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Anhalt et al.

[11] **3,905,672**

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[54] **SEALED ELECTRICAL CONNECTOR**

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[73] Assignee: **International Telephone and Telegraph Corporation,** New York, N.Y.

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[52] **U.S. Cl.** ..... **339/103 R;** 339/206 R

[51] **Int. Cl.²** **H01R 13/58**

[58] **Field of Search**... 339/59 R, 59 M, 63 R, 63 M, 339/60 C, 60 R, 60 L, 60 M, 196 R, 196 A, 196 M, 206 R, 206 C, 206 P, 101, 103 R, 103 B, 103 C, 103 M, 94 R, 94 A, 94 C; 24/115 M, 115 R; 403/334, 342, 356, 358

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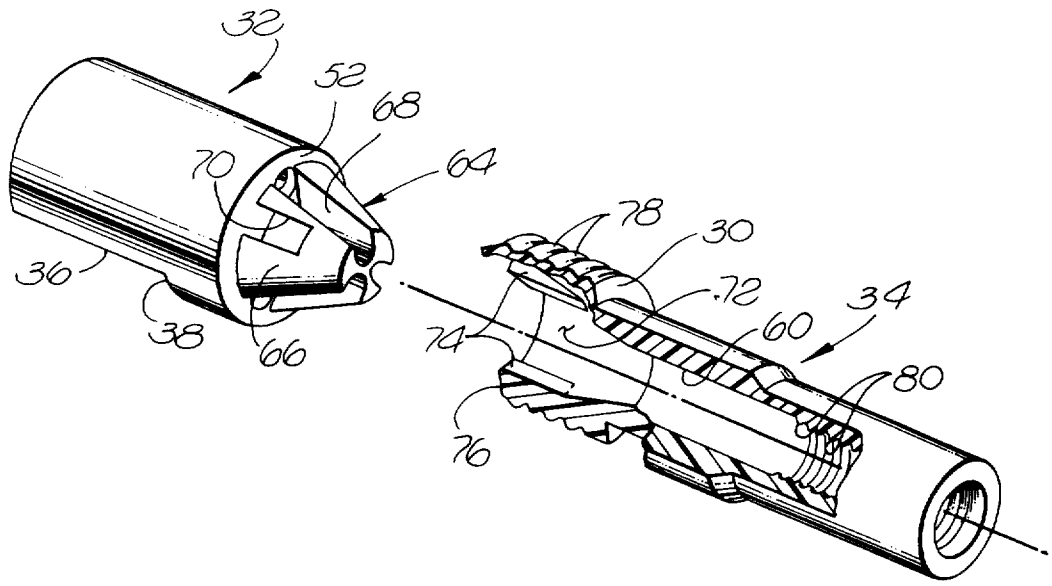
[57] **ABSTRACT**

A sealed electrical connector including a connector body containing a plurality of contacts and a cable boot mounted over a tapered projection on one end of the body. The projection is formed with channels aligned with the contact passages. The conductors of the cable lie in these channels. Keyways are formed in the projection which receive keys formed on the inner wall of the boot to restrain the boot from rotation relative to the connector body, and hence prevent twisting of the cable conductors. Integral sealing ribs are formed on the front and rear portions of the boot.

12 Claims, 7 Drawing Figures



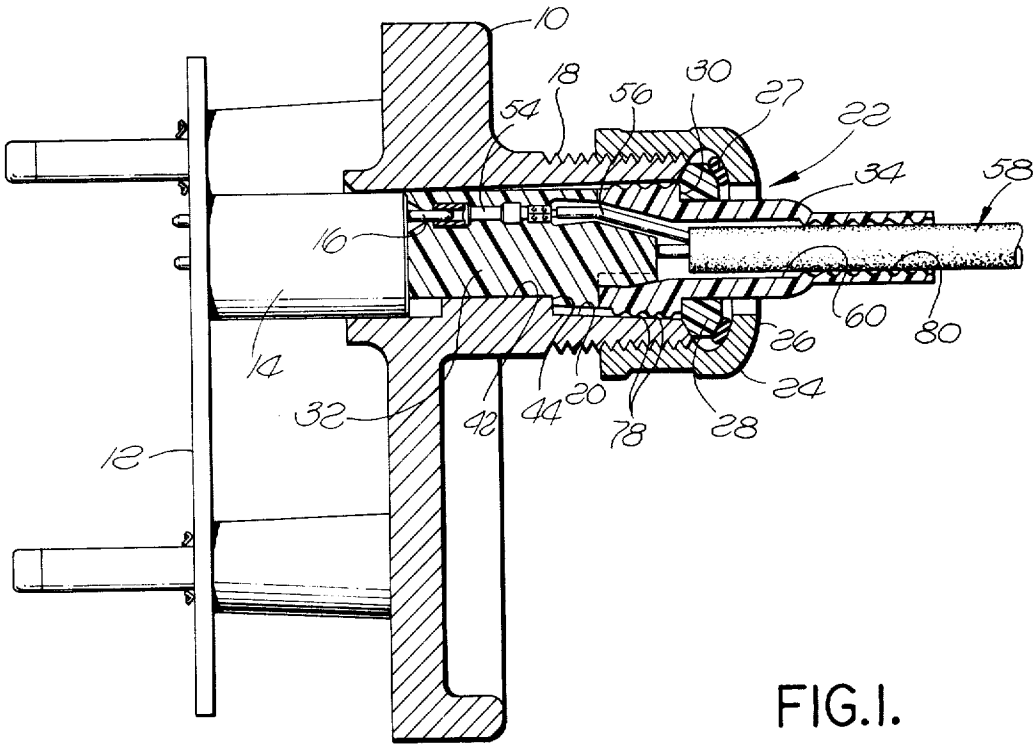


FIG.1.

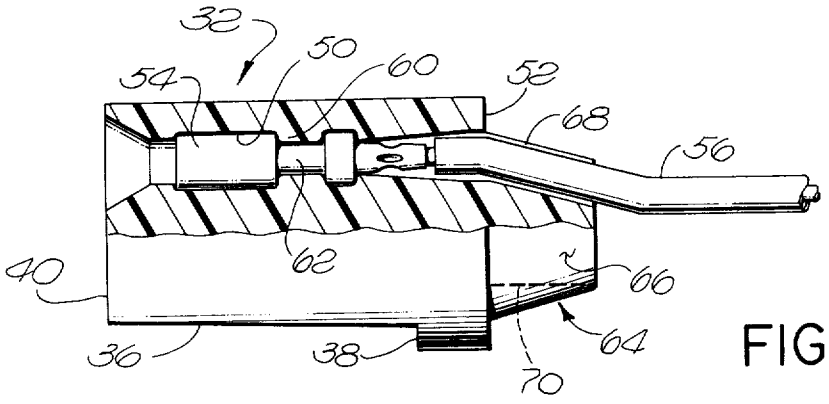


FIG.2.

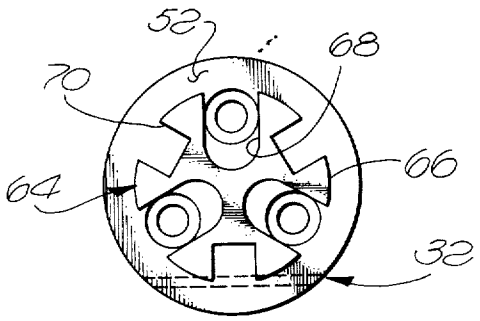


FIG.3.

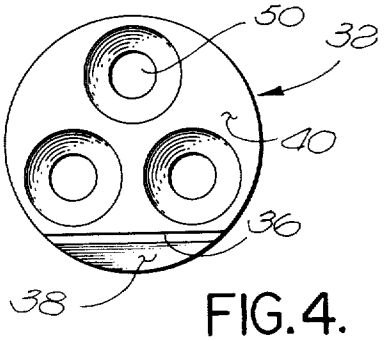


FIG.4.

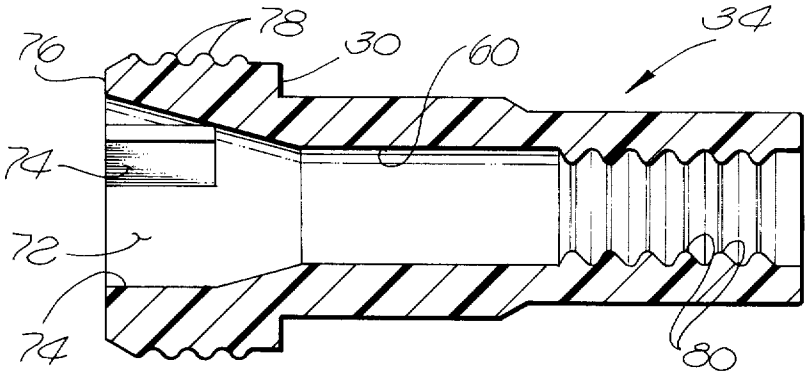


FIG. 5.

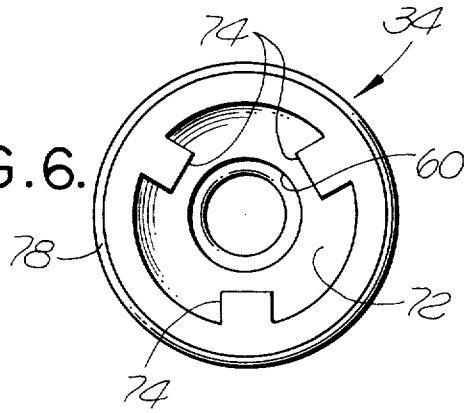


FIG. 6.

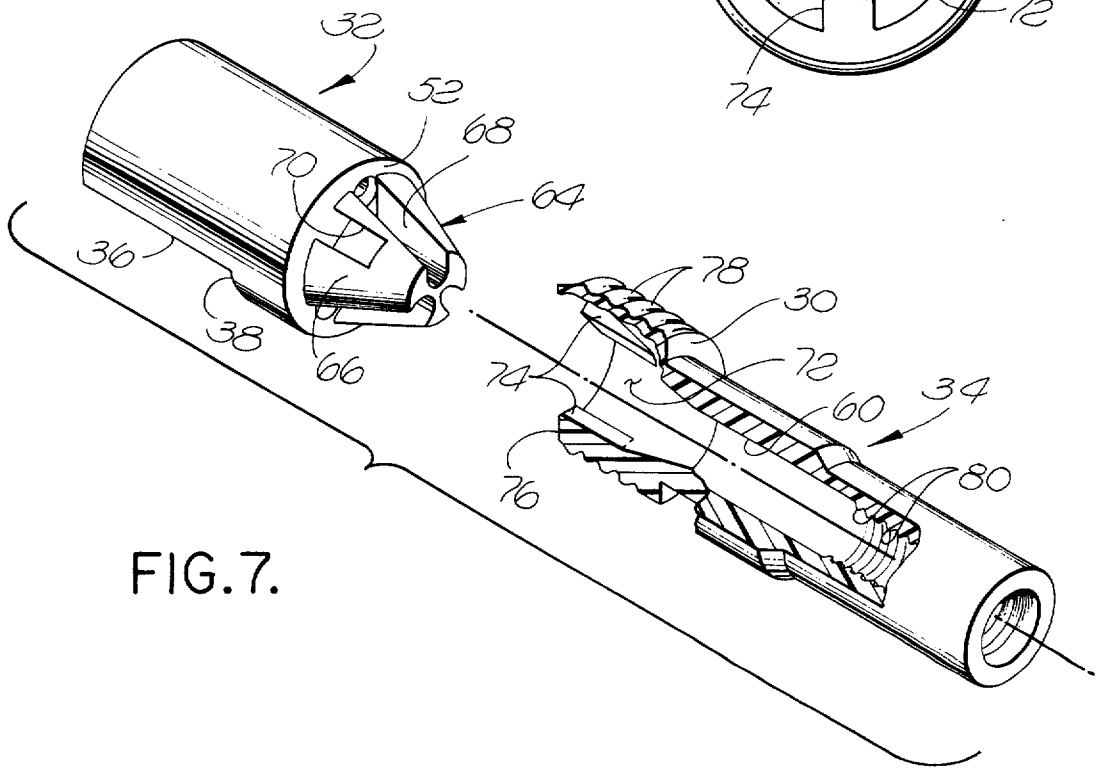


FIG. 7.

SEALED ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

This invention relates generally to an electrical connector and, more particularly, to a sealed electrical connector suitable for use, for example, in automotive vehicles.

DESCRIPTION OF THE PRIOR ART

With the advent of legislation requiring the use of anti-skid control systems for brakes on trucks, the need has arisen for low cost seated electrical connectors for making electrical connection between the wheel speed sensor and the computer housing of the anti-skid control system. Such connectors must prevent the intrusion of moisture and other contaminates into the area of the connector containing the electrical contacts in order that the electrical system of the anti-skid control will not be adversely affected. Co-pending application of Goodman et al., Ser. No. 381,267, filed July 20, 1973, entitled, "Low Cost Sealed Connector," discloses a connector assembly including mating plug and receptacle connector members which meet the required standards for anti-skid systems.

In these systems it is also necessary to connect a single connector member into the housing of the control system computer. We have found it necessary to include in the connector assembly an elastic boot which provides a seal between the main connector body containing the contacts and the cable which carries the conductors from the wheel sensor to the connector contacts. The use of rubber boots for electrical connectors, of course, is well known in the art. However, for this application the boot presents a problem in that a coupling nut is utilized on the housing for securing the connector body and boot thereto. Rotation of the coupling nut causes rotation of the boot, which in turn may cause the conductors in the cable to twist. This may result in the electrical connection between the conductors and the contacts being broken. Also, we have found that by utilizing a boot with a connector body in a conventional manner, a relatively large open cavity is provided at the rear of the connector body where the boot engages the body. When the connector is utilized on a vehicle which is operated at high altitudes, such as on mountain roads, the air trapped within this cavity will expand due to decreased atmospheric pressure, which may result in separation between the boot and the connector body, breaking the seal therebetween. This may permit the intrusion of moisture or other contaminates into the connector and ultimately into the contact passages thereof. It is the object of the present invention to overcome these problems. It is of course understood that while the connector of the present invention has been referred to as being suited for use in an anti-skid system for vehicles, it would be useful for any application wherein an environmentally sealed connection is required.

SUMMARY OF THE INVENTION

According to the principal aspect of the present invention, there is provided a sealed electrical connector including a connector body and a boot of elastic pliant material mounted on one end of the body. The body has a plurality of contact passages extending therethrough and rearwardly extending projection which extends into an enlarged cavity in the end of the boot. A

plurality of longitudinally extending channels are formed in the outer surface of the projection. Each channel is aligned with one of the contact passages. The insulated conductors of the cable which extends into the boot lie in these channels and are connected to the contacts in the contact passages. In addition, one or more longitudinally extending grooves are formed in the outer surface of the projection. Longitudinally extending ribs extend inwardly from the wall of the cavity in the boot and slidably engage in the grooves to restrain the boot from rotation relative to the connector body. As a consequence, when a coupling nut is rotated about the boot to secure the connector and boot assembly into a mounting member, the boot will be prevented from rotating relative to the connector body, thereby preventing twisting of the conductors connected to the contacts in the body. Furthermore, the enlarged cavity normally found between the end of the connector and the boot is essentially eliminated by the present invention due to the fact that the projection on the rear of the connector body extends into the cavity in the boot to substantially fill the cavity, thereby minimizing any entrapped air within the boot.

Other aspects and advantages of the invention will become more readily appreciated by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference characters designate like parts throughout the various views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partial vertical sectional view through a mounting member containing the connector member of the present invention;

FIG. **2** is a partial vertical longitudinal sectional view of the connector body of the present invention;

FIG. **3** is an elevational view showing the rear of the connector body;

FIG. **4** is an elevational view showing the front of the connector body;

FIG. **5** is a vertical longitudinal sectional view of the boot employed in the connector of the present invention;

FIG. **6** is an elevational view showing the front of the boot; and

FIG. **7** is an exploded perspective view of the connector body and the boot, with the boot being shown in partial section to illustrate the details of the interior structure thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. **1** in detail, there is illustrated a cover plate **10** for a housing, not shown, containing the computer of a anti-skid control system. The housing contains a printed circuit board **12** on which there is mounted a header **14** which has a plurality of outwardly extending pin contacts **16** on the exposed end thereof. In the example shown, three of such contacts are employed, only one being visible in FIG. **1**. It will be appreciated however that a larger or fewer number of contacts may be utilized. Typically, three or four contacts are used. An externally threaded cylindrical boss **18** is formed on the plate **10** coaxial with the header **14**. A cylindrical bore **20** extends through the boss. The end of the header extends into one end of the bore. The electrical connector member of the present

invention, generally designated 22, extends into the other end of the bore. The connector is retained in the bore by means of a coupling nut 24. This nut is formed with a radially inwardly extending annular flange 26 which engages a thrust washer 27 abutting a sealing bushing 28 that engages a rearwardly facing shoulder 30 on the connector. Threading of the nut 24 on the boss 18 urges the sealing bushing 28 into engagement with end of the boss, and urges the connector into the bore toward the header 14.

Referring now to FIGS. 2—7 of the drawings, the connector member 22 comprises an elongaged generally cylindrical insulator body 32 and a cable boot 34. Except for the contacts mounted in the body, the body and the boot each consist of a unitary mass of molded elastic pliant material which is chemically resistant to hostile environments and varying temperature conditions. Any thermoplastic elastomer, such as polyurethane polyether, for example, could be utilized as the material for the connector parts. It will be appreciated, however, that other elastomers could be utilized if they possess the required characteristics of resiliency, flexibility, and softness to produce effective seals when configured in accordance with the present invention.

The diameter of the body 32 is slightly less than the diameter of the bore 20 to allow the body to be slidably mounted within the bore. The lower portion of the body is cut out to provide a downwardly facing flat surface 36 which extends from a forwardly facing shoulder 38 to the front face 40 of the body. The surface 36 cooperates with a flat raised section 42 on the bottom of the bore 20 in the plate 10 to provide polarization of the connector with respect to the header 14 and also nonrotatably mount the connector in the plate. The raised section 42 also forms a shoulder 44 which provides a stop engageable by the shoulder 38 on the body 32 thereby limiting movement of the connector 22 into the bore 20.

The connector body 32 is provided with a plurality of axially aligned longitudinally extending contact passages 50, which extend from the front face 40 of the body to the rear face 52 thereof. Three of such passages are shown in FIGS. 3 and 4, corresponding in number to the pin contacts 16 in the header 14. A socket contact 54 is positioned in each passage 50 which is mateable with a pin contact 16 when the connector member 22 is fully mounted within the bore 20 in plate 10. Each contact terminates an insulated wire 56 of a cable 58 which extends through a passageway 60 in the boot 34. In FIG. 2, the contact is shown as being of the closed barrel type, the barrel being crimped onto the wire. Other termination techniques may obviously be utilized.

Means are integrally formed on the connector body 32 for retaining the contacts 54 therein. Such means comprises an annular flange 60 which extends radially inwardly from the wall of each contact passage 50. The flange is sufficiently resilient and pliant to allow the contact to pass therethrough when it is inserted into the rear of the contact passage. Each contact is formed with an annular recess 62. The depth of the recess and the radial dimension of each flange 60 are such that the flange will have a snug fit in the recess to hold the contact against appreciable longitudinal movement relative to the connector body.

A central relatively rigid projection 64 extends from the rear face 52 of the connector body 32. This projection is tapered to provide a frustoconical outer surface 66. It is noted that the contact passages 50 are circumferentially spaced about the body 32 adjacent to the outer periphery of the body. A plurality of channels 68 are formed in the outer surface of the projection 64. Each channel is aligned with a respective contact passage 50. Each channel 68 is sufficiently deep to receive an insulated wire 56 therein, without the wire extending above the outer surface 66 of the projection. It is noted that the bottoms of the channels 68 are curved to accommodate the insulated wires.

A plurality of grooves or keyways 70 are also formed in the outer surface of the projection 64. These grooves are disposed alternately with respect to the channels 68. The grooves have a rectangular cross section. The bottom of each groove is parallel to the longitudinal axis of the body 32. The channels 68 and grooves 70 extend to the end of the projection 64.

The passageway 60 in the boot 34 terminates in an enlarged cavity 72 which has a frustoconical wall complementary to the frustoconical outer surface 66 of the projection 64. A plurality of longitudinally extending ribs or keys 74 extend inwardly from the wall of the cavity 72. These ribs are aligned with the groove 70 and have a configuration complementary to the grooves so that when the boot 34 is mounted over the projection 64 on the body 32 the ribs 74 will be slidably engaged within the grooves. The depth of the grooves 70 and the radial distance of the ribs 74 are sufficiently great to prevent relative rotation between the cable boot and the body 32 when the rotational force imparted by the coupling nut 24 is imposed upon the boot in the assembly illustrated in FIG. 1. Thus, by this arrangement the insulated wires 56 will not be twisted when the coupling nut is rotated to fixedly mount the connector 22 in the plate 10. It is further noted that the projection 64 on the body 32 substantially completely fills the cavity 72 in the boot 34, thus minimizing any entrapped air within the boot. Furthermore, the mating frustoconical surfaces 66 and 72 on the body 32 and the boot 34, respectively, sealingly engage each other when the coupling nut 24 is tightened upon the boss 18, and also the forward edge 76 of the boot engages the rear face 52 of the body 32, thereby providing a seal for the contacts. This latter seal is in effect a secondary seal for the contacts. The primary seal for the contacts is provided by means of a plurality of integral longitudinally spaced annular sealing ribs 78 formed on the forward portion of the boot 34 which surrounds the projection 64. These ribs are deformable and are dimensioned so as to have an interference fit with the wall of the bore 20, thereby producing an intimate mechanical contact and labyrinth seal between the boot and the wall of the bore 20. It is further noted that the tapered projection 64 junctions as a wedge urging the ribs 78 outwardly into tight sealing engagement with the wall of the bore 20 when the forward end of the boot is forced into the bore by the coupling nut.

A plurality of annular longitudinally spaced integral ribs 80 are formed on the wall of the passage 60 adjacent to the rear portion of the boot 34. These ribs have an interference fit with the insulation on the cable 58, thereby providing a rear seal between the boot and the cable. Thus, the total assembly is completely sealed when the coupling nut is tightened on the boss 18.

To assembly the connector parts, and then mount the connector in the plate 10, the receptacle contacts 54

are crimped to the exposed ends of the wires **56**. The boot **34** is then forced over the cable **58** leaving the contacts and the ends of the wires **56** exposed. The contacts are then forced into the contact passages **50** in the connector body **32** by pressing them into the passages from the rear of the body. The conductors will then lie in the channel **68**. The forward end of the boot **34** is then pushed over the projection **64** on the body **32**. The connector member thus formed is then inserted into the bore **20** with the flat surface **36** aligned with the flat raised section **42** of the bore, thereby properly polarizing the connector. The connector member is pushed into the bore until the shoulder **38** thereon engages the shoulder **44** in the bore. With the connector so mounted, the pin contacts **16** on the header will be slidably engaged into the receptacle contacts **54** in the connector. Next the sealing bushing **28**, thrust washer **27**, and coupling nut **24** are mounted over the other end of the cable and the nut is tightened on the boss **18** which exerts a forward axially extending force upon the rearwardly facing shoulder **30** on the boot **34** thereby tightly retaining the connector in the bore. This mounting operation also forces the frustoconical wall of the cavity **72** into sealing engagement with the outer surface **66** of the projection **64**, and the front edge **76** of the boot into sealing engagement with the rear face **52** of the body **32**. In addition, the forcing of the boot into the bore causes the ribs **78** to sealing engage the wall of the bore **20**. Since the sealing ribs **78** surround the projection **64**, the projection provides a relatively rigid support for the ribs, assuring that the ribs remain in interference fit with the wall of the bore **20**. Thus, a completely sealed assembly is provided, with a minimum of entrapped air within the boot **34**, and relative rotation between the cable and the connector body **32** is prevented during rotation of the coupling nut due to the inter-engagement between the ribs **74** and the grooves **70** on the boot and connector body, respectively.

What is claimed is:

1. An electrical connector member comprising:

an elongated insulator body having a front face and rear face;

a plurality of contact passages in said body extending from said front face to said rear face, said passages being spaced from the outer periphery of said body;

a projection on said body extending rearwardly from said rear face, said projection having a circular cross-section less than the cross-section of said body defining on said rear face a rearwardly facing annular surface;

a plurality of longitudinally extending channels in the outer surface of said projection each aligned with a respective one of said passages;

at least one longitudinally extending groove in the outer surface of said projection;

a boot of elastic pliant material at the rear of said body having a passageway extending therethrough terminating in an enlarged cavity at one end receiving said projection, the wall of said cavity engaging the outer surface of said projection, said boot having a forward edge engaging said annular surface; and

a longitudinally extending rib extending inwardly from said wall of said cavity, said rib slidably engaging with said groove to restrain said boot from rotation to said body.

2. An electrical connector as set forth in claim **1** wherein there are provided:

a plurality of said grooves circumferentially spaced about the outer surface of said projection and a plurality of said ribs aligned and slidably engaged with said grooves.

3. An electrical connector as set forth in claim **2** wherein:

said grooves are alternately disposed with respect to said channels.

4. An electrical connector as set forth in claim **1** wherein:

said projection tapers rearwardly to define a frustoconical outer surface; and

the wall of said cavity in said boot has a configuration complementary to that of said surface.

5. An electrical connector as set forth in claim **1** including:

a plurality of integral longitudinally spaced, continuous annular sealing ribs formed on the outer surface of said boot adjacent to the forward end thereof surrounding said projection.

6. An electrical connector as set forth in claim **1** including:

an electrical contact in each of said passages;

a cable mounted in said passageway in said boot, said cable having a plurality of insulated conductors therein extending forwardly into said cavity; and

the end portion of each said insulated conductor lying in a respective one of said channels and being electrically connected to the contact in the passage aligned with said channel.

7. An electrical connector as set forth in claim **6** including:

integral retention means in each said passage engaging with the contact therein to restrict said contact against longitudinal movement in said passage.

8. An electrical connector as set forth in claim **6** including:

a plurality of integral longitudinally spaced annular sealing ribs formed on the wall of said passageway adjacent the rear of said boot, said ribs sealingly engaging the outer surface of said cable.

9. An electrical connector as set forth in claim **1** wherein:

the wall of said cavity sealingly engages the outer surface of said projection except at said channels and groove.

10. An electrical connector member as set forth in claim **1** in combination with a mounting member including an externally threaded boss having a bore extending therethrough wherein:

said connector member is mounted in said bore;

cooperating surface means are formed in said bore and on the outer surface of said body restraining said body against rotation in said bore;

a rearwardly facing shoulder on said boot; and a coupling nut threaded on said boss having an inwardly extending rear flange which acts upon said shoulder to force said boot axially into said bore against said body upon rotation of said nut.

11. An electrical connector as set forth in claim **10** including:

a plurality of integral longitudinally spaced annular sealing ribs formed on the outer surface of said

boot forward of said shoulder sealingly engaging the wall of said bore.

12. An electrical connector member comprising:

an elongaged insulator body having a front face and a rear face;

a plurality of contact passages in said body extending from said front face to said rear face and disposed adjacent to but spaced from the outer periphery of said body;

a central projection on said body extending rearwardly from said rear face, said projection tapering rearwardly to define a frustoconical outer surface, said projection having a cross-section less than that of said body defining on said rear face a rearwardly facing annular surface;

a plurality of longitudinally extending channels in the outer surface of said projection each aligned with a respective one of said passages;

a plurality of longitudinally extending keyways in the outer surface of said projection disposed alternately between said channels;

a boot of elastic pliant material at the rear of said body having a passageway extending therethrough terminating in an enlarged cavity at one end receiving said projection, the wall of said cavity having a frustoconical configuration complementary to the outer surface of said projection whereby said wall sealingly engages the outer surface of said projection, said boot having a forward edge engaging said annular surface; and

a plurality of longitudinally extending keys extending inwardly from said wall of said cavity and aligned with said grooves, said keys slidably engaging with said keyways to restrict said boot from rotation relative to said body.

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