 has a lip 310 at a front end of the body. The lip 310 has an outer diameter 311 and an inner diameter 312. The coupling nut 105 is rotatably secured about a head 330 at the front end of the tubular post 104. The head 330 of the tubular post 104 usually includes an enlarged shoulder 332. The coupling nut 105 typically includes an inwardly-directed flange 340 that extends over and around the shoulder 332 of the tubular post 104. In order to retain the grounding member 110 inside the coupling nut 105, the inner, or central, bore 342 of the coupling nut 105 may include an annular recess 343 that is proximate to the end of the coupling nut that encircles the tubular post 104. At least portions of the grounding member 110 are engaged with the annular recess 343 to prevent the grounding member from being axially displaced within the coupling nut 105. The tubular post 104 may include an enlarged shoulder 332 at the head 330 thereof. The shoulder 332 has a first radial face 333 that faces the back end of the tubular post 104. In one preferred embodiment of the present

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invention, the grounding member 110 surrounds the enlarged shoulder 332 of the tubular post 104, at least when the connector 100 is assembled onto the prepared end of a coaxial cable 301. At least portions of the grounding member 110 contact the outer surface 334 of such enlarged shoulder 332.

The coupling nut 105 has an inwardly-directed flange near the back end of the coupling nut. The coupling nut 105 has an inner diameter 341 at a back end of the coupling nut. In order to retain the back end of the coupling nut 105 on the front end of the body 108, the inner diameter 341 of the coupling nut 10 has a dimension less than the outer diameter of the lip 310 of the body 108. In order not to interfere with free rotation of the coupling nut 105, the outer diameter 336 of the shoulder 332 (at the head 330 of the tubular post 104) is of smaller dimension than the inner diameter 344 of the central bore of the 15 coupling nut 105. Likewise, the inner diameter 341 of the inwardly-directed flange 340 of the coupling nut 105 is of larger dimension than the outer diameter 337 of the nonshoulder portion 338 of the tubular post 104, again to avoid interference with rotation of the coupling nut 105 relative to 20 the tubular post.

FIG. 4 is a cross-sectional view of the connector 100 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof, prior to axial compression of the connector. FIG. 4A is an 25 enlargement of a portion of FIG. 4. Referring now to FIGS. 4 and 4A, the resilient, electrically-conductive grounding member 110 is shown disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 is disposed in the annular recess 343 that encircles the tubular 30 post 104.

FIG. 5 is a cross-sectional view of the connector 100 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof, subsequent to axial compression of the connector. 35 FIG. 5A is an enlargement of a portion of FIG. 5. Referring now to FIGS. 5 and 5A, as a result of axial compression by a standard compression tool (not shown), the tubular post 104 slides (to the right in the drawings) relative to the other components of the connector 100 and relative to the cable 301, 40 such that the shoulder 332 of the tubular post is radially inward of the grounding member 110. At least a portion of the grounding member 110 engages the coupling nut 105 at the annular recess 343 of the coupling nut, and at least another portion of the grounding member engages tubular post 104 at 45 the shoulder 332 of the tubular post. The tubular post 104 is in electrical contact with the outer conductor 304 of the cable 301 along the back portion of the tubular post, and the coupling nut 105 may engage the outer conductor of an appliance port (not shown). Therefore, when the connector 100 is fas- 50 tened to an appliance port, there is maintained an electrical grounding path between the outer conductor 304 of the cable 301 and the outer conductor of the appliance port, whether or not the coupling nut 105 of the connector is tightly fastened to the appliance port.

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of a connector 600 having a first alternate grounding member 601 (see FIGS. 6A-6C), shown subsequent to axial compression. FIG. 6A is an enlargement of a portion of the first alternate embodiment of the connector 600 60 showing a portion of the first alternate grounding member 601. FIG. 6B is a slightly enlarged side view of the first alternate grounding member 601. FIG. 6C is a slightly enlarged plan view of the first alternate grounding member 601. Referring now to FIGS. 6, 6A, 6B and 6C, the first 65 alternate grounding member 601 is a spring finger grounding member retained between the coupling nut 105 and the tubu8

lar post 104. The first alternate grounding member 601 is constructed of a thin cross section of material such beryllium copper. The first alternate grounding member 601 comprises a ring portion 602 and a plurality of fingers 603 that project at approximately a 30° angle from the plane of the ring. The spring action of the fingers 603 extend to, and make contact with, a radial surface 604 near the back end of the coupling nut 105 that faces the front end of the coupling nut, which serve to connect a ground path from the coupling nut to the tubular post while allowing the coupling nut to rotate. The first alternate grounding member 601 has optional internal lugs 605 that contact the outer diameter 337 of the nonshoulder portion of the tubular post.

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of a connector 700 having a second alternate grounding member 701 (see FIGS. 7A-7C). FIG. 7A is an enlargement of a portion of the second alternate embodiment of the connector 700, showing a portion of the second alternate grounding member 701. FIG. 7B is a slightly enlarged side view of the second alternate grounding member 701. FIG. 7C is a slightly enlarged plan view of the second alternate grounding member 701. Referring now to FIGS. 7, 7A, 7B and 7C, the second alternate grounding member 701 is a radial grounding member retained between the coupling nut 105 and the tubular post 104. The second alternate grounding member 701 is constructed of a thin cross section of metallic material such as beryllium copper. The second alternate grounding member 701 comprises a ring portion 702 and a plurality of fingers 703 extending radially from the ring portion at about a 45° angle from the plane of the ring portion. The spring action of the fingers 703 extend to inner-diameter surfaces 705 of the coupling nut 105 and serve to connect a ground path from the coupling nut to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of a connector 800 having a third alternate grounding member 801 (see FIGS. 8A-8E). FIG. 8A is a slightly enlarged side view of the third alternate grounding member 801. FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member 801. Referring now to FIG. 8 and FIGS. 8A-8E, the third alternate grounding member 801 is a conductive member retained between the coupling nut 105 and the tubular post 104. The third alternate grounding member 801 is constructed of a thin cross section of metallic material such as brass or beryllium copper. The third alternate grounding member 801 comprises a ring 802 with multiple points of contact, or internal lugs, 803 around the inner perimeter of the ring and with multiple external lugs 804 around the outer perimeter of the ring. The lugs 803 and 804 serve to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. FIGS. 8B-8E show four styles with regard to the shape of the lugs 803 and 804 and the position of the lugs on the ring 802. FIG. 8 also exhibits an alternate embodiment comprising a sealing ring 805 for forming a moisture seal between the coupling nut 105 and the body 108 of the connector 801. The sealing ring 805 is disposed between the back end of the coupling nut 105 and the body 108 for forming a seal therebetween. Preferably, the sealing ring 805 is made from ethylene propylene. Use of the sealing ring 805 is not limited to use in connectors having the third alternate grounding member 801. The third alternate grounding member 801 may also be used in connectors without the sealing ring 805.

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of a connector 900 having one of a fourth alternate grounding member 901 and a fifth alternate grounding

member 911 (see FIGS. 9A-9D). FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member 901. FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member 901. FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member 5 902. FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member 911. The fourth and fifth alternate embodiments of the grounding member 901 and 911, respectively, comprise a C-shaped ring between the coupling nut 105 and the tubular post 104. The C-shaped ring is con- 10 structed of a thin cross section of metallic material such as beryllium copper or stainless steel. It is retained by a groove in the coupling nut. The spring action of the C-shaped ring serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. 15 The fourth alternate grounding member 901 includes a circumferential metallic band 902, which has a general circular shape and approximates a section of a hollow cylinder, that extends between first 903 and second 904 opposing ends. The band 902 has first 906 and second 907 opposing side edges 20 extending along its length. The fourth alternate grounding member 901 includes a first generally radial wall 908 extending from the first side edge 906 of the band in a first radial direction, and a second generally radial wall 909 extending from the second side edge 907 of the band generally in said 25 first radial direction. The band 902 contacts a first one of the group of members that includes the coupling nut 105 and the tubular post 104. The first 908 and second 909 radial walls contact the second of the group of members that includes the coupling nut 105 and the tubular post 104. The fifth alternate 30 grounding member 911 includes a metallic band 912 extending along its length between first 913 and second 914 opposing ends, and extending along its width between first 916 and second 917 side edges. The band 912 is formed along its length into a generally circular shape. The band 912 is formed 35 along its width into a generally concave shape with the side edges 916 and 917 projecting generally in a first radial direction. The fifth alternate grounding member 911 includes a plurality of projections 918 extending from the band 912 in a second radial direction opposite to the first radial direction. 40 The first 916 and second 917 side edges of the band 912 contact a first one of the group of members that includes the coupling nut and the tubular post. The plurality of projections 918 contact the second of the group of members that includes the coupling nut 105 and the tubular post 104. 45

FIG. 10 is a partial cross-sectional view of a fifth alternate embodiment of a connector 1000 having conductive grease (not shown) that acts as a grounding member. The ground path is established by means of a close fit between the coupling nut 105 and the tubular post 104. The conductive grease 50 is disposed at a grease annular ring 1001 where mating portions of the tubular post 104 and coupling nut 105 have closely matching dimensions. Preferably, the conductive grease is a silver-loaded silicon lubricating material. The conductive grease serves to connect a ground path from the 55 109 Label coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector 1100 that includes a body 1108, and which has a sixth alternate ground- 60 ing member 1101. FIG. 11A is an enlargement of a portion of FIG. 11. FIG. 11B is a side view of the sixth alternate grounding member 1101. FIG. 11C is a plan view of the sixth alternate grounding member 1101. FIG. 11D is a perspective view of the sixth alternate grounding member 1101. Refer- 65 ring now to FIG. 11 and FIGS. 11A-11D, the sixth alternate grounding member 1101 includes a circumferential metallic

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band 1112 extending between first 1113 and second 1114 opposing ends. The band 1112 has a generally circular shape that approximates a section of a hollow cylinder. The first 1113 and second 1114 ends of the band 1112 are disposed generally proximate to each other and are directed generally toward one another. The band 1112 has first and second opposing side edges 1115 and 1116, respectively, extending along its length. The band generally defines a section of a cylindrical surface. The sixth alternate grounding member 1101 includes a plurality of projections 1101 extending from at least one of the first and second side edges 1115 and 1116 of the band 1112. The plurality of projections 1117 extend away from the cylindrical surface defined by the band 1112. The band 1112 contacts a first one of the group of members that includes the coupling nut 1105 and the tubular post 1104. The plurality of projections 1117 contact the second of the

group of members that includes the coupling nut 1105 and the tubular post 1104.

In preferred embodiments, the present invention provides a coaxial cable connector that ensures a reliable grounding path without creating undue interference with free rotation of the coupler relative to the remaining components of the connector; however, the present invention can also provide a reliable grounding path between a post and a coupler that does not rotate. Advantageously, a connector in accordance with the invention works with standard installation tools and with standard compression tools. The present invention can be used with both axially-compressible connectors as well as with older-style crimp-ring connectors. In some embodiments, the present invention is compatible with the use of a sealing ring for forming a moisture seal between the coupler and the outer body of the connector.

While the present invention has been described with respect to preferred embodiments thereof, such description is for illustrative purposes only, and is not to be construed as limiting the scope of the invention. Various modifications and changes may be made to the described embodiments by those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims. For example, the grounding member can have a shape other than generally circular, such as square, hexagonal, octagonal, oval, etc.

LIST OF REFERENCE NUMERALS

- 100 F connector ("connector")
- 101 Longitudinal axis
- 102 Front end
- 103 Back end
- 104 Tubular post
- 105 Coupling nut
- 106 End of tubular post
- 107 Shell
- 108 Body
- 110 Grounding member
- 111 Neck
- 201 Minimum diameter
- 203 Maximum diameter
- 301 Coaxial cable
- 302 Center conductor
- 303 Dielectric material
- 304 Outer conductor
- 305 Jacket
- 310 Lip of body
- 311 Outer diameter of lip body
- 312 Inner diameter of lip of body

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11 330 Head of tubular post 332 Shoulder of tubular post 333 First radial face of shoulder of tubular post 334 Outer surface of shoulder 336 Outer diameter of shoulder 337 Outer diameter of non-shoulder portion of post 338 Non-shoulder portion of post 340 Inwardly-directed flange of coupling nut 341 Inner diameter of inwardly-directed flange 342 Bore of coupling nut 343 Annular recess of coupling nut 344 Inner diameter of bore of coupling nut 600 First alternate connector 601 First alternate grounding member 602 Ring portion of first alternate grounding member 603 Fingers of first alternate grounding member 604 Radial surface of coupling nut 605 Internal lugs of first alternate grounding member 700 Second alternate connector 701 Second alternate grounding member 702 Ring portion of second alternate grounding member 703 Fingers of second alternate grounding member 800 Third alternate connector 801 Third alternate grounding member 802 Ring portion of third alternate grounding member 803 Internal lugs of third alternate grounding member 804 External lugs of third alternate grounding member 805 Sealing ring 900 Fourth alternate connector 901 Fourth alternate grounding member 902 Band of fourth alternate grounding member 903 First end of band 904 Second end of band 906 First side edge of band 907 Second side edge of band 908 First radial wall of band 909 Second radial wall of band 911 Fifth alternate grounding member 1000 Fifth alternate connector 1001 Grease annular ring 1100 Sixth alternate connector 1101 Sixth alternate grounding member 1104 Tubular post of sixth alternate connector 1105 Coupling nut of sixth alternate connector 1108 Body of sixth alternate connector 1112 Band of sixth alternate grounding member 1113 First end of band 1114 Second end of band 1115 First side edge of band 1116 Second side edge of band 1117 Projections on band We claim: 1. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric 55 material being surrounded by an outer conductor, the coaxial

- cable connector comprising: a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a 60 second end opposite the first end thereof
 - b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate 65 the second end of the coupler being adapted for engaging the equipment port;

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- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member is comprised of plastic, wherein the body member contacts the coupler; and
- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween.
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2. The connector of claim 1 wherein the body member is comprised of acetal plastic.

3. The connector of claim 1 wherein the tubular post comprises an enlarged shoulder, and the grounding member is ¹⁵ disposed between the enlarged shoulder and the coupler.

4. The connector of claim 1 wherein the coupler comprises an inwardly-directed flange, and the grounding member is disposed between the inwardly-directed flange and the second end of the coupler.

5. The coaxial cable connector recited by claim 1 wherein said grounding member is arcuately shaped to extend around the tubular post over at least 225 degrees.

6. The coaxial cable connector recited by claim 1 wherein said grounding member is formed from metal wire. 25

7. The coaxial cable connector recited by claim 1 wherein the central bore of the coupler includes an annular recess proximate to the first end of the coupler, and wherein at least portions of said grounding member are disposed within the annular recess. 30

8. The coaxial cable connector recited by claim 1 wherein the tubular post includes an enlarged shoulder at the second end thereof extending inside the coupler, and wherein the annular recess and said grounding member surround the 35 enlarged shoulder of the tubular post when the coaxial cable connector is assembled onto the prepared end of the coaxial cable.

9. The coaxial cable connector recited by claim 1 wherein said grounding member is generally circular.

10. The coaxial cable connector recited by claim 9 wherein said grounding member has a plurality of projections extending radially outwardly therefrom for engaging the coupler.

11. The coaxial cable connector recited by claim 9 wherein said grounding member has a plurality of projections extend-45 ing radially inwardly therefrom for engaging the tubular post.

12. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial 50 cable connector comprising:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member is comprised of plastic: and
- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the

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grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:

wherein the tubular post includes an enlarged shoulder at the second end thereof extending inside the coupler, the 5 enlarged shoulder including a first radial face that faces the first end of the tubular post, the coupler including a radially inwardly directed flange proximate the first end thereof directed inwardly toward the tubular post, the inwardly directed flange including a second radial face 10 that faces the second end of the coupler, said grounding member being disposed between the first radial face and the second radial face for electrically coupling the tubular post to the coupler, and

wherein the grounding member includes a central, generally 15 circular body member disposed generally within a plane, the grounding member including a plurality of resilient spring fingers extending out of said plane and being compressed between the first radial face of the tubular post and the second radial face of the coupler. 20

13. The coaxial cable connector recited by claim 12 wherein said plurality of spring fingers includes at least a first spring finger and a second spring finger, and wherein said first and second spring fingers extend out of said plane in opposing directions.

14. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof;
- b. a coupler having a first end rotatably secured over the 35 second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port; 40
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the

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outer conductor of the coaxial cable, wherein the body member is comprised of plastic; and

d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween;

wherein the grounding member includes:

- a. a circumferential metallic band extending between first and second opposing ends, the band having a generally circular shape, and approximating a section of a hollow cylinder, the first and second ends of the band being disposed generally proximate to each other and being directed generally toward one another, the band having first and second opposing side edges extending along its length;
- b. a first generally radial wall extending from the first side edge of the band in a first radial direction; and
- c. a second generally radial wall extending from the second side edge of the band generally in said first radial direction;

wherein the band contacts a first one of the group of members that consists of the coupler and the tubular post, and wherein the first and second radial walls contact the second of the group of members that consists of the coupler and the tubular post.

15. The coaxial cable connector recited by claim 1 wherein said grounding member is a C-shaped metal clip.

16. The coaxial cable connector recited by claim 15 wherein said C-shaped metal clip has an arcuate curvature that is non-circular to maximize contact with both the coupler and the tubular post.

17. The coaxial cable connector recited by claim 1 wherein a front end of the body contacts the coupler, the front end of the body comprising a lip having an outer diameter and the coupler having an inner diameter, wherein the inner diameter of the coupler has a dimension less than the outer diameter of the lip of the body in order to retain the first end of the coupler on the front end of the body.

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(12) United States Patent

Bence et al.

(54) ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

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(57) ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.

12 Claims, 8 Drawing Sheets



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ELECTRICAL CONNECTOR WITH **GROUNDING MEMBER**

CROSS-REFERENCE TO RELATED **APPLICATIONS**

This application is a continuation of U.S. patent application Ser. No. 11/541,903 filed on Oct. 2, 2006 now U.S. Pat. No. 7.479.035 which claims the benefit of priority of U.S. patent application Ser. No. 11/043,844, filed Jan. 25, 2005, 10 entitled. "Electrical Connector With Grounding Member".

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to electrical connectors. and more particularly to coaxial cable connectors capable of being connected to a terminal.

2. Description of the Related Art

Coaxial cable connectors, such as type F connectors, are 20 used to attach coaxial cable to another object or appliance. e.g., a television set or VCR having a terminal adapted to engage the connector. The terminal of the appliance includes an inner conductor and a surrounding outer conductor.

Coaxial cable includes a center conductor for transmitting 25 a signal. The center conductor is surrounded by a dielectric material, and the dielectric material is surrounded by an outer conductor: this 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 30 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 con- 35 nector 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 bare 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.

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. 45 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: this outer body of the connector is usually fixedly secured to 50 the tubular post. A coupler is 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.

When connecting the end of a coaxial cable to a terminal of 55 a television set, equipment box, 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. This goal is usually achieved by ensuring that the coupler of the connector is fully tightened 60 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: 65 in turn, the tubular post is engaged with the outer conductor of the coaxial cable.

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However, in many cases, it is difficult for an installer to reach the connection ports of the appliance with a wrench. and in some instances, it is even difficult for the installer to reach such connection ports with his or her fingers. As a result, it can often happen that type F connectors are not fully tightened to the appliance port. In such a loose connection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, a gap exists between the outer conductor of the appliance port and the tubular post of the connector. Unless an alternate ground path exists, poor signal quality, and RFI leakage, will result.

As mentioned above, the coupler is rotatably secured about the head of the tubular post. The head of the tubular post usually includes an enlarged shoulder, and the coupler typi-15 cally 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 dimension 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.

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.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a coaxial cable connector for connecting a coaxial cable to a connection port of an appliance, the coaxial cable connector being of the type that includes a tubular post and a coupler. such as a rotatable coupler, which ensures a reliable ground connection between the tubular post of the connector and an outer conductor of the appliance port, even if the coupler is not fully tightened onto the appliance port.

It is another object of the present invention to provide such a coaxial cable connector which maintains a reliable ground path between the coupler and the tubular post, at least following installation of such connector onto the end of a coaxial cable

It is still another object of the present invention to provide such a coaxial connector that can be manufactured economically.

These and other objects of the present invention will become more apparent to those skilled in the art as the description thereof proceeds.

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SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a coaxial cable connector comprising a tubular post, a coupler and a grounding means for providing an electrically conductive 5 path between the post and the coupler. In accordance with a preferred embodiment thereof, the present invention relates to a coaxial cable connector for coupling a prepared end of a coaxial cable to a threaded female equipment port, and including a tubular post having a first end adapted to be 10 inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor thereof. A coupler is rotatably secured over the second end of the tubular post. and includes a central bore, at least a portion of which is threaded for engaging the female equipment port. An outer 15 body is secured to the tubular post and extends about the first end of the tubular post for receiving the outer conductor, and preferably the cable jacket, of the coaxial cable.

In a preferred embodiment of the present invention, a resilient, electrically-conductive grounding member is disposed 20 between the tubular post and the coupler. This grounding member engages both the tubular post and the coupler for providing an electrically-conductive path therebetween, but without restricting rotation of the coupler relative to the tubular post.

For some preferred embodiments, the grounding member is generally arcuately shaped to extend around the tubular post over an arc of at least 225°, and may extend for a full 360°. This arcuately shaped grounding member may be in the form of a generally circular broken ring, or C-shaped mem- 30 ber, as by bending a strip of metal wire into an arc. Preferably, the grounding member has a shape that is out-of-round, and more preferably oblong, rather than circular, in order to ensure reliable electrical contact with both the coupler and the tubular post. In order to retain the grounding member inside 35 the coupler, the inner bore of the coupler may include an annular recess proximate to the end of the coupler that encircles the tubular post: at least portions of the grounding member are engaged with the annular recess to prevent the grounding member from being axially displaced within the 40 coupler.

As mentioned above, the tubular post may include an enlarged shoulder at the head thereof. In one preferred embodiment of the present invention, the grounding member surrounds the enlarged shoulder of the tubular post, at least 45 when the coaxial cable connector is assembled onto the prepared end of a coaxial cable, whereby at least portions of the grounding member engage the outer surface of such enlarged shoulder.

In one embodiment of the present invention, the grounding 50 member is generally circular and includes a plurality of projections extending outwardly therefrom for engaging the coupler. In another embodiment of the present invention, the grounding member is generally circular and includes a plurality of projections extending inwardly therefrom for engag- 55 ing the tubular post.

In yet another embodiment of the present invention, the tubular post includes an enlarged shoulder extending inside the coupler, and including a first radial face that faces the opposite end of the tubular post. The coupler includes a flange 60 directed inwardly toward the tubular post: this inwardly directed flange including a second radial face that faces toward the connection port of the appliance to which the coaxial cable is to be connected. The grounding member is disposed between the first radial face and the second radial face. In this embodiment, the grounding member is resilient relative to the longitudinal axis of the connector, and is com4

pressed between the first radial face and the second radial face to maintain sliding electrical contact between the shoulder of the tubular post (via its first radial face) and the flange of the coupler (via its second radial face).

The coaxial connector of the present invention may also include a sealing ring seated within the coupler for rotatably engaging the body member to form a seal therebetween.

In an alternate embodiment of the present invention, conductive grease is substituted for a discrete grounding member. In this embodiment, an outer dimension of a portion of the tubular post is caused to be commensurate with an inner dimension of an adjacent portion of the coupler. While the gap between such adjacent portions, coupled with the lubrication provided by the conductive grease, is sufficient to permit rotation of the coupler relative to the tubular post, the conductive grease nonetheless functions to maintain reliable electrical coupling across such gap.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with greater specificity and clarity with reference to the following drawings, in which:

FIG. 1 is a perspective view of an F connector in accordance with the preferred embodiment of the invention. including a body and a coupling nut:

FIG. 2 is an exploded view of the F connector of FIG. 1. including a preferred embodiment of a grounding member:

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member of FIG. 2:

FIG. 3 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and a side view of a prepared coaxial cable ready to be inserted into a back end of the F connector:

FIG. 3A is a cross-sectional view of the body of the F connector of FIG. 1 through cut-line 3-3:

FIG. 3B is a cross-sectional view of a tubular post of the F connector of FIG. 1. through cut-line 3-3:

FIG. 3C is a cross-sectional view of the coupling nut of the F connector of FIG. 1 through cut-line 3-3:

FIG. 4 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof. prior to axial compression of the F connector:

FIG. 4A is an enlargement of a portion of FIG. 4:

FIG. 5 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, subsequent to axial compression of the F connector:

FIG. 5A is an enlargement of a portion of FIG. 5:

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of an F connector having a first alternate grounding member:

FIG. 6A is an enlargement of a portion of FIG. 6:

FIG. 6B is a slightly enlarged side view of the first alternate grounding member of FIG. 6:

FIG. 6C is a slightly enlarged plan view of the first alternate grounding member of FIG. 6:

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of an F connector having a second alternate grounding member:

FIG. 7A is an enlargement of a portion of FIG. 7:

FIG. 7B is a slightly enlarged side view of the second alternate grounding member of FIG. 7:

FIG. 7C is a slightly enlarged plan view of the second alternate grounding member of FIG. 7:

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FIG. 8 is a partial cross-sectional view of a third alternate embodiment of an F connector having a third alternate grounding member:

FIG. 8A is a slightly enlarged side view of the third alternate grounding member of FIG. 8:

FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member of FIG. 8:

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of an F connector having one of a fourth alternate grounding member and a fifth alternate grounding mem- 10 ber:

FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member of FIG. 9:

FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member of FIG. 9:

FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member of FIG. 9:

FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member of FIG. 9:

FIG. 10 is a partial cross-sectional view of a fifth alternate 20 embodiment of an F connector having conductive grease that acts as a grounding member:

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector having a sixth alternate grounding member:

FIG. 11A is an enlargement of a portion of FIG. 11:

FIG. 11B is a side view of the sixth alternate grounding member of FIG. 11:

FIG. 11C is a plan view of the sixth alternate grounding member of FIG. 11: and

FIG. 11D is a perspective view of the sixth alternate grounding member of FIG. 11.

For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and descriptions and details of well-known features and tech- 35 niques are omitted to avoid unnecessarily obscuring the invention. Furthermore, elements in the drawing figures are not necessarily drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a perspective view of an F connector 100 in accordance with the preferred embodiment of the invention. The F connector 100 hereinafter. "connector") has a longitu- 45 dinal axis 101. The connector has a front end 102 and a back end 103.

FIG. 2 is an exploded view of the connector 100. The connector 100 includes tubular post 104. a coupling nut 105 rotatably secured over an end 106 of the tubular post for 50 securing the connector to an appliance (not shown), and a body 108 secured to the tubular post. A shell 107 and a label 109 are secured to the body 108. Preferably, the body 108 is made entirely of acetal plastic. Alternatively, the body 108 is made of brass, plated with nickel. The shell 107 adds strength 55 to the plastic body 108 and protects the plastic body from ultraviolet light. The tubular post **104** is preferably metallic. and more preferably, made of brass, with a tin plating; as tin is more conductive than nickel. The coupling nut 105 is preferably metallic, and more preferably, formed from brass. plated with nickel or with another non-corrosive material.

In the embodiment shown in the drawings, the coupling nut 105 is rotatably secured over an end 106 of the tubular post 104 via a neck 111 of the body 108. Advantageously, an electrical grounding path is constantly maintained between 65 the coupling nut 105 and the tubular post 104, including, in particular, when the coupling nut 105 of the connector 100 is

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not tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member 110 disposed between the tubular post 104 and the coupling nut 105.

FIG. 2.A is an enlarged plan view of the preferred embodiment of the grounding member 110. In the preferred embodiment of the present invention, the electrically-conductive grounding member 110 is disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 contacts both the tubular post 104 and the coupling nut 105 for providing an electrically-conductive path therebetween. but without restricting rotation of the coupling nut relative to the tubular post. A preferred embodiment of the grounding member 110 shown in FIG. 2.A is a spring member, or circlip. 15 disposed between the coupling nut 105 and the tubular post 104, which establishes a stable ground path between the coupling nut and the post, and which is preferably constructed of a wire-type material. The grounding member 110 is retained in the coupling nut 105 by an annular recess 343 (see FIG. 3C) in the coupling nut. The spring action of the grounding member 110 serves to form a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut 105 to rotate. The grounding member 110 is resilient and is generally arcuately shaped. The grounding member 110 extends around the tubular post 104 over an arc of at least 225°, and may extend for a full 360°. The arcuately shaped grounding member 110 may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member 110 is a C-shaped metal clip that has an arcuate curvature that is non-circular. The grounding member 110 has a minimum diameter 201 and a maximum diameter 203. Preferably, the grounding member 110 is made of stainless steel wire that has a wire diameter of between 0.010-inch and 0.020-inch: in a preferred embodiment, the wire diameter is about 0.016-inch. Stainless steel is a preferred metal for the grounding member 110 because it need not be plated for corrosion resistance.

FIG. 3 is a cross-sectional view of the connector 100 40 through cut-line 3-3 of FIG. 1, and a side view of a prepared coaxial cable 301 ready to be inserted into a back end 103 of the connector. The center conductor 302 of the coaxial cable 301 is surrounded by a dielectric material 303, and the dielectric material is surrounded by an outer conductor 304 that may be in the form of a conductive foil and/or braided sheath. The outer conductor 304 is usually surrounded by a plastic cable jacket 305 that electrically insulates, and mechanically protects, the outer conductor.

FIG. 3A is a cross-sectional view of the body 108 of FIG. 1 through cut-line 3-3. FIG. 3B is a cross-sectional view of the tubular post 104 of FIG. 1 through cut-line 3-3. FIG. 3C is a cross-sectional view of the coupling nut 105 of FIG. 1 through cut-line 3-3. Referring now to FIGS. 3, 3A, 3B and 3C, the body 108 has a lip 310 at a front end of the body. The lip 310 has an outer diameter 311 and an inner diameter 312. The coupling nut 105 is rotatably secured about a head 330 at the front end of the tubular post 104. The head 330 of the tubular post 104 usually includes an enlarged shoulder 332. The coupling nut 105 typically includes an inwardly-directed flange 340 that extends over and around the shoulder 332 of the tubular post 104. In order to retain the grounding member 110 inside the coupling nut 105, the inner, or central, bore 342 of the coupling nut 105 may include an annular recess 343 that is proximate to the end of the coupling nut that encircles the tubular post 104. At least portions of the grounding member 110 are engaged with the annular recess 343 to prevent the grounding member from being axially displaced within the

coupling nut 105. The tubular post 104 may include an enlarged shoulder 332 at the head 330 thereof. The shoulder 332 has a first radial face 333 that faces the back end of the tubular post 104. In one preferred embodiment of the present invention, the grounding member 110 surrounds the enlarged shoulder 332 of the tubular post 104, at least when the connector 100 is assembled onto the prepared end of a coaxial cable 301. At least portions of the grounding member 110 contact the outer surface 334 of such enlarged shoulder 332.

The coupling nut 105 has an inwardly-directed flange near 10 the back end of the coupling nut. The coupling nut 105 has an inner diameter 341 at a back end of the coupling nut. In order to retain the back end of the coupling nut 105 on the front end of the body 108, the inner diameter 341 of the coupling nut has a dimension less than the outer diameter of the lip 310 of 15 the body 108. In order not to interfere with free rotation of the coupling nut 105, the outer diameter 336 of the shoulder 332 (at the head 330 of the tubular post 104) is of smaller dimension than the inner diameter 344 of the central bore of the coupling nut 105. Likewise, the inner diameter 341 of the 20inwardly-directed flange 340 of the coupling nut 105 is of larger dimension than the outer diameter 337 of the nonshoulder portion 338 of the tubular post 104, again to avoid interference with rotation of the coupling nut 105 relative to the tubular post.

FIG. 4 is a cross-sectional view of the connector 100 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof prior to axial compression of the connector. FIG. 4A is an enlargement of a portion of FIG. 4. Referring now to FIGS. 4 3/ and 4A, the resilient, electrically-conductive grounding member 110 is shown disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 is disposed in the annular recess 343 that encircles the tubular post 104.

FIG. 5 is a cross-sectional view of the connector 100 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof, subsequent to axial compression of the connector. FIG. 5A is an enlargement of a portion of FIG. 5. Referring now to FIGS. 5 and 5A, as a result of axial compression by a standard compression tool (not shown), the tubular post 104 slides (to the right in the drawings) relative to the other components of the connector 100 and relative to the cable 301. such that the shoulder 332 of the tubular post is radially 45 inward of the grounding member 110. At least a portion of the grounding member 110 engages the coupling nut 105 at the annular recess 343 of the coupling nut, and at least another portion of the grounding member engages tubular post 104 at the shoulder 332 of the tubular post. The tubular post 104 is in 50 electrical contact with the outer conductor 304 of the cable 301 along the back portion of the tubular post, and the coupling nut 105 may engage the outer conductor of an appliance port (not shown). Therefore, when the connector 100 is fastened to an appliance port, there is maintained an electrical 55 grounding path between the outer conductor 304 of the cable 301 and the outer conductor of the appliance port, whether or not the coupling nut 105 of the connector is tightly fastened to the appliance port.

FIG. 6 is a partial cross-sectional view of a first alternate ⁶⁰ embodiment of a connector **600** having a first alternate grounding member **601** (see FIGS. **6A-6C**), shown subsequent to axial compression. FIG. **6A** is an enlargement of a portion of the first alternate embodiment of the connector **600** showing a portion of the first alternate grounding member ⁶⁵ **601**. FIG. **6B** is a slightly enlarged side view of the first alternate grounding member **601**. FIG. **6C** is a slightly

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enlarged plan view of the first alternate grounding member 601. Referring now to FIGS. 6. 6A, 6B and 6C, the first alternate grounding member 601 is a spring finger grounding member retained between the coupling nut 105 and the tubular post 104. The first alternate grounding member 601 is constructed of a thin cross section of material such beryllium copper. The first alternate grounding member 601 comprises a ring portion 602 and a plurality of fingers 603 that project at approximately a 30° angle from the plane of the ring. The spring action of the fingers 603 extend to, and make contact with, a radial surface 604 near the back end of the coupling nut 105 that faces the front end of the coupling nut, which serve to connect a ground path from the coupling nut to the tubular post while allowing the coupling nut to rotate. The first alternate grounding member 601 has optional internal lugs 605 that contact the outer diameter 337 of the nonshoulder portion of the tubular post.

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of a connector 700 having a second alternate grounding member 701 (see FIGS. 7A-7C). FIG. 7A is an enlargement of a portion of the second alternate embodiment of the connector 700, showing a portion of the second alternate grounding member 701. FIG. 7B is a slightly enlarged side view of the second alternate grounding member 701. FIG. 7C is a slightly enlarged plan view of the second alternate grounding member 701. Referring now to FIGS. 7. 7.A. 7B and 7C, the second alternate grounding member 701 is a radial grounding member retained between the coupling nut 105 and the tubular post 104. The second alternate grounding member 701 is constructed of a thin cross section of metallic material such as beryllium copper. The second alternate grounding member 701 comprises a ring portion 702 and a plurality of fingers 703 extending radially from the ring portion at about a 45° angle from the plane of the ring portion. The spring action of the fingers 703 extend to inner-diameter surfaces 705 of the coupling nut 105 and serve to connect a ground path from the coupling nut to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of a connector 800 having a third alternate grounding member 801 (see FIGS. 8A-8E). FIG. 8A is a slightly enlarged side view of the third alternate grounding member 801. FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member 801. Referring now to FIG. 8 and FIGS. 8A-8E, the third alternate grounding member 801 is a conductive member retained between the coupling nut 105 and the tubular post 104. The third alternate grounding member 801 is constructed of a thin cross section of metallic material such as brass or beryllium copper. The third alternate grounding member 801 comprises a ring 802 with multiple points of contact, or internal lugs, 803 around the inner perimeter of the ring and with multiple external lugs 804 around the outer perimeter of the ring. The lugs 803 and 804 serve to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. FIGS. 8B-8E show four styles with regard to the shape of the lugs 803 and 804 and the position of the lugs on the ring 802. FIG. 8 also exhibits an alternate embodiment comprising a sealing ring 805 for forming a moisture seal between the coupling nut 105 and the body 108 of the connector 801. The sealing ring 805 is disposed between the back end of the coupling nut 105 and the body 108 for forming a seal therebetween. Preferably, the sealing ring 805 is made from ethylene propylene. Use of the sealing ring 805 is not limited to use in connectors having the third

alternate grounding member 801. The third alternate grounding member 801 may also be used in connectors without the sealing ring 805.

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of a connector 900 having one of a fourth alternate grounding member 901 and a fifth alternate grounding member 911 (see FIGS. 9A-9D). FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member 901. FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member 901. FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member 902. FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member 911. The fourth and fifth alternate embodiments of the grounding member 901 and 911. respectively, comprise a C-shaped ring between the coupling 15 nut 105 and the tubular post 104. The C-shaped ring is constructed of a thin cross section of metallic material such as beryllium copper or stainless steel. It is retained by a groove in the coupling nut. The spring action of the C-shaped ring serves to connect a ground path from the coupling nut 105 to 20 the tubular post 104 while allowing the coupling nut to rotate. The fourth alternate grounding member 901 includes a circumferential metallic band 902, which has a general circular shape and approximates a section of a hollow cylinder, that extends between first 903 and second 904 opposing ends. The 25 band 902 has first 906 and second 907 opposing side edges extending along its length. The fourth alternate grounding member 901 includes a first generally radial wall 908 extending from the first side edge 906 of the band in a first radial direction, and a second generally radial wall 909 extending 30 from the second side edge 907 of the band generally in said first radial direction. The band 902 contacts a first one of the group of members that includes the coupling nut 105 and the tubular post 104. The first 908 and second 909 radial walls contact the second of the group of members that includes the 35 coupling nut 105 and the tubular post 104. The fifth alternate grounding member 911 includes a metallic band 912 extending along its length between first 913 and second 914 opposing ends, and extending along its width between first 916 and second 917 side edges. The band 912 is formed along its 40 respect to preferred embodiments thereof, such description is length into a generally circular shape. The band 912 is formed along its width into a generally concave shape with the side edges 916 and 917 projecting generally in a first radial direction. The fifth alternate grounding member 911 includes a plurality of projections 918 extending from the band 912 in a 45 second radial direction opposite to the first radial direction. The first 916 and second 917 side edges of the band 912 contact a first one of the group of members that includes the coupling nut and the tubular post The plurality of projections 918 contact the second of the group of members that includes 50 the coupling nut 105 and the tubular post 104.

FIG. 10 is a partial cross-sectional view of a fifth alternate embodiment of a connector 1000 having conductive grease (not shown) that acts as a grounding member. The ground path is established by means of a close fit between the cou- 55 pling nut 105 and the tubular post 104. The conductive grease is disposed at a grease annular ring 1001 where mating portions of the tubular post 104 and coupling nut 105 have closely matching dimensions. Preferably, the conductive grease is a silver-loaded silicon lubricating material. The 60 conductive grease serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector 1100 that 65 includes a body 1108, and which has a sixth alternate grounding member 1101. FIG. 11.A is an enlargement of a portion of

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FIG. 11. FIG. 11B is a side view of the sixth alternate grounding member 1101. FIG. 11C is a plan view of the sixth alternate grounding member 1101. FIG. 11D is a perspective view of the sixth alternate grounding member 1101. Referring now to FIG. 11 and FIGS. 11A-11D, the sixth alternate grounding member 1101 includes a circumferential metallic band 1112 extending between first 1113 and second 1114 opposing ends. The band 1112 has a generally circular shape that approximates a section of a hollow cylinder. The first 1113 and second 1114 ends of the band 1112 are disposed generally proximate to each other and are directed generally toward one another. The band 1112 has first and second opposing side edges 1115 and 1116, respectively, extending along its length. The band generally defines a section of a cylindrical surface. The sixth alternate grounding member 1101 includes a plurality of projections 1101 extending from at least one of the first and second side edges 1115 and 1116 of the band 1112. The plurality of projections 1117 extend away from the cylindrical surface defined by the band 1112. The band 1112 contacts a first one of the group of members that includes the coupling nut 1105 and the tubular post 1104. The plurality of projections 1117 contact the second of the group of members that includes the coupling nut 1105 and the tubular post 1104.

In preferred embodiments, the present invention provides a coaxial cable connector that ensures a reliable grounding path without creating undue interference with free rotation of the coupler relative to the remaining components of the connector; however, the present invention can also provide a reliable grounding path between a post and a coupler that does not rotate. Advantageously, a connector in accordance with the invention works with standard installation tools and with standard compression tools. The present invention can be used with both axially-compressible connectors as well as with older-style crimp-ring connectors. In some embodiments, the present invention is compatible with the use of a sealing ring for forming a moisture seal between the coupler and the outer body of the connector.

While the present invention has been described with for illustrative purposes only, and is not to be construed as limiting the scope of the invention. Various modifications and changes may be made to the described embodiments by those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims. For example, the grounding member can have a shape other than generally circular. such as square. hexagonal. octagonal. oval. etc.

LIST OF REFERENCE NUMERALS

- F connector ("connector") 101 Longitudinal axis 102 Front end 103 Back end 104 Tubular post 105 Coupling nut 106 End of tubular post 107 Shell 108 Body 109 Label 110 Grounding member 111 Neck 201 Minimum diameter 203 Maximum diameter 301 Coaxial cable
- 302 Center conductor

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303 Dielectric material	
304 Outer conductor	
305 Jacket	
310 Lip of body 211 Out on diamentaria film hashe	
311 Outer diameter of lip of body	ì
330 Head of tubular post	
332 Shoulder of tubular post	
333 First radial face of shoulder of tubular post	
334 Outer surface of shoulder	10
336 Outer diameter of shoulder	
337 Outer diameter of non-shoulder portion of post	
338 Non-shoulder portion of post	
340 Inwardly-directed flange of coupling nut	
341 Inner diameter of inwardly-directed flange	15
342 Bore of coupling nut	
343 Annular recess of coupling nut	
344 Inner diameter of bore of coupling nut	
600 First alternate connector	
601 First alternate grounding member	20
602 King portion of first alternate grounding member	
604 Radial surface of coupling nut	
605 Internal lugs of first alternate grounding member	
700 Second alternate connector	25
701 Second alternate grounding member	-
702 Ring portion of second alternate grounding member	
703 Fingers of second alternate grounding member	
800 Third alternate connector	
801 Third alternate grounding member	30
802 Ring portion of third alternate grounding member	
803 Internal lugs of third alternate grounding member	
804 External lugs of third alternate grounding member	
805 Sealing ring	
900 Fourth alternate connector	52
901 Fourth alternate grounding member	
903 First end of band	
904 Second end of band	
906 First side edge of band	40
907 Second side edge of band	
908 First radial wall of band	
909 Second radial wall of band	
911 Fifth alternate grounding member	
1000 Fifth alternate connector	45
1001 Grease annular ring	
1100 Sixth alternate connector	
1101 Sixth alternate grounding member	
1104 Tubular post of sixth alternate connector	÷
1105 Coupling hut of sixth alternate connector	20
1112 Band of sixth alternate grounding member	
1113 First end of band	
1114 Second end of band	
1115 First side edge of band	55
1116 Second side edge of band	
1117 Projections on band	
We claim:	
1. A coaxial cable connector for coupling a coaxial cable to	
an equipment port, the coaxial cable including a center con-	60
ductor surrounded by a dielectric material, the dielectric	
material being surrounded by an outer conductor, the coaxial	
cable connector comprising in combination:	

a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the 65 dielectric material and the outer conductor, and having a second end opposite the first end thereof:

b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:

c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member contacts the coupler: and

- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the tubular post includes an enlarged shoulder at the second end thereof extending inside the coupler and wherein at least a portion of the grounding member contacting the tubular post surrounds the enlarged shoulder of the tubular post.

2. The coaxial cable connector of claim 1. wherein at least a portion of the grounding member does not contact the tubular post and is angled relative to the portion of the ground-25 ing member that contacts the tubular post.

3. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial 30 cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member contacts the coupler; and
- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the coaxial cable connector extends along a longitudinal axis and at least a portion of the grounding member contacting the tubular post coextends with the tubular post along a length parallel to the longitudinal axis.

4. The coaxial cable connector of claim 3, wherein at least a portion of the grounding member does not contact the tubular post and is angled relative to the portion of the grounding member that contacts the tubular post.

5. The coaxial cable connector of claim 4. wherein the portion of the grounding member that is angled relative to the portion of the grounding member that contacts the tubular post is angled radially outward.

6. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:

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- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the -5 second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member contacts the coupler; and
- d. a resilient. electrically-conductive grounding member ¹⁵ disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the grounding member comprises a circumferential band comprising a section that approximates a hollow cylinder, the circumferential band having first and second opposing side edges.

7. The coaxial cable connector of claim **6**, wherein the section that approximates a hollow cylinder comprises a ²⁵ cylindrical surface that extends to one of first and second opposing side edges and wherein the other of first and second opposing side edges extends away from the cylindrical surface.

8. The coaxial cable connector of claim 7, wherein the coaxial cable connector extends along a longitudinal axis and the cylindrical surface coextends with the tubular post along a length parallel to the longitudinal axis.

9. The coaxial cable connector of claim 3, wherein the grounding member comprises metal.

10. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising in combination:

- a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor, and having a second end opposite the first end thereof:
- b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:
- c. a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable, wherein the body member contacts the coupler; and
- d. a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler, the grounding member contacting both the tubular post and the coupler for providing an electrically-conductive path therebetween:
- wherein the grounding member is a radial grounding member.

11. The coaxial cable connector of claim 10, wherein the grounding member comprises a thin cross section of metallic material.

12. The coaxial cable connector of claim 11, wherein the grounding member comprises beryllium copper.

* * *

UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

PATENT NO.	: 7,955,126 B2
APPLICATION NO.	: 12/332925
DATED	: June 7, 2011
INVENTOR(S)	: Bence et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,

Related U.S. Application Data

Item (63) "Continuation of application No. 11/541,903, filed on Oct. 2, 2006, now Pat. No. 7,479,035." should be -- Continuation of application No. 11/541,903, filed on Oct. 2, 2006, now Pat. No. 7,479,035 which is a Continuation of application No. 11/043,844, filed on Jan. 25, 2005, now Pat. No. 7,114,990. --.

Signed and Sealed this Eighth Day of November, 2011

and J. Kappos

David J. Kappos Director of the United States Patent and Trademark Office



US008172612B2

(12) United States Patent

Bence et al.

(54) ELECTRICAL CONNECTOR WITH **GROUNDING MEMBER**

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- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: 13/117.843
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Related U.S. Application Data

- (63) Continuation of application No. 12/332,925, filed on Dec. 11, 2008, now Pat. No. 7.955,126, which is a continuation of application No. 11/541.903, filed on Oct. 2, 2006, now Pat. No. 7,479,035, which is a continuation of application No. 11/043.844, filed on Jan. 25, 2005, now Pat. No. 7,114,990.
- (51) Int. Cl.
- H01R 9/05 (2006.01)
- (58) Field of Classification Search 439/578, 439/583. 584. 320. 322. 314 See application file for complete search history.

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(45) Date of Patent: May 8, 2012

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(57) ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.

23 Claims, 8 Drawing Sheets

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4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986	A A A A A A	*	2 6 7 8 9 10	1981 1981 1981 1981 1981 1981 1981	Kitagawa Law 439 462 Hemmer Spinner Fowler Herrmann, Jr. 439 322
4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926	A A A A A A A	*	2 6 7 8 9 10 12	1981 1981 1981 1981 1981 1981 1981	Kitagawa Law 439 462 Hemmer Spinner Fowler Herrmann, Jr. 439 322 Smith
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4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926 4.322.121 4.326.769 4.339.166		*	2 6 7 8 9 10 12 3 4 7	1981 1981 1981 1981 1981 1981 1981 1981	Kitagawa Law
$\begin{array}{r} 4.250.548\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\end{array}$	A A A A A A A A A A A A A A A A A A A	*	2 6 7 8 9 10 12 3 4 7 8	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa I.aw
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4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926 4.322.121 4.326.769 4.339.166 4.346.958 4.354.721 4.358.174	A A A A A A A A A A A A A A A A A A A	*	2 6 7 8 9 10 12 3 4 7 8 10 11	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law 439 462 Hemmer Spinner Fowler Herrmann, Jr. 439 322 Smith Riches et al. Dorsey et al. Dayton Blanchard Luzzi Dreyer
$\begin{array}{c} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\end{array}$	A A A A A A A A A A A A A A A A A A A	*	2 6 7 8 9 10 12 3 4 7 8 10 11 2	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law
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4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926 4.322.121 4.326.769 4.339.166 4.346.958 4.358.174 4.358.174 4.373.767 4.389.081 4.400.050 4.407.529	A A A A A A A A A A A A A A A A A A A	*	2 6 7 8 9 10 12 3 4 7 8 10 11 2 6 8 10	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law 439 462 Hemmer Spinner Fowler Herrmann, Jr. 439 322 Smith Riches et al. Dorsey et al. Dayton Blanchard Luzzi Dreyer Cairns Gallusser et al. 339 89 M Hayward Holman
4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926 4.322.121 4.326.769 4.339.166 4.346.958 4.354.721 4.358.174 4.373.767 4.389.081 4.400.050 4.407.529	A A A A A A A A A A A A A A A A A A A	*	2 6 7 8 9 10 12 3 4 7 8 10 11 2 6 8 10 10	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law
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$\begin{array}{c} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.358.174\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.408.822\\ 4.412.717\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \end{array}$	1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law
$\begin{array}{c} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.683\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.408.821\\ 4.408.822\\ 4.412.717\\ 4.421.377\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \end{array}$	1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law 439 462 Hemmer Spinner Fowler Herrmann, Jr. 439 322 Smith Riches et al. Dorsey et al. Dayton Blanchard Luzzi Dreyer Cairns Gallusser et al. 339 89 M Hayward Holman Forney, Jr. Nikitas 439 583 Monroe Spinner
4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926 4.322.121 4.326.769 4.339.166 4.346.958 4.354.721 4.358.174 4.373.767 4.389.081 4.400.050 4.407.529 4.408.821 4.408.821 4.408.821 4.408.821 4.408.821	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
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4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.322.121 4.326.769 4.339.166 4.346.958 4.354.721 4.358.174 4.373.767 4.389.081 4.400.050 4.407.529 4.408.821 4.408.822 4.412.717 4.421.377 4.426.127 4.425.503	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{r} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.683\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.426.127\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.455.832\\ 4.455.852\\ 4.455.852\\ 4.455.852\\ 4.455.852\\ 4.455.852\\ 4.455.852\\ 4.455.852\\ 4.455.852\\ 4.45$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \end{array}$	1981 1981 1981 1981 1981 1981 1981 1981	Kıtagawa Law 439 462 Hemmer Spinner Fowler Herrmann, Jr. 439 322 Smith Riches et al. Dorsey et al. Dayton Blanchard Luzzi Dreyer Cairns Gallusser et al. 339 89 M Hayward Holman Forney, Jr. Nikitas 439 583 Monroe Spinner Kubota Kirby et al. Forney, Jr. Pitcher et al
$\begin{array}{r} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.455.252\\ 4.45$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{r} 4.250.548\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.421.377\\ 4.426.127\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.452.503\\ 4.456.323\\ 4.456.323\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.456.323\\ 4.45$	A X A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 7 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 10 \\ 10 $	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kitagawa Law
$\begin{array}{c} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.683\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.400.8821\\ 4.408.822\\ 4.412.717\\ 4.421.377\\ 4.421.377\\ 4.425.125\\ 4.452.503\\ 4.455.2503\\ $	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ \circ \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
4.250.348 4.273.405 4.280.749 4.285.564 4.290.663 4.296.986 4.307.926 4.322.121 4.326.769 4.339.166 4.346.958 4.354.721 4.358.174 4.373.767 4.389.081 4.400.050 4.407.529 4.408.821 4.408.821 4.412.717 4.426.127 4.421.377 4.426.127 4.444.453 4.452.503 4.452.503 4.452.503 4.462.653 4.464.001 4.464.001	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8 \\ 8$	1981 1981 1981 1981 1981 1981 1981 1981	Kıtagawa Law
$\begin{array}{c} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.412.717\\ 4.421.377\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.452.503\\ 4.452.503\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.464.000\\ 4.464.001\\ 4.469.386\\ 4.470.657\\ 4.444.93\\ 4.459.362\\ 4.452.503\\ 4.464.001\\ 4.469.386\\ 4.470.657\\ 4.444.93\\ 4.459.362\\ 4.459.$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 8 \\ 9 \\ 8 \\ 8 \\ 9 \\ 8 \\ 8$	1981 1981 1981 1981 1981 1981 1981 1981	Kıtagawa Law
$\begin{array}{c} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.408.821\\ 4.406.533\\ 4.462.653\\ 4.456.323\\ 4.456.323\\ 4.456.323\\ 4.462.653\\ 4.464.000\\ 4.464.001\\ 4.469.386\\ 4.470.657\\ 4.470.657\\ 4.441.572\\ 4.44$	A A A A A A A A A A A A A A A A A A A	*	2 6 7 8 9 10 2 3 4 7 8 10 11 2 6 8 10 10 11 12 1 4 6 6 7 8 8 9 9 :	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{c} 4.250.548\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.400.8821\\ 4.408.822\\ 4.412.717\\ 4.421.377\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.452.503\\ 4.456.323\\ 4.456.323\\ 4.456.323\\ 4.462.653\\ 4.464.000\\ 4.469.386\\ 4.470.657\\ 4.484.792\\ 5.257\\ 4.484.792\\ 5.257\\ 5.25$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 & 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 9 \\ 11 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ $	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{r} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.683\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.408.821\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.426.127\\ 4.426.127\\ 4.426.533\\ 4.456.323\\ 4.45$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 9 \\ 11 \\ 11 \\ 11 \\ 11 \\ 1$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{l} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.290.683\\ 4.296.986\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.452.503\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.464.000\\ 4.469.386\\ 4.470.657\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.484.796\\ 4.506.943\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 9 \\ 11 \\ 1 \\ 3 \\ \end{array}$	1981 1981 1981 1981 1981 1981 1981 1981	Kıtagawa I.aw
$\begin{array}{r} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.400.8821\\ 4.400.8821\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.426.127\\ 4.426.127\\ 4.426.127\\ 4.444.53\\ 4.452.503\\ 4.456.323\\ 4.456.323\\ 4.462.653\\ 4.456.323\\ 4.464.001\\ 4.469.386\\ 4.470.657\\ 4.484.792\\ 4.484.796\\ 4.506.943\\ 4.515.427\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	•	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 9 \\ 11 \\ 13 \\ 5 \\ \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{r} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.400.8821\\ 4.400.8821\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.426.127\\ 4.426.127\\ 4.442.503\\ 4.452.503\\ 4.456.323\\ 4.462.653\\ 4.462.653\\ 4.462.653\\ 4.464.000\\ 4.469.386\\ 4.470.657\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.555.017\\ 4.525.017\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 9 \\ 11 \\ 13 \\ 5 \\ 6 \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa Law
$\begin{array}{r} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.821\\ 4.400.8821\\ 4.400.8821\\ 4.400.8821\\ 4.400.8821\\ 4.408.822\\ 4.412.717\\ 4.421.377\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.456.323\\ 4.456.323\\ 4.456.323\\ 4.456.323\\ 4.464.001\\ 4.469.386\\ 4.470.657\\ 4.484.792\\ 4.484.792\\ 4.484.796\\ 4.506.943\\ 4.515.427\\ 4.525.017\\ 4.531.805\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	*	$\begin{array}{c} 2 & 6 \\ 7 & 8 \\ 9 \\ 10 \\ 12 \\ 3 \\ 4 \\ 7 \\ 8 \\ 10 \\ 11 \\ 2 \\ 6 \\ 8 \\ 10 \\ 10 \\ 11 \\ 12 \\ 1 \\ 4 \\ 6 \\ 6 \\ 7 \\ 8 \\ 8 \\ 9 \\ 9 \\ 11 \\ 11 \\ 3 \\ 5 \\ 6 \\ 7 \\ \end{array}$	1981 1981 1981 1981 1981 1981 1981 1982 1982	KitagawaI.awI.awI.awI.awA39 462HemmerSpinnerFowlerHerrmann, Jr.439 322SmithRiches et al.Dorsey et al.DaytonBlanchardLuzziDreyerCairnsGallusser et al.339 89 MHaywardHolmanForney, Jr.NikitasA39 583MonroeSpinnerKubotaKirby et al.Forney, Jr.Pitcher et al.Flederbach et al.Werth et al.CollinsAckermanDeaconTengler et al.Sato et al.Drogo339 90 RSmithSchildkraut et al.339 143 R
$\begin{array}{l} 4.250.348\\ 4.273.405\\ 4.280.749\\ 4.285.564\\ 4.290.663\\ 4.290.663\\ 4.290.663\\ 4.307.926\\ 4.322.121\\ 4.326.769\\ 4.332.121\\ 4.326.769\\ 4.339.166\\ 4.346.958\\ 4.354.721\\ 4.358.174\\ 4.373.767\\ 4.389.081\\ 4.400.050\\ 4.407.529\\ 4.408.822\\ 4.412.717\\ 4.426.127\\ 4.444.453\\ 4.452.503\\ 4.469.386\\ 4.470.657\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.484.792\\ 4.550.17\\ 4.531.805\\ 4.531.805\\ 4.533.191\\ \end{array}$	A A A A A A A A A A A A A A A A A A A	*	2678910123478101126810101011121466788999111135678	1981 1981 1981 1981 1981 1981 1981 1982 1982	Kıtagawa I.aw
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ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

This application is a continuation of U.S. patent application Ser. No. 12/332.925 filed on Dec. 11, 2008, now U.S. Pat. 5 No. 7.955.126, which is a continuation of U.S. patent application Ser. No. 11/541.903 filed on Oct. 2, 2006, now U.S. Pat. No. 7.479.035, which claims the benefit of priority to U.S. patent application Ser. No. 11/043.844 filed on Jan. 25, 2005, the content of which is relied upon and incorporated by 10 reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to electrical connectors, and more particularly to coaxial cable connectors capable of being connected to a terminal.

2. Description of the Related Art

Coaxial cable connectors, such as type F connectors, are 20 used to attach coaxial cable to another object or appliance, e.g., a television set or VCR having a terminal adapted to engage the connector. The terminal of the appliance includes an inner conductor and a surrounding outer conductor.

Coaxial cable includes a center conductor for transmitting 25 a signal. The center conductor is surrounded by a dielectric material, and the dielectric material is surrounded by an outer conductor: this 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 30 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 by the center conductor from stray noise, and to maintain a continuous desired impedance over the signal 35 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 40 the jacket to bare 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.

Coaxial cable connectors of the type known in the trade as "F connectors" often include a tubular post designed to slide 45 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; this outer body of the connector is usually fixedly secured to the tubular post. A coupler is rotatably secured around the tubular post and includes an internally-threaded region for 55 engaging external threads formed on the outer conductor of the appliance terminal.

When connecting the end of a coaxial cable to a terminal of a television set, equipment box, 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. 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 65 engages the edge of the outer conductor of the appliance port, thereby making a direct electrical ground connection between 2

the outer conductor of the appliance port and the tubular post: in turn, the tubular post is engaged with the outer conductor of the coaxial cable.

However, in many cases, it is difficult for an installer to reach the connection ports of the appliance with a wrench, and in some instances, it is even difficult for the installer to reach such connection ports with his or her fingers. As a result, it can often happen that type F connectors are not fully tightened to the appliance port. In such a loose connection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, a gap exists between the outer conductor of the appliance port and the tubular post of the connector. Unless an alternate ground path exists, poor signal quality, and RFI leakage, will result.

As mentioned above, the coupler is 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 dimension 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.

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.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a coaxial cable connector for connecting a coaxial cable to a connection port of an appliance, the coaxial cable connector being of the type that includes a tubular post and a coupler, such as a rotatable coupler, which ensures a reliable ground connection between the tubular post of the connector and an outer conductor of the appliance port, even if the coupler is not fully tightened onto the appliance port.

It is another object of the present invention to provide such a coaxial cable connector which maintains a reliable ground path between the coupler and the tubular post, at least following installation of such connector onto the end of a coaxial cable.

It is still another object of the present invention to provide such a coaxial connector that can be manufactured economically.

These and other objects of the present invention will become more apparent to those skilled in the art as the description thereof proceeds.

SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a coaxial cable connector comprising a tubular post, a coupler and a grounding means for providing an electrically conductive path between the post and the coupler. In accordance with a 10 preferred embodiment thereof, the present invention relates to a coaxial cable connector for coupling a prepared end of a coaxial cable to a threaded female equipment port, and including a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the 15 dielectric material and the outer conductor thereof. A coupler is rotatably secured over the second end of the tubular post. and includes a central bore, at least a portion of which is threaded for engaging the female equipment port. An outer body is secured to the tubular post and extends about the first 20 end of the tubular post for receiving the outer conductor, and preferably the cable jacket, of the coaxial cable.

In a preferred embodiment of the present invention, a resilient, electrically-conductive grounding member is disposed between the tubular post and the coupler. This grounding 25 member engages both the tubular post and the coupler for providing an electrically-conductive path therebetween, but without restricting rotation of the coupler relative to the tubular post.

For some preferred embodiments, the grounding member 30 is generally arcuately shaped to extend around the tubular post over an arc of at least 225°, and may extend for a full 360°. This arcuately shaped grounding member may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, 35 the grounding member has a shape that is out-of-round, and more preferably oblong, rather than circular, in order to ensure reliable electrical contact with both the coupler and the tubular post. In order to retain the grounding member inside the coupler, the inner bore of the coupler may include an 40 annular recess proximate to the end of the coupler that encircles the tubular post: at least portions of the grounding member are engaged with the annular recess to prevent the grounding member from being axially displaced within the coupler.

As mentioned above, the tubular post may include an enlarged shoulder at the head thereof. In one preferred embodiment of the present invention. the grounding member surrounds the enlarged shoulder of the tubular post, at least when the coaxial cable connector is assembled onto the pre- 50 pared end of a coaxial cable, whereby at least portions of the grounding member engage the outer surface of such enlarged shoulder.

In one embodiment of the present invention, the grounding member is generally circular and includes a plurality of pro- 55 embodiment of an F connector having a first alternate groundjections extending outwardly therefrom for engaging the coupler. In another embodiment of the present invention, the grounding member is generally circular and includes a plurality of projections extending inwardly therefrom for engaging the tubular post.

In yet another embodiment of the present invention, the tubular post includes an enlarged shoulder extending inside the coupler, and including a first radial face that faces the opposite end of the tubular post. The coupler includes a flange directed inwardly toward the tubular post: this inwardly 65 directed flange including a second radial face that faces toward the connection port of the appliance to which the

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coaxial cable is to be connected. The grounding member is disposed between the first radial face and the second radial face. In this embodiment, the grounding member is resilient relative to the longitudinal axis of the connector, and is compressed between the first radial face and the second radial face to maintain sliding electrical contact between the shoulder of the tubular post (via its first radial face) and the flange of the coupler (via its second radial face).

The coaxial connector of the present invention may also include a sealing ring seated within the coupler for rotatably engaging the body member to form a seal therebetween.

In an alternate embodiment of the present invention, conductive grease is substituted for a discrete grounding member. In this embodiment, an outer dimension of a portion of the tubular post is caused to be commensurate with an inner dimension of an adjacent portion of the coupler. While the gap between such adjacent portions, coupled with the lubrication provided by the conductive grease, is sufficient to permit rotation of the coupler relative to the tubular post, the conductive grease nonetheless functions to maintain reliable electrical coupling across such gap.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with greater specificity and clarity with reference to the following drawings, in which:

FIG. 1 is a perspective view of an F connector in accordance with the preferred embodiment of the invention. including a body and a coupling nut:

FIG. 2 is an exploded view of the F connector of FIG. 1. including a preferred embodiment of a grounding member:

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member of FIG. 2:

FIG. 3 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and a side view of a prepared coaxial

cable ready to be inserted into a back end of the F connector: FIG. 3A is a cross-sectional view of the body of the F connector of FIG. 1 through cut-line 3-3:

FIG. 3B is a cross-sectional view of a tubular post of the F connector of FIG. 1. through cut-line 3-3:

FIG. 3C is a cross-sectional view of the coupling nut of the F connector of FIG. 1 through cut-line 3-3:

FIG. 4 is a cross-sectional view of the F connector of FIG. 45 1 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof. prior to axial compression of the F connector:

FIG. 4A is an enlargement of a portion of FIG. 4:

FIG. 5 is a cross-sectional view of the F connector of FIG. through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, subsequent to axial compression of the F connector: FIG. 5A is an enlargement of a portion of FIG. 5:

FIG. 6 is a partial cross-sectional view of a first alternate ing member:

FIG. 6A is an enlargement of a portion of FIG. 6:

FIG. 6B is a slightly enlarged side view of the first alternate grounding member of FIG. 6:

FIG. 6C is a slightly enlarged plan view of the first alternate grounding member of FIG. 6:

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of an F connector having a second alternate grounding member:

FIG. 7A is an enlargement of a portion of FIG. 7:

FIG. 7B is a slightly enlarged side view of the second alternate grounding member of FIG. 7:

FIG. 7C is a slightly enlarged plan view of the second alternate grounding member of FIG. 7:

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of an F connector having a third alternate grounding member:

FIG. **8**A is a slightly enlarged side view of the third alternate grounding member of FIG. **8**:

FIGS. **8B-8**E are slightly enlarged plan views of four styles of the third alternate grounding member of FIG. **8**:

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of an F connector having one of a fourth alternate grounding member and a fifth alternate grounding member:

FIG. **9A** is a slightly enlarged side view of the fourth alternate grounding member of FIG. **9**: 15

FIG. **9B** is a slightly enlarged plan view of the fourth alternate grounding member of FIG. **9**:

FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member of FIG. 9:

FIG. 9D is a slightly enlarged plan view of the fifth alter- 20 nate grounding member of FIG. 9:

FIG. **10** is a partial cross-sectional view of a fifth alternate embodiment of an F connector having conductive grease that acts as a grounding member:

FIG. 11 is a partial cross-sectional view of a front end of a 25 sixth alternate embodiment of an F connector having a sixth alternate grounding member:

FIG. 11A is an enlargement of a portion of FIG. 11:

FIG. 11B is a side view of the sixth alternate grounding member of FIG. 11:

FIG. 11C is a plan view of the sixth alternate grounding member of FIG. 11: and

FIG. 11D is a perspective view of the sixth alternate grounding member of FIG. 11.

For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and descriptions and details of well-known features and techniques are omitted to avoid unnecessarily obscuring the invention. Furthermore, elements in the drawing figures are not necessarily drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a perspective view of an F connector 100 in 45 accordance with the preferred embodiment of the invention. The F connector 100 (hereinafter. "connector") has a longitudinal axis 101. The connector has a front end 102 and a back end 103.

FIG. 2 is an exploded view of the connector 100. The 50 connector 100 includes tubular post 104. a coupling nut 105 rotatably secured over an end 106 of the tubular post for securing the connector to an appliance (not shown), and a body 108 secured to the tubular post. A shell 107 and a label 109 are secured to the body 108. Preferably, the body 108 is 55 made entirely of acetal plastic. Alternatively, the body 108 is made of brass, plated with nickel. The shell 107 adds strength to the plastic body 108 and protects the plastic body from ultraviolet light. The tubular post 104 is preferably metallic, and more preferably, made of brass, with a tin plating; as tin 60 is more conductive than nickel. The coupling nut 105 is preferably metallic, and more preferably, formed from brass, plated with nickel or with another non-corrosive material.

In the embodiment shown in the drawings, the coupling nut 105 is rotatably secured over an end 106 of the tubular post 65 104 via a neck 111 of the body 108. Advantageously, an electrical grounding path is constantly maintained between 6

the coupling nut 105 and the tubular post 104, including, in particular, when the coupling nut 105 of the connector 100 is not tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member 110 disposed between the tubular post 104 and the coupling nut 105.

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member 110. In the preferred embodiment of the present invention, the electrically-conductive grounding member 110 is disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 contacts both the tubular post 104 and the coupling nut 105 for providing an electrically-conductive path therebetween. but without restricting rotation of the coupling nut relative to the tubular post. A preferred embodiment of the grounding member 110 shown in FIG. 2A is a spring member. or circlip. disposed between the coupling nut 105 and the tubular post 104, which establishes a stable ground path between the coupling nut and the post, and which is preferably constructed of a wire-type material. The grounding member 110 is retained in the coupling nut 105 by an annular recess 343 (see FIG. 3C) in the coupling nut. The spring action of the grounding member 110 serves to form a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut 105 to rotate. The grounding member 110 is resilient and is generally arcuately shaped. The grounding member 110 extends around the tubular post 104 over an arc of at least 225°, and may extend for a full 360°. The arcuately shaped grounding member 110 may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member 110 is a C-shaped metal clip that has an arcuate curvature that is non-circular. The grounding member 110 has a minimum diameter 201 and a maximum diameter 203. Preferably, the grounding member 110 is made of stainless steel wire that has a wire diameter of between 0.010-inch and 0.020-inch: in a preferred embodiment, the wire diameter is about 0.016-inch. Stainless steel is a preferred metal for the grounding member 110 because it need not be plated for corrosion resistance.

FIG. 3 is a cross-sectional view of the connector 100 through cut-line 3-3 of FIG. 1. and a side view of a prepared coaxial cable 301 ready to be inserted into a back end 103 of the connector. The center conductor 302 of the coaxial cable 301 is surrounded by a dielectric material 303, and the dielectric material is surrounded by an outer conductor 304 that may be in the form of a conductive foil and/or braided sheath. The outer conductor 304 is usually surrounded by a plastic cable jacket 305 that electrically insulates, and mechanically protects, the outer conductor.

FIG. 3A is a cross-sectional view of the body 108 of FIG. 1 through cut-line 3-3. FIG. 3B is a cross-sectional view of the tubular post 104 of FIG. 1 through cut-line 3-3. FIG. 3C is a cross-sectional view of the coupling nut 105 of FIG. 1 through cut-line 3-3. Referring now to FIGS. 3, 3A, 3B and 3C, the body 108 has a lip 310 at a front end of the body. The lip 310 has an outer diameter 311 and an inner diameter 312. The coupling nut 105 is rotatably secured about a head 330 at the front end of the tubular post 104. The head 330 of the tubular post 104 usually includes an enlarged shoulder 332. The coupling nut 105 typically includes an inwardly-directed flange 340 that extends over and around the shoulder 332 of the tubular post 104. In order to retain the grounding member 110 inside the coupling nut 105, the inner, or central, bore 342 of the coupling nut 105 may include an annular recess 343 that is proximate to the end of the coupling nut that encircles the tubular post 104. At least portions of the grounding mem-

ber 110 are engaged with the annular recess 343 to prevent the grounding member from being axially displaced within the coupling nut 105. The tubular post 104 may include an enlarged shoulder 332 at the head 330 thereof. The shoulder 332 has a first radial face 333 that faces the back end of the tubular post 104. In one preferred embodiment of the present invention, the grounding member 110 surrounds the enlarged shoulder 332 of the tubular post 104, at least when the connector 100 is assembled onto the prepared end of a coaxial cable 301. At least portions of the grounding member 110 contact the outer surface 334 of such enlarged shoulder 332.

The coupling nut 105 has an inwardly-directed flange near the back end of the coupling nut. The coupling nut 105 has an inner diameter 341 at a back end of the coupling nut. In order to retain the back end of the coupling nut 105 on the front end 15 of the body 108, the inner diameter 341 of the coupling nut has a dimension less than the outer diameter of the lip 310 of the body 108. In order not to interfere with free rotation of the coupling nut 105, the outer diameter 336 of the shoulder 332 (at the head 330 of the tubular post 104) is of smaller dimen- $_{20}$ sion than the inner diameter 344 of the central bore of the coupling nut 105. Likewise, the inner diameter 341 of the inwardly-directed flange 340 of the coupling nut 105 is of larger dimension than the outer diameter 337 of the nonshoulder portion 338 of the tubular post 104, again to avoid 25 interference with rotation of the coupling nut 105 relative to the tubular post.

FIG. 4 is a cross-sectional view of the connector 100 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 thereof. 30 prior to axial compression of the connector. FIG. 4A is an enlargement of a portion of FIG. 4. Referring now to FIGS. 4 and 4A, the resilient, electrically-conductive grounding member 110 is shown disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 is 35 disposed in the annular recess 343 that encircles the tubular post 104.

FIG. 5 is a cross-sectional view of the connector 100 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 40 thereof, subsequent to axial compression of the connector. FIG. 5A is an enlargement of a portion of FIG. 5. Referring now to FIGS. 5 and 5A, as a result of axial compression by a standard compression tool (not shown), the tubular post 104 slides (to the right in the drawings) relative to the other com- 45 ponents of the connector 100 and relative to the cable 301. such that the shoulder 332 of the tubular post is radially inward of the grounding member 110. At least a portion of the grounding member 110 engages the coupling nut 105 at the annular recess 343 of the coupling nut, and at least another 50 portion of the grounding member engages tubular post 104 at the shoulder 332 of the tubular post. The tubular post 104 is in electrical contact with the outer conductor 304 of the cable 301 along the back portion of the tubular post, and the coupling nut 105 may engage the outer conductor of an appliance 55 port (not shown). Therefore, when the connector 100 is fastened to an appliance port, there is maintained an electrical grounding path between the outer conductor 304 of the cable 301 and the outer conductor of the appliance port, whether or not the coupling nut 105 of the connector is tightly fastened to 60 the appliance port.

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of a connector 600 having a first alternate grounding member 601 (see FIGS. 6.A-6C), shown subsequent to axial compression. FIG. 6.A is an enlargement of a portion of the first alternate embodiment of the connector 600 showing a portion of the first alternate grounding member 8

601. FIG. 6B is a slightly enlarged side view of the first alternate grounding member 601. FIG. 6C is a slightly enlarged plan view of the first alternate grounding member 601. Referring now to FIGS. 6. 6A. 6B and 6C. the first alternate grounding member 601 is a spring finger grounding member retained between the coupling nut 105 and the tubular post 104. The first alternate grounding member 601 is constructed of a thin cross section of material such as beryllium copper. The first alternate grounding member 601 comprises a ring portion 602 and a plurality of circumferential fingers 603 that project at approximately a 30° angle from the plane of the ring. As is clearly illustrated in FIGS. 6B and 6C. the circumferential spring members 603 are arranged symmetrically about the ring portion and project from respective base portions in a plane of the ring to respective movable portions displaced from the plane of the ring along a circumferential path of the ring. The respective base and movable portions of each circumferential spring member 603 lie along a common circumferential path and, collectively, the circumferential spring members 603 track a common circumference of the grounding member 601 and do not extend radially inwardly toward a center of the grounding member 601. This configuration is also clearly illustrated in FIGS. 6B and 6C. The spring action of the fingers 603 extend to, and make contact with, a radial surface 604 near the back end of the coupling nut 105 that faces the front end of the coupling nut. which serve to connect a ground path from the coupling nut to the tubular post while allowing the coupling nut to rotate. The first alternate grounding member 601 has optional internal lugs 605 that contact the outer diameter 337 of the nonshoulder portion of the tubular post.

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of a connector 700 having a second alternate grounding member 701 (see FIGS. 7A-7C). FIG. 7A is an enlargement of a portion of the second alternate embodiment of the connector 700, showing a portion of the second alternate grounding member 701. FIG. 7B is a slightly enlarged side view of the second alternate grounding member 701. FIG. 7C is a slightly enlarged plan view of the second alternate grounding member 701. Referring now to FIGS. 7. 7.A. 7B and 7C, the second alternate grounding member 701 is a radial grounding member retained between the coupling nut 105 and the tubular post 104. The second alternate grounding member 701 is constructed of a thin cross section of metallic material such as beryllium copper. The second alternate grounding member 701 comprises a ring portion 702 and a plurality of fingers 703 extending radially from the ring portion at about a 45° angle from the plane of the ring portion. The spring action of the fingers 703 extend to inner-diameter surfaces 705 of the coupling nut 105 and serve to connect a ground path from the coupling nut to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of a connector 800 having a third alternate grounding member 801 (see FIGS. 8A-8E). FIG. 8A is a slightly enlarged side view of the third alternate grounding member 801. FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member 801. Referring now to FIG. 8 and FIGS. 8A-8E, the third alternate grounding member 801 is a conductive member retained between the coupling nut 105 and the tubular post 104. The third alternate grounding member 801 is constructed of a thin cross section of metallic material such as brass or beryllium copper. The third alternate grounding member 801 comprises a ring 802 with multiple points of contact, or internal lugs. 803 around the inner perimeter of the ring and with multiple external lugs 804 around the outer perimeter of the ring. The

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lugs 803 and 804 serve to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. FIGS. 8B-8E show four styles with regard to the shape of the lugs 803 and 804 and the position of the lugs on the ring 802. FIG. 8 also exhibits an alternate freembodiment comprising a sealing ring 805 for forming a moisture seal between the coupling nut 105 and the body 108 of the connector 801. The sealing ring 805 is disposed between the back end of the coupling nut 105 and the body 108 for forming a seal therebetween. Preferably, the sealing ring 805 is made from ethylene propylene. Use of the sealing ring 805 is not limited to use in connectors having the third alternate grounding member 801. The third alternate grounding member 801 may also be used in connectors without the sealing ring 805.

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of a connector 900 having one of a fourth alternate grounding member 901 and a fifth alternate grounding member 911 (see FIGS. 9A-9D). FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member 20 901. FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member 901. FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member 902. FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member 911. The fourth and fifth alter- 25 nate embodiments of the grounding member 901 and 911. respectively, comprise a C-shaped ring between the coupling nut 105 and the tubular post 104. The C-shaped ring is constructed of a thin cross section of metallic material such as beryllium copper or stainless steel. It is retained by a groove in the coupling nut. The spring action of the C-shaped ring serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. The fourth alternate grounding member 901 includes a circumferential metallic band 902, which has a general circular 35 shape and approximates a section of a hollow cylinder, that extends between first 903 and second 904 opposing ends. The band 902 has first 906 and second 907 opposing side edges extending along its length. The fourth alternate grounding member 901 includes a first generally radial wall 908 extend-40 ing from the first side edge 906 of the band in a first radial direction, and a second generally radial wall 909 extending from the second side edge 907 of the band generally in said first radial direction. As is clearly illustrated in FIG. 9A, the radial walls 908, 909 extend away from the side edges 906. 45 907 along a radial path that extends radially from the width that is defined between the first and second side edges 906. 907. The band 902 contacts a first one of the group of members that includes the coupling nut 105 and the tubular post 104. The first 908 and second 909 radial walls contact the 50 second of the group of members that includes the coupling nut 105 and the tubular post 104. The fifth alternate grounding member 911 includes a metallic band 912 extending along its length between first 913 and second 914 opposing ends. and extending along its width between first 916 and second 917 55 side edges. The band 912 is formed along its length into a generally circular shape. The band 912 is formed along its width into a generally concave shape with the side edges 916 and 917 projecting generally in a first radial direction. The fifth alternate grounding member 911 includes a plurality of projections 918 extending from the band 912 in a second radial direction opposite to the first radial direction. The first 916 and second 917 side edges of the band 912 contact a first one of the group of members that includes the coupling nut and the tubular post. The plurality of projections 918 contact 65 the second of the group of members that includes the coupling nut 105 and the tubular post 104.

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FIG. 10 is a partial cross-sectional view of a fifth alternate embodiment of a connector 1000 having conductive grease (not shown) that acts as a grounding member. The ground path is established by means of a close fit between the coupling nut 105 and the tubular post 104. The conductive grease is disposed at a grease annular ring 1001 where mating portions of the tubular post 104 and coupling nut 105 have closely matching dimensions. Preferably, the conductive grease is a silver-loaded silicon lubricating material. The conductive grease serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector 1100 that includes a body 1108, and which has a sixth alternate grounding member 1101. FIG. 11A is an enlargement of a portion of FIG. 11. FIG. 11B is a side view of the sixth alternate grounding member 1101. FIG. 11C is a plan view of the sixth alternate grounding member 1101. FIG. 11D is a perspective view of the sixth alternate grounding member 1101. Referring now to FIG. 11 and FIGS. 11A-11D. the sixth alternate grounding member 1101 includes a circumferential metallic band 1112 extending between first 1113 and second 1114 opposing ends. The band 1112 has a generally circular shape that approximates a section of a hollow cylinder. The first 1113 and second 1114 ends of the band 1112 are disposed generally proximate to each other and are directed generally toward one another. The band 1112 has first and second opposing side edges 1115 and 1116, respectively, extending along its length. The band generally defines a section of a cylindrical surface. The sixth alternate grounding member 1101 includes a plurality of projections 1101 extending from at least one of the first and second side edges 1115 and 1116 of the band 1112. The plurality of projections 1117 extend away from the cylindrical surface defined by the band 1112. The band 1112 contacts a first one of the group of members that includes the coupling nut 1105 and the tubular post 1104. The plurality of projections 1117 contact the second of the group of members that includes the coupling nut 1105 and the tubular post 1104.

In preferred embodiments, the present invention provides a coaxial cable connector that ensures a reliable grounding path without creating undue interference with free rotation of the coupler relative to the remaining components of the connector; however, the present invention can also provide a reliable grounding path between a post and a coupler that does not rotate. Advantageously, a connector in accordance with the invention works with standard installation tools and with standard compression tools. The present invention can be used with both axially-compressible connectors as well as with older-style crimp-ring connectors. In some embodiments, the present invention is compatible with the use of a sealing ring for forming a moisture seal between the coupler and the outer body of the connector.

While the present invention has been described with respect to preferred embodiments thereof, such description is for illustrative purposes only, and is not to be construed as limiting the scope of the invention. Various modifications and changes may be made to the described embodiments by those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims. For example, the grounding member can have a shape other than generally circular, such as square, hexagonal, octagonal, oval, etc.

LIST OF REFERENCE NUMERALS

100 F connector ("connector") **101** Longitudinal axis

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102 Front end 103 Back end 104 Tubular post 105 Coupling nut 106 End of tubular post 107 Shell 108 Body 109 Label 110 Grounding member 111 Neck 201 Minimum diameter 203 Maximum diameter 301 Coaxial cable 302 Center conductor 303 Dielectric material 304 Outer conductor 305 Jacket 310 Lip of body 311 Outer diameter of lip body 312 Inner diameter of lip of body 330 Head of tubular post 332 Shoulder of tubular post 333 First radial face of shoulder of tubular post **334** Outer surface of shoulder 336 Outer diameter of shoulder 337 Outer diameter of non-shoulder portion of post 338 Non-shoulder portion of post 340 Inwardly-directed flange of coupling nut 341 Inner diameter of inwardly-directed flange 342 Bore of coupling nut 343 Annular recess of coupling nut 344 Inner diameter of bore of coupling nut 600 First alternate connector 601 First alternate grounding member 602 Ring portion of first alternate grounding member 603 Fingers of first alternate grounding member 604 Radial surface of coupling nut 605 Internal lugs of first alternate grounding member 700 Second alternate connector 701 Second alternate grounding member 702 Ring portion of second alternate grounding member 703 Fingers of second alternate grounding member 800 Third alternate connector 801 Third alternate grounding member 802 Ring portion of third alternate grounding member 803 Internal lugs of third alternate grounding member 804 External lugs of third alternate grounding member 805 Sealing ring 900 Fourth alternate connector 901 Fourth alternate grounding member 902 Band of fourth alternate grounding member 903 First end of band 904 Second end of band 906 First side edge of band 907 Second side edge of band 908 First radial wall of band 909 Second radial wall of band 911 Fifth alternate grounding member 1000 Fifth alternate connector 1001 Grease annular ring 1100 Sixth alternate connector 1101 Sixth alternate grounding member 1104 Tubular post of sixth alternate connector 1105 Coupling nut of sixth alternate connector 1108 Body of sixth alternate connector 1112 Band of sixth alternate grounding member 1113 First end of band

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- 1114 Second end of band
- 1115 First side edge of band
- 1116 Second side edge of band
- 1117 Projections on band
- We claim:
- 1. A coaxial cable connector having a grounding member. a post and a nut, the grounding member comprising:
- a metallic band comprising first and second side edges and a width extending between the first and second side edges, said metallic band comprising of a pair of oppos-10 ing radial walls extending away from the first and second side edges along a pair of radial paths extending radially from the width and being composed at least partially of electrically conductive material, and 15
 - a contact portion defined by the radial wall, wherein the contact portion contacts the group members that includes the post and the nut and provides for an electrically-conductive path through the post and the nut.
- 2. A grounding member for a coaxial cable connector hav-20 ing a post and a nut, comprising:
 - a ring portion composed at least partially of electrically conductive material, and
 - a contact portion composed at least partially of a plurality of circumferential spring members projecting from respective base portions in a plane of the ring to respective movable portions displaced from the plane of the ring along a circumferential path of the ring, wherein the spring members are arranged symmetrically about the ring portion.
 - respective base and movable portions of each circumferential spring member lie predominantly along a common circumferential path. and
 - the contact portion provides for an electrically-conductive path through the post and the nut.
 - 3. The grounding member of claim 2. wherein the ring portion extends at least partially around the post, and wherein the at least one contact portion contacts the nut, and wherein the at least one contact portion contacts the post.

4. The grounding member of claim 2, wherein the contact 40 portion is a plurality of fingers extending radially from the ring portion.

5. The grounding member of claim 4. wherein the plurality of fingers extend at about a 45° angle from the plane of the ring portion.

45 6. The grounding member of claim 4, wherein the plurality of fingers project at approximately a 30° angle from the plane of the ring.

7. The grounding member of claim 2 wherein, collectively. the circumferential spring members track a common circum-50 ference of the grounding member.

- 8. The grounding member of claim 2 wherein the circumferential spring members do not extend radially inwardly toward a center of the grounding member.
- 9. A grounding member for a coaxial cable connector hav-55 ing a post and a nut, comprising a generally arcuate shaped member, composed at least partially of electrically conductive material, and a contact portion of the generally arcuate shaped member, wherein:
- the at least one contact portion provides for an electricallyconductive path through the post and the nut: 60
 - the generally arcuate shaped member comprises a circumferential metallic band; and
 - the circumferential metallic band has a general circular shape and approximates a section of a hollow cylinder that extends between first and second opposing ends.
- 65 10. The grounding member of claim 9, wherein the generally arcuate shaped member is C-shaped member.

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11. The grounding member of claim 10. wherein the C-shaped member defines a circular broken ring extending over an arc of about at least 225 degrees.

12. The grounding member of claim **10**, wherein the C-shaped member is a metal clip that has an arcuate curvature 5 that is non-circular.

13. The grounding member of claim **9**, wherein the generally arcuate shaped member is a stainless steel wire having a wire diameter of between about 0.010-inch and 0.020-inch.

14. The grounding member of claim 13. wherein the stainless steel wire has a diameter of about 0.016-inch.

15. The grounding member of claim 9, wherein at least a portion of the generally arcuate member positions in an annular recess in the nut.

16. The grounding member of claim **15**, wherein the contact portion engages the nut at the annular recess.

17. The grounding member of claim 9, wherein the contact portion comprises internal lugs around an inner perimeter of the generally arcuate member, and wherein the internal lugs 20 contact the post.

18. The grounding member of claim 9, wherein the contact portion comprises external lugs around an outer perimeter of the generally arcuate member, wherein the external lugs contact the nut.

19. The grounding member of claim 9, wherein the circumferential metallic band has first and second opposing side edges extending along a length of the circumferential metallic band.

20. The grounding member of claim **19**, wherein the circumferential metallic band includes a first generally radial wall extending from the first side edge in a first radial direction, and a second generally radial wall extending from the second side edge generally in the first radial direction.

21. The grounding member of claim 20, the circumferential metallic band contacts a first one of the group of members that includes the nut and the post, and wherein the first and second radial walls contact the second of the group of members that includes the nut and the post.

22. The grounding member of claim 19. wherein the circumferential metallic band is formed along a width into a generally concave shape with the first and second side edges projecting generally in a first radial direction.

23. The grounding member of claim 19, wherein the contact portion comprises a plurality of projections, and wherein the first and second side edges contact a first one of a group of members that includes the nut and the post, and the plurality of projections contact a second one of the group of members that includes the nut and the post.

* * * * *

Case 4:22-cv-00163-LPR Docume

US008172612C1

(12) EX PARTE REEXAMINATION CERTIFICATE (10300th) **United States Patent** (10) **Number:**

Bence et al.

(54) ELECTRICAL CONNECTOR WITH **GROUNDING MEMBER**

- (75) Inventors: Bruce D. Bence, Glendale, AZ (US): Donald A. Burris, Peoria, AZ (US): Brian L. Kisling. Phoenix. AZ (US): John A. Kooiman, Peoria, AZ (US): William B. Lutz, Glendale, AZ (US); William F. McDade, Glendale, AZ (US); Thomas D. Miller. Peoria. AZ (US): Lee Yung Chuan. Sanchong (TW)
- (73) Assignee: Corning Gilbert Inc., Glendale, AZ (US)

Reexamination Request: No. 90/012,835, Apr. 11, 2013

Reexamination Certificate for:

Patent No.:	8,172,612
Issued:	May 8, 2012
Appl. No.:	13/117,843
Filed:	May 27, 2011

Related U.S. Application Data

- (63) Continuation of application No. 12/332.925, filed on Dec. 11, 2008, now Pat. No. 7,955,126, which is a continuation of application No. 11/541.903, filed on Oct. 2, 2006, now Pat. No. 7,479,035, which is a continuation of application No. 11/043.844, filed on Jan. 25, 2005, now Pat. No. 7.114,990.
- (51) Int. Cl.

H01R 9/05	(2006.01)
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- (52) U.S. Cl.
- USPC 439/578 Field of Classification Search (58)CPC H01R 9/05 USPC 439/578 See application file for complete search history.

US 8,172,612 C1 (45) Certificate Issued: Sep. 26, 2014

(56)**References** Cited

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/012.835, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner John S Heyman

(57)ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.

Attention is directed to the decision of Corning Gilbert Incorporated v. John Mezzalingua Associates Incorporated, US District Court Civil Docket U.S District - Arizona (Phoenix Division) 2:12cv2208 relating to this patent. This reexamination may not have resolved all questions raised by this decision. See 37 CFR 1.552(c) for ex parte reexamination and 37 CFR 1.906(c) for inter partes reexamination.

At the time of issuance and publication of this certificate, the patent remains subject to pending reexamination control number 90/012,300 filed May 21, 2012. The claim content of the patent may be subsequently revised if a reexamination certificate issues from the reexamination proceeding.



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EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

Matter enclosed in heavy brackets [] appeared in the patent, but has been deleted and is no longer a part of the 10 patent; matter printed in italics indicates additions made to the patent.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT: 15

Claim 16 is determined to be patentable as amended.

New claims 24-26 are added and determined to be patentable.

Claims 1-15 and 17-23 were not reexamined.

16. The grounding member of claim 15, wherein the contact portion engages the nut at the annular recess, wherein the grounding member contacts an axially extending outer surface of a flange of the post, wherein the axially extending outer surface of the flange of the post is radially spaced from the annular recess by the grounding member, wherein the axially extending outer surface is arranged between a forward facing surface of the flange of the post and a rearward facing surface of the flange of the post.

24. The grounding member of claim 16, wherein the contact portion comprises a plurality of projections extending radially outwardly from the axially extending outer surface of the flange of the post, and contacting the annular recess.

25. A coaxial cable connector, comprising:

a nut. a post, and the grounding member of claim 16. wherein the grounding member electrically contacts the annular recess of the nut and the axially extending outer surface of the flange of the post so as to provide a ground path between the nut and the post.

26. The coaxial cable connector of claim 25. wherein the contact portion comprises a plurality of projections extend-

20 ing radially outwardly from the axially extending outer surface of the flange of the post, and contacting the annular recess.

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Case 4:22-cv-00163-LPR Documental polarity

US008172612C1

(12) EX PARTE REEXAMINATION CERTIFICATE (10583rd)

United States Patent

Bence et al.

(54) ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

- (75) Inventors: Bruce D. Bence, Glendale, AZ (US): Donald A. Burris. Peoria, AZ (US): Brian L. Kisling, Phoenix, AZ (US): John A. Kooiman, Peoria, AZ (US): William B. Lutz, Glendale, AZ (US): William F. McDade, Glendale, AZ (US): Thomas D. Miller, Peoria, AZ (US): Lee Yung Chuan, Sanchong (TW)
- (73) Assignee: Corning Incorporated

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Filed:	May 27, 2011

Related U.S. Application Data

- (63) Continuation of application No. 12/332.925, filed on Dec. 11, 2008, now Pat. No. 7.955.126, which is a continuation of application No. 11/541.903, filed on Oct. 2, 2006, now Pat. No. 7.479.035, which is a continuation of application No. 11/043.844, filed on Jan. 25, 2005, now Pat. No. 7.114.990.
- (51) Int. Cl.

H01R 9/05	(2006.01)
H01R 24/44	(2011.01)

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	H01R 103/00	(2006.01)
	H01R 13/52	(2006.01)
(52)	U.S. Cl.	

- (58) Field of Classification Search None

See application file for complete search history.

(56) **References Cited**

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 90/012.300. please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner --- Yuzhen Ge

(57) ABSTRACT

A coaxial cable connector includes tubular post, a coupler secured over an end of the tubular post for securing the connector to an appliance, and an outer body secured to the tubular post. An electrical grounding path is maintained between the coupler and the tubular post whether or not the coupler is tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member disposed between the tubular post and the coupler. Alternatively, the connector includes conductive grease at a point where mating portions of the tubular post and coupler have closely matching dimensions.



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EX PARTE REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 307

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

AS A RESULT OF REEXAMINATION. IT HAS BEEN DETERMINED THAT: 10

Claims 2-11, 15 and 19 are cancelled. Claims 1, 12-14, 16-18 and 20-23 were not reexamined.

* * * * *
LIS01075645

US010756455B2

(12) United States Patent

Bence et al.

(54) ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

(71) Applicant: Corning Optical Communications RF LLC, Glendale, AZ (US)

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- (73) Assignee: Corning Optical Communications RF LLC, Glendale, AZ (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 93 days.
- (21) Appl. No.: 14/166,653
- (22) Filed: Jan. 28, 2014

(65) **Prior Publication Data**

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Related U.S. Application Data

- (63) Continuation of application No. 13/438,532, filed on Apr. 3, 2012, now Pat. No. 8,690,603, which is a (Continued)
- (51) Int. Cl. H01R 9/05 (2006.01) H01R 24/44 (2011.01)

(Continued)

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(45) **Date of Patent:** Aug. 25, 2020

(58) Field of Classification Search CPC H01R 9/0521; H01R 9/0524; H01R 2103/00; H01R 24/564; H01R 24/40 (Continued)

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Primary Examiner — Abdullah A Riyami Assistant Examiner — Vladimir Imas

(74) Attorney, Agent, or Firm - Tamika A. Crawl-Bey

(57) **ABSTRACT**

A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector including: a post including a first end adapted to be inserted into a prepared end of the coaxial cable between the dielectric material and the outer conductor, wherein the post includes a second end including an enlarged shoulder, wherein the enlarged shoulder has a radial face that faces away from the first end of the post, wherein the radial face is substantially flat; a body member adjacent to the post; a coupler including an internally-threaded region for engaging the equipment port; and a grounding member contacting the post and the coupler,

(Continued)





Page 2

wherein the grounding member provides an electricallyconductive grounding path through the post and the coupler while allowing the coupler to rotate, wherein the grounding member includes at least one resilient portion.

15 Claims, 8 Drawing Sheets

Related U.S. Application Data

continuation of application No. 13/117,843, filed on May 27, 2011, now Pat. No. 8,172,612, which is a continuation of application No. 12/332,925, filed on Dec. 11, 2008, now Pat. No. 7,955,126, which is a continuation of application No. 11/541,903, filed on Oct. 2, 2006, now Pat. No. 7,479,035, which is a continuation of application No. 11/043,844, filed on Jan. 25, 2005, now Pat. No. 7,114,990.

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H01R 13/52	(2006.01)
H01R 103/00	(2006.01)

- (52) U.S. CL CPC H01R 13/5202 (2013.01); H01R 13/5216 (2013.01); H01R 2103/00 (2013.01)

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ELECTRICAL CONNECTOR WITH GROUNDING MEMBER

This application is a continuation of U.S. patent application Ser. No. 13/438,532, filed Apr. 3, 2012, which is a 5 continuation of U.S. patent application Ser. No. 13/117,843 filed on May 27, 2011, now U.S. Pat. No. 8,172,612, which is a continuation of U.S. patent application Ser. No. 12/332, 925 filed on Dec. 11, 2008, now U.S. Pat. No. 7,955,126, which is a continuation of U.S. patent application Ser. No. 10 11/541,903 filed on Oct. 2, 2006, now U.S. Pat. No. 7,479, 035, which is a continuation of U.S. patent application Ser. No. 11/043,844 filed on Jan. 25, 2005, now U.S. Pat. No. 7,114,990, the contents of which are relied upon and incorporated by reference in their entirety. 15

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to electrical connectors, 20 and more particularly to coaxial cable connectors capable of being connected to a terminal.

2. Description of the Related Art

Coaxial cable connectors, such as type F connectors, are used to attach coaxial cable to another object or appliance, 25 e.g., a television set or VCR having a terminal adapted to engage the connector. The terminal of the appliance includes an inner conductor and a surrounding outer conductor,

Coaxial cable includes a center conductor for transmitting a signal. The center conductor is surrounded by a dielectric 30 material, and the dielectric material is surrounded by an outer conductor; this 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, 35 and to maintain a continuous desired impedance over the signal path. The outer conductor is usually surrounded by a plastic cable jacket that by the center conductor from stray noise, and to maintain a continuous desired impedance over the signal path. The outer conductor is usually surrounded 40 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 bare the end portion of the 45 outer conductor. Similarly, it is common to strip off a portion of the dielectric to expose the end portion of the center conductor.

Coaxial cable connectors of the type known in the trade as "F connectors" often include a tubular post designed to 50 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 55 outer conductor extend generally around the outside of the tubular post and are typically received in an outer body of the connector; this outer body of the connector is usually fixedly secured to the tubular post. A coupler is rotatably secured around the tubular post and includes an internally-60 threaded region for engaging external threads formed on the outer conductor of the appliance terminal.

When connecting the end of a coaxial cable to a terminal of a television set, equipment box, or other appliance, it is important to achieve a reliable electrical connection between 65 the outer conductor of the coaxial cable and the outer conductor of the appliance terminal. This goal is usually 2

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; in turn, the tubular post is engaged with the outer conductor of the coaxial cable.

However, in many cases, it is difficult for an installer to reach the connection ports of the appliance with a wrench, and in some instances, it is even difficult for the installer to reach such connection ports with his or her fingers. As a result, it can often happen that typo F connectors are not fully tightened to the appliance port. In such a loose connection system, wherein the coupler of the coaxial connector is not drawn tightly to the appliance port connector, a gap exists between the outer conductor of the appliance port and the tubular post of the connector. Unless an alternate ground path exists, poor signal quality, and RFI leakage, will result.

As mentioned above, the coupler is 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 dimension 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.

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 the to intermittent failures that are costly and timeconsuming to diagnose.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a coaxial cable connector for connecting a coaxial cable to a connection port of an appliance, the coaxial cable connector being of the type that includes a tubular post and a coupler, such as a rotatable coupler, which ensures a reliable ground connection between the tubular post of the connector and an outer conductor of the appliance port, even if the coupler is not fully tightened onto the appliance port.

It is another object of the present invention to provide such a coaxial cable connector which maintains a reliable

ground path between the coupler and the tubular post, at least following installation of such connector onto the end of a coaxial cable.

It is still another object of the present invention to provide such a coaxial connector that can be manufactured economically.

These and other objects of the present invention will become more apparent to those skilled in the art as the description thereof proceeds.

SUMMARY OF THE INVENTION

Briefly described, the present invention relates to a coaxial cable connector comprising a tubular post, a coupler and a grounding means for providing an electrically con- 15 ductive path between the post and the coupler. In accordance with a preferred embodiment thereof, the present invention relates to a coaxial cable connector for coupling a prepared end of a coaxial cable to a threaded female equipment port, and including a tubular post having a first end adapted to be 20 inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor thereof. A coupler is rotatably secured over the second end of the tubular post, and includes a central bore, at least a portion of which is threaded for engaging the female equipment port. 25 An outer body is secured to the tubular post and extends about the first end of the tubular post for receiving the outer conductor, and preferably the cable jacket, of the coaxial cable.

In a preferred embodiment of the present invention, a 30 resilient, electrically-conductive grounding member is disposed between the tubular post and the coupler. This grounding member engages both the tubular post and the coupler for providing an electrically-conductive path therebetween, but without restricting rotation of the coupler relative to the 35 tubular post. BRIEF D

For some preferred embodiments, the grounding member is generally arcuately shaped to extend around the tubular post over an arc of at least 225°, and may extend for a full 360°. This arcuately shaped grounding member may be in 40 the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member has a shape that is outof-round, and more preferably oblong, rather than circular, in order to ensure reliable electrical contact with both the 45 coupler and the tubular post. In order to retain the grounding member inside the coupler, the inner bore of the coupler may include an annular recess proximate to the end of the coupler that encircles the tubular post; at least portions of the grounding member are engaged with the annular recess to 50 prevent the grounding member from being axially displaced within the coupler.

As mentioned above, the tubular post may include an enlarged shoulder at the head thereof. In one preferred embodiment of the present invention, the grounding member 55 surrounds the enlarged shoulder of the tubular post, at least when the coaxial cable connector is assembled onto the prepared end of a coaxial cable, whereby at least portions of the grounding member engage the outer surface of such enlarged shoulder. 60

In one embodiment of the present invention, the grounding member is generally circular and includes a plurality of projections extending outwardly therefrom for engaging the coupler. In another embodiment of the present invention, the grounding member is generally circular and includes a 65 plurality of projections extending inwardly therefrom for engaging the tubular post. 4

In yet another embodiment of the present invention, the tubular post includes an enlarged shoulder extending inside the coupler, and including a first radial face that faces the opposite end of the tubular post. The coupler includes a flange directed inwardly toward the tubular post; this inwardly directed flange including a second radial face that faces toward the connection port of the appliance to which the coaxial cable is to be connected. The grounding member is disposed between the first radial face and the second radial face. In this embodiment, the grounding member is resilient relative to the longitudinal axis of the connector, and is compressed between the first radial face and the second radial face to maintain sliding electrical contact between the shoulder of the tubular post (via its first radial face).

The coaxial connector of the present invention may also include a sealing ring seated within the coupler for rotatably engaging the body member to form a seal therebetween.

In an alternate embodiment of the present invention, conductive grease is substituted for a discrete grounding member. In this embodiment, an outer dimension of a portion of the tubular post is caused to be commensurate with an inner dimension of an adjacent portion of the coupler. While the gap between such adjacent portions, coupled with the lubrication provided by the conductive grease, is sufficient to permit rotation of the coupler relative to the tubular post, the conductive grease nonetheless functions to maintain reliable electrical coupling across such gap.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with greater specificity and clarity with reference to the following drawings, in which:

FIG. 1 is a perspective view of an F connector in accordance with the preferred embodiment of the invention, including a body and a coupling nut;

FIG. 2 is an exploded view of the F connector of FIG. 1, including a preferred embodiment of a grounding member;

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member of FIG. 2;

FIG. 3 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and a side view of a prepared coaxial

cable ready to be inserted into a back end of the F connector; FIG. 3A is a cross-sectional view of the body of the F connector of FIG. 1 through cut-line 3-3;

FIG. 3B is a cross-sectional view of a tubular post of the F connector of FIG. 1, through cut-line 3-3;

FIG. 3C is a cross-sectional view of the coupling nut of the F connector of FIG. 1 through cut-line 3-3;

FIG. 4 is a cross-sectional view of the F connector of FIG. 1 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable fully inserted into the back end thereof, prior to axial compression of the F connector;

FIG. 4A is an enlargement of a portion of FIG. 4;

FIG. 5 is a cross-sectional view of the F connector of FIG.
1 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable fully inserted into the back end
60 thereof, subsequent to axial compression of the F connector;

FIG. 5A is an enlargement of a portion of FIG. 5;

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of an F connector having a first alternate grounding member;

FIG. 6A is an enlargement of a portion of FIG. 6;

FIG. 6B is a slightly enlarged side view of the first alternate grounding member of FIG.6;

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FIG. 6C is a slightly enlarged plan view of the first alternate grounding member of FIG. 6;

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of an F connector having a second alternate grounding member;

FIG. 7A is an enlargement of a portion of FIG. 7;

FIG. 7B is a slightly enlarged side view of the second alternate grounding member of FIG. 7;

FIG. 7C is a slightly enlarged plan view of the second alternate grounding member of FIG. 7;

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of an F connector having a third alternate grounding member;

FIG. 8A is a slightly enlarged side view of the third alternate grounding member of FIG. 8;

FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member of FIG. 8;

FIG. 9 is a partial cross-sectional view of a fourth alternate embodiment of an F connector having one of a fourth alternate grounding member and a fifth alternate 20 grounding member;

FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member of FIG. 9;

FIG. 9B is a slightly enlarged plan view of the fourth alternate grounding member of FIG. 9;

FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member of FIG. 9;

FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member of FIG. 9;

FIG. 10 is a partial cross-sectional view of a fifth alternate 30 embodiment of an F connector having conductive grease that acts as a grounding member;

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector having a sixth alternate grounding member;

FIG. 11A is an enlargement of a portion of FIG. 11;

FIG. 11B is a side view of the sixth alternate grounding member of FIG. 11;

FIG. 11C is a plan view of the sixth alternate grounding member of FIG. 11; and

FIG. 11D is a perspective view of the sixth alternate grounding member of FIG. 11.

For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and descriptions and details of well-known features and tech- 45 niques are omitted to avoid unnecessarily obscuring the invention. Furthermore, elements in the drawing figures are not necessarily drawn to scale.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a perspective view of an F connector 100 in accordance with the preferred embodiment of the invention. The F connector 100 (hereinafter, "connector") has a lon- 55 gitudinal axis 101. The connector has a front end 102 and a back end 103.

FIG. 2 is an exploded view of the connector 100. The connector 100 includes tubular post 104, a coupling nut 105 rotatably secured over an end 106 of the tubular post for 60 securing the connector to an appliance (not shown), and a body 108 secured to the tubular post. A shell 107 and a label 109 are secured to the body 108. Preferably, the body 108 is made entirely of acetal plastic. Alternatively, the body 108 is made of brass, plated with nickel. The shell 107 acids 65 strength to the plastic body 108 and protects the plastic body from ultraviolet light. The tubular post 104 is preferably

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metallic, and more preferably, made of brass, with a tin plating; as tin is more conductive than nickel. The coupling nut 105 is preferably metallic, and more preferably, formed from brass, plated with nickel or with another non-corrosive material.

In the embodiment shown in the drawings, the coupling nut 105 is rotatably secured over an end 106 of the tubular post 104 via a neck 111 of the body 108. Advantageously, an electrical grounding path is constantly maintained between the coupling nut 105 and the tubular post 104, including, in particular, when the coupling nut 105 of the connector 100 is not tightly fastened to the appliance. The electrical grounding path is provided by a resilient, electrically-conductive grounding member 110 disposed between the tubu-15 lar post 104 and the coupling nut 105.

FIG. 2A is an enlarged plan view of the preferred embodiment of the grounding member 110. In the preferred embodiment of the present invention, the electrically-conductive grounding member 110 is disposed between the tubular post 104 and the coupling nut 105. The grounding member 110 contacts both the tubular post 104 and the coupling nut 105 for providing an electrically-conductive path therebetween, but without restricting rotation of the coupling nut relative to the tubular post. A preferred embodiment of the grounding member 110 shown in FIG. 2A is a spring member, or circlip, disposed between the coupling nut 105 and the tubular post 104, which establishes a stable ground path between the coupling nut and the post, and which is preferably constructed of a wire-type material. The grounding member 110 is retained in the coupling nut 105 by an annular recess 343 (see FIG. 3C) in the coupling nut. The spring action of the grounding member 110 serves to form a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut 105 to rotate. The grounding member 110 is resilient and is generally arcuately shaped. The grounding member 110 extends around the tubular post 104 over an arc of at least 225°, and may extend for a full 360°. The arcuately shaped grounding member 110 may be in the form of a generally circular broken ring, or C-shaped member, as by bending a strip of metal wire into an arc. Preferably, the grounding member 110 is a C-shaped metal clip that has an arcuate curvature that is non-circular. The grounding member 110 has a minimum diameter 201 and a maximum diameter 203. Preferably, the grounding member 110 is made of stainless steel wire that has a wire diameter of between 0.010-inch and 0.020-inch; in a preferred embodiment, the wire diameter is about 0.016-inch. Stainless steel is a preferred metal for the grounding member 110 because it need not be plated for corrosion resistance.

FIG. 3 is a cross-sectional view of the connector 100 through cut-line 3-3 of FIG. 1, and a side view of a prepared coaxial cable 301 ready to be inserted into a back end 103 of the connector. The center conductor 302 of the coaxial cable 301 is surrounded by a dielectric material 303, and the dielectric material is surrounded by an outer conductor 304 that may be in the form of a conductive foil and/or braided sheath. The outer conductor 304 is usually surrounded by a plastic cable jacket 305 that electrically insulates, and mechanically protects, the outer conductor.

FIG. 3A is a cross-sectional view of the body 108 of FIG. 1 through cut-line 3-3. FIG. 3B is a cross-sectional view of the tubular post 104 of FIG. 1 through cut-line 3-3. FIG. 3C is a cross-sectional view of the coupling nut 105 of FIG. 1 through cut-line 3-3. Referring now to FIGS. 3, 3A, 3B and 3C, the body 108 has a lip 310 at a front end of the body. The lip 310 has an outer diameter 311 and an inner diameter 312. The coupling nut 105 is rotatably secured about a head 330

at the front end of the tubular post 104. The head 330 of the tubular post 104 usually includes an enlarged shoulder 332. The coupling nut 105 typically includes an inwardly-directed flange 340 that extends over and around the shoulder 332 of the tubular post 104. In order to retain the grounding 5 member 110 inside the coupling nut 105, the inner, or central, bore 342 of the coupling nut 105 may include an annular recess 343 that is proximate to the end of the coupling nut that encircles the tubular post 104. At least portions of the grounding member 110 are engaged with the 10 annular recess 343 to prevent the grounding member from being axially displaced within the coupling nut 105. The tubular post 104 may include an enlarged shoulder 332 at the head 330 thereof. The shoulder 332 has a first radial face 333 that faces the back end of the tubular post 104. In one 15 preferred embodiment of the present invention, the grounding member 110 surrounds the enlarged shoulder 332 of the tubular post 104, at least when the connector 100 is assembled onto the prepared end of a coaxial cable 301. At least portions of the grounding member 110 contact the outer 20 surface 334 of such enlarged shoulder 332.

The coupling nut 105 has an inwardly-directed flange near the back end of the coupling nut. The coupling nut 105 has an inner diameter 341 at a back end of the coupling nut. In order to retain the buck end of the coupling nut 105 on the 25 front end of the body 108, the inner diameter 341 of the coupling nut has a dimension less than the outer diameter of the lip 310 of the body 108. In order not to interfere with free rotation of the coupling nut 105, the outer diameter 336 of the shoulder 332 (at the head 330 of the tubular post 104) is 30 of smaller dimension than the inner diameter 344 of the central bore of the coupling nut 105. Likewise, the inner diameter 341 of the inwardly-directed flange 340 of the coupling nut 105 is of larger dimension than the outer diameter 337 of the non-shoulder portion 338 of the tubular 35 post 104, again to avoid interference with rotation of the coupling nut 105 relative to the tubular post.

FIG. 4 is a cross-sectional view of the connector 100 through cut-line 3-3, and cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 103 40 thereof, prior to axial compression of the connector. FIG. 4A is an enlargement of a portion of FIG. 4. Referring now to FIGS. 4 and 4A, the resilient, electrically-conductive grounding member 110 is shown disposed between the tubular post 104 and the coupling nut 105. The grounding 45 member 110 is disposed in the annular recess 343 that encircles the tubular post 104.

FIG. 5 is a cross-sectional view of the connector 100 through cut-line 3-3, and a cross-sectional view of the prepared coaxial cable 301 fully inserted into the back end 50 103 thereof, subsequent to axial compression of the connector. FIG. 5A is an enlargement of a portion of FIG. 5. Referring now to FIGS. 5 and 5A, as a result of axial compression by a standard compression tool (not shown), the tubular post 104 slides (to the right in the drawings) 55 relative to the other components of the connector 100 and relative to the cable 301, such that the shoulder 332 of the tubular post is radially inward of the grounding member 110. At least a portion of the grounding member 110 engages the coupling nut 105 at the annular recess 343 of the coupling 60 nut, and at least another portion of the grounding member engages tubular post 104 at the shoulder 332 of the tubular post. The tubular post 104 is in electrical contact with the outer conductor 304 of the cable 301 along the back portion of the tubular post, and the coupling nut 105 may engage the 65 outer conductor of an appliance port (not shown). Therefore, when the connector 100 is fastened to an appliance port,

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there is maintained an electrical grounding path between the outer conductor 304 of the cable 301 and the outer conductor of the appliance port, whether or not the coupling nut 105 of the connector is tightly fastened to the appliance port.

FIG. 6 is a partial cross-sectional view of a first alternate embodiment of a connector 600 having a first alternate grounding member 601 (see FIGS. 6A-6C), shown subsequent to axial compression. FIG. 6A is an enlargement of a portion of the first alternate embodiment of the connector 600 showing a portion of the first alternate grounding member 601. FIG. 6B is a slightly enlarged side view of the first alternate grounding member 601. FIG. 6C is a slightly enlarged plan view of the first alternate grounding member 601. Referring now to FIGS. 6, 6A, 6B and 6C, the first alternate grounding member 601 is a spring finger grounding member retained between the coupling nut 105 and the tubular post 104. The first alternate grounding member 601 is constructed of a thin cross section of material such beryllium copper. The first alternate grounding member 601 comprises a ring portion 602 and a plurality of fingers 603 that project at approximately a 30° angle from the plane of the ring. The spring action of the fingers 603 extend to, and make contact with, a radial surface 604 near the back end of the coupling nut 105 that faces the front end of the coupling nut, which serve to connect a ground path from the coupling nut to the tubular post while allowing the coupling nut to rotate. The first alternate grounding member 601 has optional internal lugs 605 that contact the outer diameter 337 of the non-shoulder portion of the tubular post.

FIG. 7 is a partial cross-sectional view of a second alternate embodiment of a connector 700 having a second alternate grounding member 701 (see FIGS. 7A-7C). FIG. 7A is an enlargement of a portion of the second alternate embodiment of the connector 700, showing a portion of the second alternate grounding member 701. FIG. 7B is a slightly enlarged side view of the second alternate grounding member 701. FIG. 7C is a slightly enlarged plan view of the second alternate grounding member 701. Referring now to FIGS. 7, 7A, 7B and 7C, the second alternate grounding member 701 is a radial grounding member retained between the coupling nut 105 and the tubular post 104. The second alternate grounding member 701 is constructed of a thin cross section of metallic material such as beryllium copper. The second alternate grounding member 701 comprises a ring portion 702 and a plurality of fingers 703 extending radially from the ring portion at about a 45° angle from the plane of the ring portion. The spring action of the fingers 703 extend to inner-diameter surfaces 705 of the coupling nut 105, and serve to connect a ground path from the coupling nut to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 8 is a partial cross-sectional view of a third alternate embodiment of a connector 800 having a third alternate grounding member 801 (see FIGS. 8A-8E), FIG. 8A is a slightly enlarged side view of the third alternate grounding member 801. FIGS. 8B-8E are slightly enlarged plan views of four styles of the third alternate grounding member 801. Referring now to FIG. 8 and FIGS. 8A-8E, the third alternate grounding member 801 is a conductive member retained between the coupling nut 105 and the tubular post 104. The third alternate grounding member 801 is constructed of a thin cross section of metallic material such as brass or beryllium copper. The third alternate grounding member 801 comprises a ring 802 with multiple points of contact, or internal lugs, 803 around the inner perimeter of the ring and with multiple external lugs 804 around the outer perimeter of the ring. The lugs 803 and 804 serve to connect

a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. FIGS. 8B-8E show four styles with regard to the shape of the lugs 803 and 804 and the position of the lugs on the ring 802. FIG. 8 also exhibits an alternate embodiment comprising a sealing ring 805 for forming a moisture seal between the coupling nut 105 and the body 108 of the connector 801. The sealing ring 805 is disposed between the back end of the coupling nut 105 and the body 108 for forming a seal therebetween. Preferably, the sealing ring 805 is made from ethylene 10 propylene. Use of the sealing ring 805 is not limited to use in connectors having the third alternate grounding member 801. The third alternate grounding member 801 may also be used in connectors without the sealing ring 805.

FIG. 9 is a partial cross-sectional view of a fourth 15 alternate embodiment of a connector 900 having one of a fourth alternate grounding member 901 and a fifth alternate grounding member 911 (see FIGS. 9A-9D). FIG. 9A is a slightly enlarged side view of the fourth alternate grounding member 901. FIG. 9B is a slightly enlarged plan view of the 20 fourth alternate grounding member 901. FIG. 9C is a slightly enlarged side view of the fifth alternate grounding member 902. FIG. 9D is a slightly enlarged plan view of the fifth alternate grounding member 911. The fourth and filth alternate embodiments of the grounding member 901 and 911, 25 respectively, comprise a C-shaped ring between the coupling nut 105 and the tubular post 104. The C-shaped ring is constructed of a thin cross section of metallic material such as beryllium copper or stainless steel. It is retained by a groove in the coupling nut. The spring action of the 30 C-shaped ring serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate. The fourth alternate grounding member 901 includes a circumferential metallic band 902, which has a general circular shape and approximates a section of a 35 hollow cylinder, that extends between first 903 and second 904 opposing ends. The band 902 has first 906 and second 907 opposing side edges extending along its length. The fourth alternate grounding member 901 includes a first generally radial wall 908 extending from the first side edge 40 906 of the band in a first radial direction, and a second generally radial wall 909 extending from the second side edge 907 of the band generally in said first radial direction. The band 902 contacts a first one of the group of members that includes the coupling nut 105 and the tubular post 104. The first 908 and second 909 radial walls contact the second of the group of members that includes the coupling nut 105 and the tubular post 104. The fifth alternate grounding member 911 includes a metallic band 912 extending along its length between first 913 and second 914 opposing ends, and extending along its width between first 916 and second 917 side edges. The band 912 is formed along its length into a generally circular shape. The band 912 is formed along its width into a generally concave shape with the side edges 916 and 917 projecting generally in a first radial direction. The 55 fifth alternate grounding member 911 includes a plurality of projections 918 extending from the band 912 in a second radial direction opposite to the first radial direction. The first 916 and second 917 side edges of the band 912 contact a first one of the group of members that includes the coupling nut 60 and the tubular post. The plurality of projections 918 contact the second of the group of members that includes the coupling nut 105 and the tubular post 104,

FIG. 10 is a partial cross-sectional view of a fifth alternate embodiment of a connector 1000 having conductive grease 65 (not shown) that acts as a grounding member. The ground path is established by means of a close fit between the 10

coupling nut 105 and the tubular post 104. The conductive grease is disposed at a grease annular ring 1001 where mating portions of the tubular post 104 and coupling nut 105 have closely matching dimensions. Preferably, the conductive grease is a silver-loaded silicon lubricating material. The conductive grease serves to connect a ground path from the coupling nut 105 to the tubular post 104 while allowing the coupling nut to rotate.

FIG. 11 is a partial cross-sectional view of a front end of a sixth alternate embodiment of an F connector 1100 that includes a body 1108, and which has a sixth alternate grounding member 1101. FIG. 11A is an enlargement of a portion of FIG. 11. FIG. 11B is a side view of the sixth alternate grounding member 1101. FIG. 11C is a plan view of the sixth alternate grounding member 1101. FIG. 11D is a perspective view of the sixth alternate grounding member 1101. Referring now to FIG. 11 and FIGS. 11A-11D, the sixth alternate grounding member 1101 includes a circumferential metallic band 1112 extending between first 1113 and second 1114 opposing ends. The band 1112 has a generally circular shape that approximates a section of a hollow cylinder. The first 1113 and second 1114 ends of the band 1112 are disposed generally proximate to each other and are directed generally toward one another. The band 1112 has first and second opposing side edges 1115 and 1116, respectively, extending along its length. The band generally de fines a section of a cylindrical surface. The sixth alternate grounding member 1101 includes a plurality of projections 1101 extending from at least one of the first and second side edges 1115 and 1116 of the band 1112. The plurality of projections 1117 extend away from the cylindrical surface defined by the band 1112. The band 1112 contacts a first one of the group of members that includes the coupling nut 1105 and the tubular post 1104. The plurality of projections 1117 contact the second of the group of members that includes the coupling nut 1105 and the tubular post 1104.

In preferred embodiments, the present invention provides a coaxial cable connector that ensures a reliable grounding path without creating undue interference with free rotation of the coupler relative to the remaining components of the connector, however, the present invention can also provide a reliable grounding path between a post and a coupler that does not rotate. Advantageously, a connector in accordance with the invention works with standard installation tools and with standard compression tools. The present invention can be used with both axially-compressible connectors as well as with older-style crimp-ring connectors. In some embodiments, the present invention is compatible with the use of a sealing ring for forming a moisture seal between the coupler and the outer body of the connector.

While the present invention has been described with respect to preferred embodiments thereof, such description is for illustrative purposes only, and is not to be construed as limiting the scope of the invention. Various modifications and changes may be made to the described embodiments by those skilled in the art without departing from the true spirit and scope of the invention as defined by the appended claims. For example, the grounding member can have a shape other than generally circular, such as square, hexagonal, octagonal, oval, etc.

LIST OF REFERENCE NUMERALS

- 100 F connector ("connector")
- 101 Longitudinal axis

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	11	
103	Back end	
104	Tubular post	
105	Coupling nut	
106	End of tubular post	
107	Shell	5
108	Body	
109	Label	
110	Grounding member	
111	Neck	
201	Minimum diameter	10
203	Maximum diameter	
301	Coaxial cable	
302	Center conductor	
303	Dielectric material	
304	Outer conductor	15
305	Jacket	
310	Lip of body	
311	Outer diameter of lip body	
312	Inner diameter of lip of body	•
330	Shoulder of tubular post	20
334	First redial free of shoulder of tubular nest	
333	Outer surface of shoulder	
226	Outer surface of shoulder	
227	Outer diameter of non shoulder nortion of nost	25
229	Non-shoulder portion of post	25
330	Inwardly-directed flange of coupling put	
341	Inner diameter of inwardly-directed flange	
347	Bore of coupling put	
343	Annular recess of coupling nut	30
344	Inner diameter of hore of coupling nut	50
600	First alternate connector	
601	First alternate grounding member	
602	Ring portion of first alternate grounding member	
603	Fingers of first alternate grounding member	35
604	Radial surface of coupling nut	
605	Internal lugs of first alternate grounding member	
700	Second alternate connector	
701	Second alternate grounding member	
702	Ring portion of second alternate grounding member	40
703	Fingers of second alternate grounding member	
800	Third alternate connector	
801	Third alternate grounding member	
802	Ring portion of third alternate grounding member	
803	Internal lugs of third alternate grounding member	45
804	External lugs of third alternate grounding member	
805	Sealing ring	
900	Fourth alternate connector	
901	Fourth alternate grounding member	
902	Band of fourth alternate grounding member	50
903	First end of band	
904	Second end of band	
900	First side edge of band	
907	Einst radial well of hand	
500	First radial wall of band	22
909	Eith alternate grounding member	
100	A Fifth alternate connector	
100	1 Grease annular ring	
110	0 Sixth alternate connector	60
110	1 Sixth alternate grounding member	00
1104	4 Tubular post of sixth alternate connector	
110	5 Coupling nut of sixth alternate connector	
110	8 Body of sixth alternate connector	
1112	2 Band of sixth alternate grounding member	65
1113	3 First end of band	
1114	Second end of band	

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1115 First side edge of band 1116 Second side edge of band 1117 Projections on band

5 We claim:

1. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial 10 cable connector comprising:

a post including a first end adapted to be inserted into a prepared end of the coaxial cable between the dielectric material and the outer conductor, wherein the post includes a second end including an enlarged shoulder, wherein the enlarged shoulder has a radial face that faces away from the first end of the post, wherein the radial face is substantially flat;

a body member adjacent to the post;

- a coupler including an internally-threaded region for engaging the equipment port and an inwardly directed flange having a forward face; and
- a grounding member configured to be inserted forward of at least a portion of the forward face of the inwardly directed flange of the coupler and rearward of the radial face of the post, the grounding member contacting the post and the coupler and configured to provide an electrically-conductive grounding path through the post and the coupler while allowing the coupler to rotate,
- wherein the grounding member includes a first portion configured to contact the coupler while allowing the coupler to rotate and a second portion configured to contact the post, the first and second portions of the grounding member existing in a plane of the grounding member.
- wherein the second portion of the grounding member comprises a plurality of internal lugs configured to contact the post.

2. The coaxial cable connector of claim 1, wherein the grounding member is formed from a metal.

3. The coaxial cable connector of claim 1, wherein the body member is formed from a plastic.

4. The coaxial cable connector of claim 1, wherein the 45 first portion of the grounding member comprises a plurality of external lugs configured to contact the coupler.

5. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric 50 material being surrounded by an outer conductor, the coaxial cable connector comprising:

- a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor to reliably contact the outer conductor, and having a second end opposite the first end;
- a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port;
- a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable; and
- an electrically-conductive grounding component disposed between the tubular post and the coupler;

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- wherein the tubular post includes a tubular post grounding path portion having an outer surface, and the coupler includes a coupler grounding path portion having an inner surface; and
- wherein the electrically-conductive grounding component ⁵ reliably contacts both the tubular post grounding path portion and the coupler grounding path portion to provide a stable and reliable electrically-conductive grounding path between the tubular post grounding path portion and the coupler grounding path portion ¹⁰ when a gap between the tubular post and the equipment port exists while the coupler is engaged with the equipment port.

6. The coaxial cable connector of claim 5, wherein the electrically-conductive grounding component is at least one of a resilient electrically-conductive grounding member and electrically-conductive grease.

7. The coaxial cable connector of claim 5, wherein the electrically-conductive grounding component is an arcuately shaped resilient electrically-conductive grounding member configured to extend around the tubular post over at least 225 degrees.

8. The coaxial cable connector of claim 5, wherein the coupler includes an annular recess configured to engage and retain the electrically-conductive grounding component.

9. The coaxial cable connector of claim 1, wherein the grounding component is a resilient electrically-conductive grounding member having engagement portions configured to reliably contact the tubular post grounding path portion and engagement portions configured to reliably contact the coupler grounding path portion.

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10. The coaxial cable connector of claim 9, wherein the engagement portions of the resilient electrically-conductive grounding member configured to reliably contact the tubular post grounding path portion are internal lugs distributed along an inner perimeter of the resilient electrically-conductive grounding member.

11. The coaxial cable connector of claim 9, wherein the engagement portions of the resilient electrically-conductive grounding member configured to reliably contact the coupler grounding path portion extend outward from non-engagement portions of the resilient electrically-conductive grounding member.

12. The coaxial cable connector of claim 9, wherein the engagement portions of the resilient electrically-conductive grounding member configured to reliably contact a shoulder of the tubular post located at the second end of the tubular post, the shoulder of the tubular post comprising the tubular post grounding path portion.

13. The coaxial cable connector of claim 9, wherein at the engagement portions of the resilient electrically-conductive grounding member are resilient.

14. The coaxial cable connector of claim 11, wherein the engagement portions of the resilient electrically-conductive grounding member configured to reliably contact the coupler grounding path portion extend away from a plane defined by the non-engagement portions of the resilient electrically-conductive grounding member.

15. The coaxial cable connector of claim 5, wherein the grounding component is retained between the tubular post 30 and the coupler.

* * * *

BARCLAY DAMON¹¹⁰

Douglas J. Nash Partner

January 27, 2022

By Email and UPS Overnight Delivery

Daryl Miller Chief Executive Officer PerfectVision Manufacturing, Inc. 16101 La Grande Drive Little Rock, Arkansas 72223

RE: PerfectVision's Infringement Patents Owned by PPC Broadband, Inc.

Dear Mr. Miller:

We represent PPC Broadband, Inc. ("PPC"). PPC owns U.S. Patent Nos. 7,114,990 (the "'990 Patent"), 7,479,035 (the "'035 Patent"), 7,955,126 (the "'126 Patent"), 8,172,612 (the "'612 Patent"), and 10,756,455 (the "'455 Patent") (the "Asserted Patents") (each of which is enclosed herewith), including the right to sue for damages related to past infringement. Pursuant to 35 U.S.C. § 287(a), PPC hereby provides notice that PerfectVision Manufacturing, Inc. ("PV") has infringed and continues to infringe one or more claim in each of the Asserted Patents by making, using, selling, offering to sell and/or importing its SignaLoc[®] line of coaxial cable connectors in the United States.

The following representative figures illustrate the internal construction of PV's SignaLoc[®] coaxial cable connector design:



Barclay Damon Tower - 125 East Jefferson Street - Syracuse, New York 13202 barclaydamon.com DNash@barclaydamon.com Direct: (315) 425-2828 Fax: (315) 703-7364 Also Admitted in: Massachusetts



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Without limitation, and as shown in the charts below, the SignaLoc^{*} connectors infringe at least the following exemplary claims in the Asserted Patents:

- Claim 6 in the '990 Patent:
- Claim 11 in the '035 Patent:
- Claim 6 in the 126 Patent:
- Claim 23 in the '612 Patent: and
- Claim 5 in the `455 Patent.





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'035 Patent, Claim 11	SignaLoc [®] Connector
1. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the coaxial cable connector comprising:	The SignaLoc [*] line of coaxial cable connectors are cable connectors for coupling a coaxial cable to an equipment port. the coaxial cable including a center conductor surrounded by a dielectric material. the dielectric material being surrounded by an outer conductor. (<i>See</i> https://www.perfect-vision.com/WebSupport/webstore/spec- sheets/PV6USLP.PDF.) center conductor dielectric outer conductor
a. a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor. and having a second end opposite the first end thereof	tubular post
b. a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port:	a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port

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'612 Patent, Claim 23	SignaLoc [®] Connector
'612 Patent, Claim 23 9. A grounding member for a coaxial cable connector having a post and a nut, comprising a generally arcuate shaped member, composed at least partially of electrically conductive material, and a contact portion of the generally arcuate shaped member, wherein:	SignaLoc [®] Connector The SignaLoc [®] line of coaxial cable connectors include a grounding member for a coaxial cable connector having a post and a nut, comprising a generally arcuate shaped member, composed at least partially of electrically conductive material, and a contact portion of the generally arcuate shaped member.

the at least one contact portion provides for an electrically-conductive path through the post and the nut;	a contact portion provides for an electrically- conductive path through the post and the nut
the generally arcuate shaped member comprises a circumferential metallic band; and	
the circum ferential metallic band has a general circular shape and approximates a section of a hollow cylinder that extends between first and second opposing ends.	opposing ends
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'455 Patent, Claim 5	Signa Lac [®] Connector
5. A coaxial cable connector for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor, the	The SignaLoc [*] line of coaxial cable connectors are cable connectors for coupling a coaxial cable to an equipment port, the coaxial cable including a center conductor surrounded by a dielectric material, the dielectric material being surrounded by an outer conductor. (<i>See</i> https://www.perfect-vision.com/WebSupport/webstore/spec-sheets/PV6USLP.PDF.)
coaxial cable connector comprising:	center conductor dielectric
a tubular post having a first end adapted to be inserted into the prepared end of the coaxial cable between the dielectric material and the outer conductor to reliably contact the outer conductor, and having a second end opposite the first end:	outer conductor
	Designed with patented grounding insert to provide enhanced continuity and minimize signal ingress/egress. (See https://www.perfect-vision.com/WebSupport/webstore/spec-sheets/PV6USLP.PDF.)

a coupler having a first end rotatably secured over the second end of the tubular post, and having an opposing second end, the coupler including a central bore extending therethrough, a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port;	a portion of the central bore proximate the second end of the coupler being adapted for engaging the equipment port
a body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable; and	body member secured to the tubular post and extending about the first end of the tubular post for receiving the outer conductor of the coaxial cable
an electrically-conductive grounding component disposed between the tubular post and the coupler;	electrically-conductive grounding member between the tubular post and the coupler

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Against this backdrop, PPC demands that PV cease and desist from further infringement of the Asserted Patents by immediately stopping the production, use, sale, offer for sale and importation of the SignaLoc[®] line of coaxial cable connectors in the United States, along with any other connectors of similar design made, used, sold, offered for sale and or imported in the United States. PPC further demands that PV provide PPC with a full accounting of all sales of SignaLoc[®] and similar connectors over the past six (6) years in the United States along with the number of such connectors currently in production, in inventory and in transit to the United States. Finally, PPC demands that PV disclose to PPC the name and address of the company or companies that PV has used over the past six (6) years to manufacture the SignaLoc[®] line of coaxial cable connectors sold in the United States. PPC reserves all rights if these demands are not met within two (2) weeks of PV's receipt of this letter.

If PV retains counsel in this matter, please provide this letter to such counsel and let us know so we will know to whom to direct future correspondence. We look forward to hearing back from you or your counsel promptly.

Very truly yours.

Douglas J. Nash

cc: Christopher W. Day, Esq.