This invention relates to a coaxial connector having improved sealing features adapted to effectively eliminate connector failure due to moisture, corrosive gases and the like.

As a result of connection failures caused by moisture and/or corrosive gases, a considerable effort has been made by the connector industry to provide sealed connectors. The typical approach has been to provide gaskets at each point within a given connector assembly, wherein moisture or corrosive gases might enter and find a path to the electrical contact surfaces within the connector. In the past, however, such gaskets and/or seal assemblies having as many as ten separate sealing gaskets installed at different points within the connector assembly. Aside from increased cost of material and assembly labor inherent in this practice, overall connector reliability is reduced by extending the opportunity for failure.

A more specific problem of sealing arises with respect to the sealing of coaxial cable connectors, due to the particular construction of typical coaxial cable, which includes by reason of the nature of the outer conductor, a continuous coaxial volume or air space capable of accommodating any and transferring corrosive and/or permeating gases from entry to each area of contact interface. Contained in one of the dielectric inserts and held in position thereby, is a central conductive pin member adapted to receive the central conductor of a coaxial cable within a tubular portion thereof. The connector shell includes access ports to permit the insertion of crimping die faces within the connector assembly to crimp the conductive pin member and form a connection with the central conductor of the coaxial cable through, but without penetration of, the central center dielectric insert. Further sealing is provided by an annular gasket affixed to the entry portion of the cable crimping sleeve and adapted to be compressed directly against the cable inner dielectric, underneath the braid to block entry of moisture and the like, into the connector assembly by the braid. A single crimping ferrule is provided and adapted to be positioned so that all crimps may be accomplished simultaneously. The construction of the novel connector of the invention is such that, following the crimping operation, no additional sealing gaskets need be added. The connector assembly of the invention thus provides an improved, totally sealed connector construction with far fewer parts than prior art devices and considerable reduction in connector assembly labor requirements.

In the drawings:

FIGURE 1 is a longitudinal cross-section of an embodiment of the connector assembly of the invention crimped onto a coaxial conductor cable;

FIGURE 2 is a cross-section taken along lines 2—2, of FIGURE 1, showing the sealing features at the central conductive pin crimp;

FIGURE 3 is a perspective view of coaxial cable including a showing of one of the seals of the invention positioned thereon;

FIGURE 4 is an enlarged, partial section showing the details of the seal shown in FIGURE 1, in cross-section;

FIGURES 5 and 6 are partial sections of the seal of FIGURE 3, showing the configuration thereof, before and after the connector of the invention has been crimped respectively.

Before turning to a detailed description of the invention, the aspects of the connector exemplifying the invention can be best visualized from FIGURE 1, which represents a connection of coaxial cable signal paths, showing in detail, half of a pair of complementary connector assemblies crimped onto a coaxial cable such as 100. The general object of the invention is, of course, to electrically and mechanically interconnect coaxial cables, such as 100, in a manner providing a stable, low-resistance signal path for each of two signal conductors 104 and 110 coaxially disposed by a dielectric core 106 within a cable sheath 102. Assembly 10 accomplishes this in a standard fashion with an outer conductive shell 30 and a central conductive pin 40, serving as continuations of conductors 104 and 110, respectively. With respect to the special problems of impedance matching of connector to cable, necessary for high signal frequency ranges, assembly 10 includes standard compensation sections with as few discontinuities as possible, considering the limitations imposed by the provision of crimp parts.

The primary object of the invention is to assure that the coaxial signal paths along shell 30 and pin 40 are sealed against the entry of moisture and/or corrosive gases at the various points of contact with conductors 104 and 110, and between the connector halves. With respect to assembly 10, shown in FIGURE 1, the critical interface zones requiring sealing are indicated as C1, C2, and C3. The zone C1 is important, since it is between the surfaces within this zone that the actual electrical connection between the central conductors of cables is accomplished. Zone C3 is important, since it is at this point that the crimp of the central conductor to the central pin member occurs, and the presence of access ports permits moisture to enter the connector in the
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Zone C₂ is of particular importance, because one of the most common reasons for connector failure is due to moisture and/or corrosive gas entry into the connector at the point of cable entry. Additionally, slight penetrations or breaks in the outer sheath, indicated as L₁, may be considered to permit entry of moisture along the dotted paths shown, via the metallic braid 104, which will act as wicking to draw moisture down the cable and at least into the connector ferrule 60.

Considering now the invention in detail, the construction of assembly 10, includes an integral shell-like member 30, having a forward portion 12, a middle portion 33, and a rear portion 50. Forward portion 12 is internally bored as at 14, to a diameter complementing the insertion of a dielectric insert 34, extending from a mating connector half itself connected to a coaxial cable such as 100, not shown. Bore 14 abuts within the inward portion of 12, to form therewith an offset 16, contiguous with a bore 31, extending through portion 33, of the connector shell. Tightly fitted within 31, is a dielectric insert 36, generally cylindrical, but with recessed portions 38 proximate its center, forming a relieved insert thickness to accommodate the crimping operation performed at C₂.

Section 33 includes further access ports 34 generally aligned with the recessed portions 38 and adapted to provide access for crimping dies inserted therethrough to engage and crimp the central pin member 40, to the central conductor 110 of cable 100. As a radial extension of shell 30, there is provided a flange 46, adapted to permit assembly 10 to be held by portions (not shown) in engagement with a mating connector half, such as 80, shown in part, in FIGURE 1.

The internal diameter of shell 30 at 46, is slightly tapered, as at 48, to lock dielectric insert 36 against axial movement toward the direction of entry of cable 100. Insert 36 includes a sleeve extension 37, fitted within portion 50 having an internal bore 59 approximately the same in inner diameter as the outer diameter of the dielectric core 106.

Portion 50 defines a crimping support and includes, about its outer circumference, a series of serrations 52 adapted to provide an improved gripping action, with respect to cable braid driven thereagainst during the crimping of an outer ferrule 60. The extension of ferrule 60 to overlap by a considerable length crimping shell 30 is important to prevent an undue 70, unattached partial sealing of cable 100, and additionally a partial sealing against entry of moisture at the point of entry of the cable. The design of the die faces engaging the zone at C₂ should be such as to leave the interior diameter of 60 tightly pressed against shear 102. Portion 50 includes, at its end, a projection 54 having an internal face 56 adapted to seat and secure a seal 70.

During normal assembly cable 100 is first stripped with a section of the central conductor 110 extending outwardly as indicated in FIGURE 3, a section of the cable dielectric 106 exposed and a section of the wire braid exposed and adapted to be positioned over the portion 50. The outer insulating sheath 102 of cable 100, is expanded as indicated in FIGURE 3, to be crimped against 50. Cable 100, thus prepared, is inserted within the assembly 10, with the central conductor 110 inserted in a bore 42 of pin 40, dielectric 106 inserted within bore 39 of dielectric section 37 and braid 104 disposed about portion 50. Thereafter, ferrule 60 is slid forward and over braid 104 and positioned as shown in FIGURE 1, and the assembly crimped by a tool capable of applying crimps simultaneously through die faces engaging the zones C₂ and C₃. A tool of this general type is shown in U.S. patent application, Serial No. 238,457, filed Nov. 19, 1962, in the name of Robert S. Stull.

Particularly sealing features of the connector assembly shown in FIGURE 1, reference is made to the three seals 18, 36, and 70. The surface defining the contact between the connector central conductor paths is disposed about the end of pin 40 along zone C₁ and protected from the corrosive effects of moisture and the like by the presence of dielectric 36, tightly formed against bore 31 within shell of the connector. Additionally, a seal 18 is provided to block the path of entry with respect to moisture entering the connector from the rear portions such as through crimp portholes 34 or through cable 100. Seal 18 is held in compression by the engagement of connector half 12 with connector half 80, so as to be pressed radially against the inside diameter of the shell and axially against offset 16. The crimp zone C₂ is protected by the presence of the dielectric material 36, surrounding the area of crimp and filling the insides of the connector shell member on both sides of the crimp ports 34.

As herefore indicated, the most important advantage offered by the construction of the assembly shown in FIGURE 1, is to seal 70 and its operation to block entry of moisture into the connector assembly via the point of entry of the cable or from within the cable itself. FIGURE 3 shows the annular configuration of seal 79, in its position relative to the dielectric 106, braid 104 and outer sheath 102 of cable 100. Seal 70, is, of course, affixed to portion 50, the showing in FIGURE 3 being for the purpose of illustration only. The important point to note is that the seal 70 is positioned beneath the braid 104 with its inner surface against the outer surface of dielectric 106.

FIGURES 4, 5 and 6 show enlarged views of seal 70 in cross-section and demonstrate the function of providing an improved high resistance path against contaminants entering the connector assembly. Seal 70 is comprised of resiliently deformable material such as silicone or neoprene, substantially softer than the dielectric material of core 106. As indicated in FIGURE 5, the cross-sectional configuration of seal 70 includes displaced integral wall sections 72 and 74, extending radially from a transversely extending bottom section 76. The three sections define a slot or well 90 such as to permit the engagement of seal 70 with the projecting rim 56 of portion 50. The diameter of seal 70, as measured at the bottom of groove 76, should be such as to permit the seal to be seated within rim 56 and held thereby during insertion of core 106 and central conductor 110. This feature eliminates the need for loose piece seals applied during the assembly of the connector as in the prior art. FIGURES 4, 5 and 6 show the configuration assumed by seal 70 before and after crimp.

As shown in FIGURES 4, 5, and 6, the smaller flange portion 72 operates with flange 74 and groove 78, to hold or position the seal within 50. The outer and larger flange 74 serves to provide sealing. The crimping forces applied to ferrule 60 generate forces indicated by the arrows in FIGURE 2, tending to compress seal 70 and a resulting compression of flange 74. The principal forces, as indicated, operate along radial lines about the circumference of ferrule 60, transmitted through the braid 104 to flange 74, to drive the under surface of the seal in and against dielectric 106. These forces also operate obliquely due to the presence of outer insulating material 102 driven by ferrule 60. The resulting compression and deformation of flange 74 results in the seal also being compressed against the end of face of 58, as indicated in FIGURE 6 to thus seal the assembly against entry of moisture and/or corrosive gases into assembly 10 from either braid 104 or under ferrule 60.
While the assembly 10, heretofore shown and described, is of a type termed TNC, the particular sealing features may be used with other types of coaxial connectors, including non-crimp versions. For example, the seal 70 may be incorporated at the entry portion of the crimping shell of BNC, TNC, or TPS connectors in the same manner, and an insulating shell 60, the combination comprising a shell of conductive material forming an outer signal path including a tubular extension at one end of the shell adapted to receive the cable outer conductor crimped thereto by a ferrule, the shell including a longitudinal bore extending forwardly from said extension and containing a dielectric core secured to said shell, a central conductor pin member forming an inner signal path supported and held in coaxial relationship to said shell by said core, the forward end of said dielectric core being relieved to expose one end of said pin for contact with a mating pin member of a mating connector, a center portion of said dielectric core being relieved and defining a relatively thin unbroken wall of dielectric material surrounding said pin member at a central point wherein the pin can be crimped inwardly to connect the cable central conductor thereto, a resiliently deformable annular seal disposed about the forward end of said pin member engaging the interior surface of said shell and the end of the dielectric core, a further resiliently deformable annular seal secured to said tubular extension at the outer end thereof and projecting outwardly therefrom such as to be driven in compression against the end face of said extension and against the dielectric core of said cable and beneath the outer conductor of said cable when a ferrule is crimped over said outer conductor and said further seal during crimping.

2. The connector of claim 1, wherein said tubular extension includes an interorily disposed rim and said further seal includes first and second flanges joined by a base portion defining a groove mating with said extension rim securing said seal within said extension.

3. A sealed coaxial connector assembly of improved construction including in combination, a connector secured to a coaxial cable, said connector including a body portion having a shell-like forward section defining a central bore, opposed crimp ports in said shell, a core of dielectric material fitted within a portion of said bore including relieved portions aligned with said ports, a central conductive pin member secured and coaxially disposed in said forward section by said core receiving the central conductor of a coaxial cable therein and cramped thereto by die faces entering said crimp ports, a portion of said shell extending from the end thereof opposite to said forward section defining a surface receiving the braid of the coaxial cable, a ferrule positioned over said braid and cramped to said extending portion, the extending portion of said shell having an inner diameter receiving the dielectric core of the coaxial cable in a close fit, the end of the said extending portion of said shell including a rim projecting inwardly, an annular seal of resiliently deformable material seated and secured against said rim, the said seal including faces coinciding the end face of said extending portion and the surface face of the coaxial cable dielectric, the seal being held in compression against such faces to block entry of moisture and corrosive gases into said connector assembly.

4. In a coaxial connector assembly including a connector and a coaxial cable, the said connector having a projecting tubular shell having the metallic braid of said coaxial cable secured thereto by a ferrule cramped thereto against, an improved seal construction including means disposed at the end of said shell seating and securing a resiliently deformable seal thereto, said seal being positioned beneath the cable braid, the said seal including a flange portion extending axially from the end of said shell and radially from the diameter of the cable dielectric core and held in compression against the end face of said shell and against the outer surface of the dielectric core beneath said cable braid by said ferrule.

5. An improved sealed coaxial connector attached to a coaxial cable, said connector having a conductive shell member housing a central dielectric core, a central pin member coaxially secured in said core including a pin portion surrounded and sealed by core material, the pin portion and surrounding core material cramped inwardly connecting said pin to the central conductor of said coaxial cable, said shell member having an extension at one end thereof, an annular seal of resilient material softer than the dielectric core of the coaxial cable inserted partially within said extension in contact with said extension, the braid of said cable positioned over said extension of said seal, a ferrule positioned over the braid of the cable and said seal and cramped inwardly against the outer surface of said extension securing said braid to said extension and compressing said seal against said core and the end face of said extension.

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