

[54] **HERMETICALLY SEALED ELECTRICAL TERMINAL**

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[51] Int. Cl. **H01r 9/16, H01b 17/26**

[58] Field of Search..... **174/50.61, 52 S, 174/142, 153 R; 339/126 R, 192 RL, 218 R, 218 C, 218 M**

[56] **References Cited**

UNITED STATES PATENTS

2,748,187 5/1956 Conrad 174/153 R
3,522,575 8/1970 Watson et al. 339/126 R X

FOREIGN PATENTS OR APPLICATIONS

284,897 2/1928 Great Britain 174/142
499,872 11/1954 Italy 174/153 R

OTHER PUBLICATIONS

Wyzeenbeek, "Hermetic Feed-Through Terminals", Electrical Manufacturing, Jan. 1954, pages 129-131.

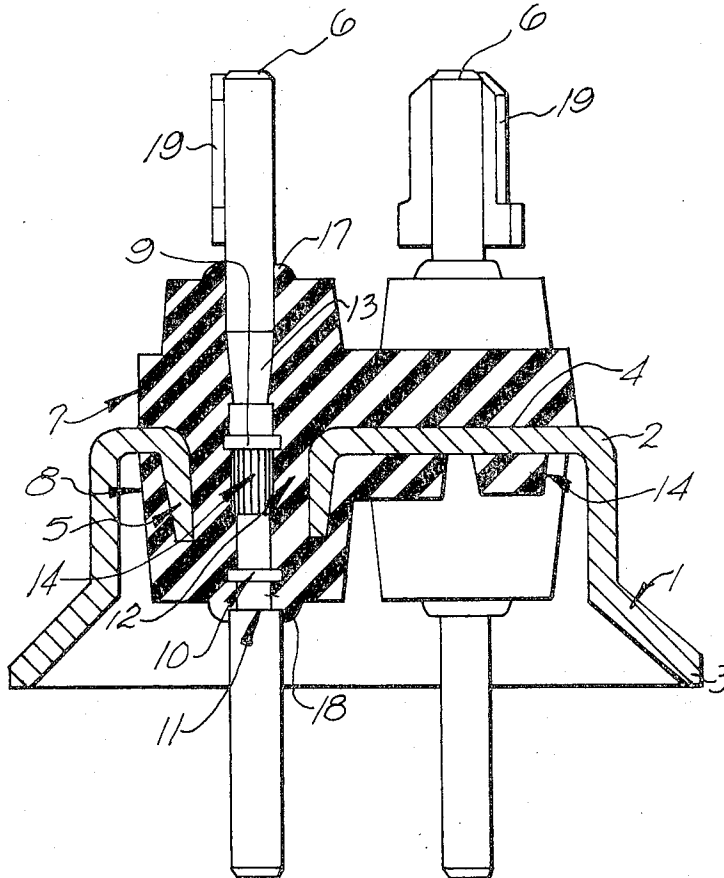
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[57] **ABSTRACT**

A hermetically sealed electrical terminal in which one or more highly conductive conductor pins, formed from materials such as copper and copper alloys, are electrically insulated from a supporting member, such as a metallic shell, by means of a molded dielectric sealing member which coats with the conductor pins and the supporting member to provide a reliable hermetic seal.

14 Claims, 6 Drawing Figures



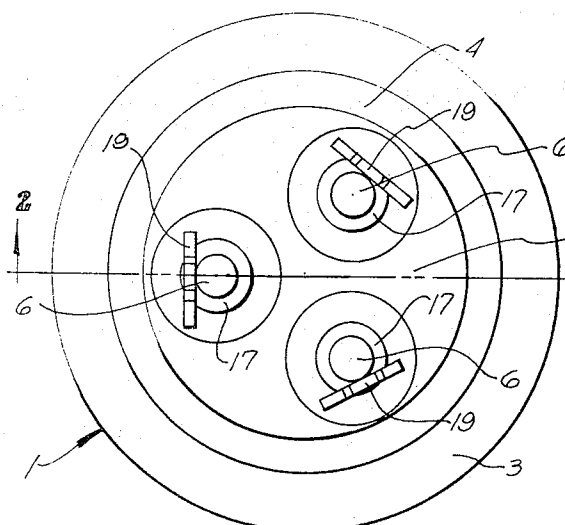


FIG 1

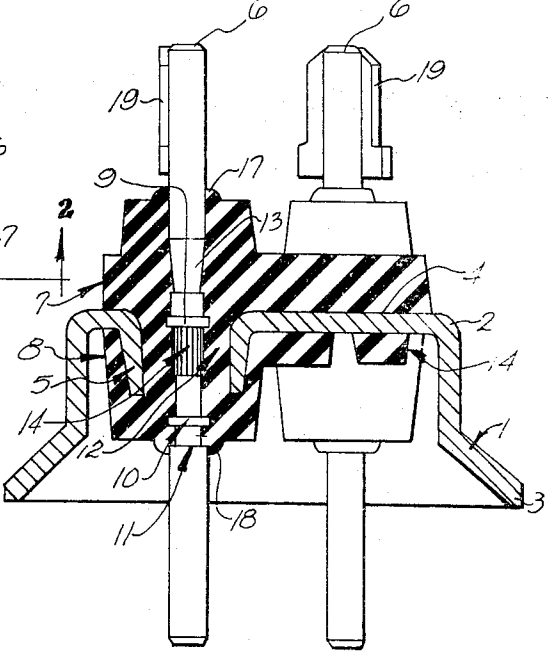


FIG 2

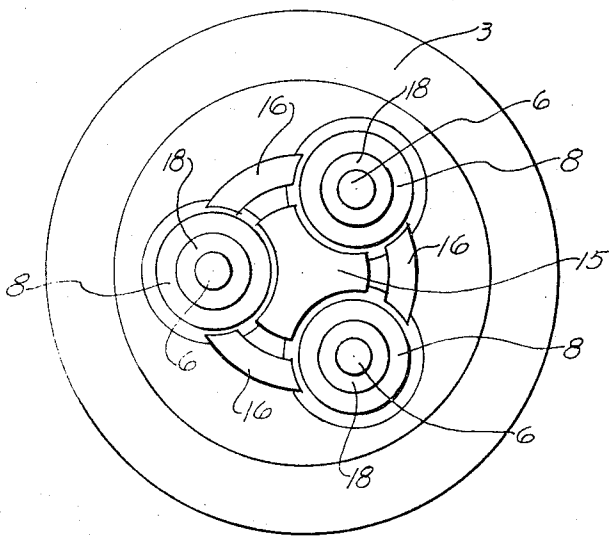


FIG 3

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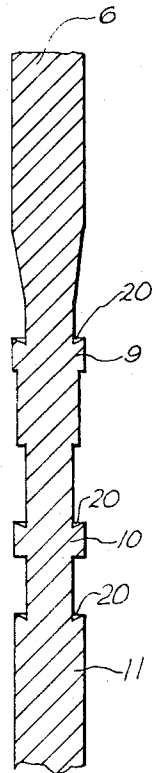


FIG 4

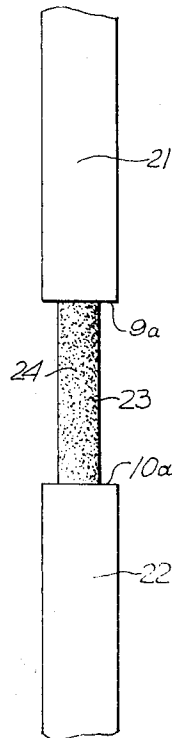


FIG 5

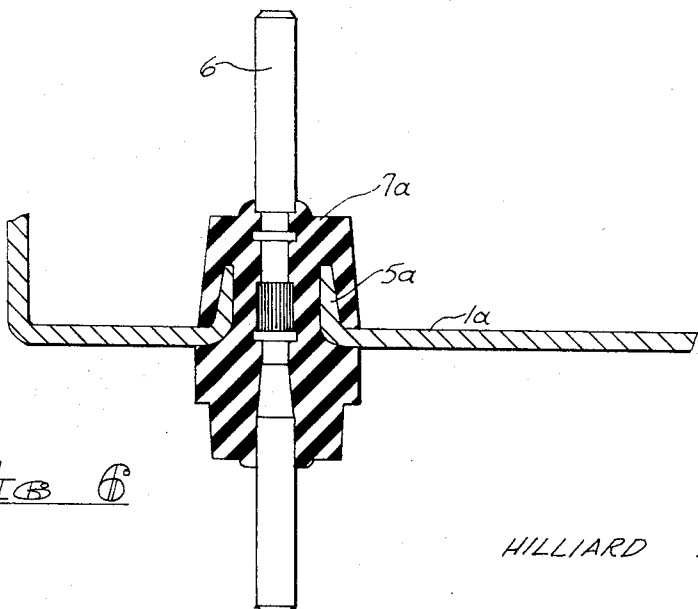


FIG 6

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HERMETICALLY SEALED ELECTRICAL TERMINAL

BACKGROUND OF THE INVENTION

The present invention relates to electrical terminals of the type wherein one or more conductor pins project through and are secured to a supporting body by means of a seal which electrically insulates the conductor pins from the supporting body and at the same time hermetically seals the pins against the exchange of atmosphere between one side of the terminal body and the other. Such terminals are widely used in refrigeration headers, for example, wherein an electrical connection is made with components mounted within a sealed receptacle or chamber. Such terminals also find wide usage in transformers, relays, switches, circuit breakers, heaters, communications equipment, and space vehicle accessories.

The great bulk of hermetically sealed terminals in current use are of what may be called a "hard seal" type, in which the conductor pins are mounted in the supporting body by means of a glass-to-metal or ceramic-to-metal seal. Such terminals, while providing an effective hermetic seal, are subject to a number of disadvantages. A principal disadvantage lies in the limitations imposed upon the materials from which the conductor pins may be formed. While copper and copper alloy conductor pins are ideal conductors of electricity, they cannot be successfully used with glass or ceramic seals due to differences in the coefficients of expansion between the conductor pins and the sealing material. In order to minimize the problem, conventional hermetic terminals of the "hard seal" type employ conductor pins formed from stainless steel, stainless steel with a copper core, or nickel alloys. However, pins formed from these materials have an extremely low percentage of conductivity as compared with comparable size pins formed from copper or a copper alloy. As a result, terminals utilizing steel conductor pins must be substantially larger than would be required were the conductor pins formed from copper or other materials having greater conductivity.

Terminals incorporating glass or ceramic seals are also subject to being cracked or broken if roughly handled or if the pins are bent during installation. If the seals are cracked or broken, the hermetic barrier between the pins and their supporting structure is impaired or destroyed, as is the ability of the seals to electrically insulate the conductor pins relative to the support in which the pins are mounted. In addition, it has not heretofore been possible to repair conventional "hard seal" terminals where such repairs involve a heat generating operation, such as brazing or resistance welding, because of the critical temperature considerations involving the expansion and contraction of the parts.

Various expedients have been proposed to overcome the shortcomings of the "hard seal" terminals, but such expedients have met with only limited success. For example, U.S. Pat. No. 3,160,460, dated Dec. 8, 1964, and entitled "Terminal Assembly Having Conductor Pins In Terminal Block," teaches an essentially "hard seal" terminal having a glass-to-metal seal covered on the outer side of the terminal by a resilient insulator bonded to the support and adjacent portions of the conductor pins. Such arrangement does not, however, overcome the expansion problem between the conduc-

tor pins and their glass seals. In addition, the configuration of the seals is still limited to the flow and wetting characteristics of the glass, which in turn limits the ability of the seals to meet long path arc resistance requirements in spite of the molded overlay.

Efforts have also been made to mold the seals from various distortable dielectric materials to provide what may be called a "soft seal" terminal, but such terminals have been unsuccessful due primarily to their inability to withstand high pressure, as well as other environmental conditions, such as elevated temperatures. These failures are believed due in large measure to plastic flow and creep of the distortable materials from which the seals are formed. One solution to the problems encountered in "soft seal" terminals is taught in U.S. Pat. No. 3,605,076, dated Sept. 14, 1971, and entitled "Hermetically Sealed Terminal Construction," which teaches a terminal construction of the "soft seal" type in which each conductor pin is electrically insulated and hermetically sealed relative to its support by means of a distortable dielectric sealing member encapsulated between a pair of essentially rigid dielectric caps. While such arrangement provides a highly effective hermetic seal, the cost of producing the terminals is relatively high due to the number of parts involved and the labor required to assemble them.

In contrast to the foregoing, the present invention provides a terminal construction of essentially the "soft seal" type in which each conductor pin is effectively sealed to its surrounding support by a unitary molded dielectric sealing member which is free from the disadvantages heretofore encountered in molded "soft seal" terminal constructions, the configuration of the conductor pins together with the configuration of the sealing members and their relationship to the supporting body of the terminal coacting to provide a highly effective hermetic seal which can be efficiently and inexpensively manufactured and the seal configured to provide the desired arc resistance.

RESUME OF THE INVENTION

The present invention contemplates a terminal construction wherein a unitary sealing member is integrally molded to each conductor pin and its surrounding support, the construction and arrangement of parts being such that expansion and contraction of the metallic parts does not interfere with or otherwise adversely affect the bond between the sealing member and the metallic parts.

To implement the foregoing, the conductor pins are provided with a plurality of shoulders which materially increase the bonding surface areas of the pins and which are positioned to effectively control the location and degree of contraction of the sealing material as it is molded and cured, as well as control plastic flow and creep after molding.

In similar fashion, the molded sealing member is of a configuration such that it effectively insulates both the conductor pin and the supporting body in all critical areas, the parts being configured to take advantage of the natural contraction of the sealing material during molding to insure a positive and tight seal between the metallic parts and the sealing material.

While the terminals of the present invention may be characterized as being of the "soft seal" type in that they are not frangible in the sense of a glass or ceramic seal, the sealing members may be formed from materi-

als which are essentially hard and rigid when cured. For example, epoxy molding compounds provide excellent seals, yet they are not "soft" in the sense of being readily distortable. They are, however, sufficiently compliant to accommodate expansion and contraction of the conductor pins. On the other hand, the sealing members may be formed from materials which are relatively soft and readily distortable, such as synthetic elastomers. A key consideration in the formation of the seal is the use of a sealing material which, in addition to providing the required dielectric properties, is capable of maintaining a tight bond with both the conductor pins and the supporting body irrespective of environmental conditions, such as elevated temperatures. This permits the use of copper and copper alloy conductor pins, which result in a substantial reduction in the size of the conductor pins for a given current conducting capacity. The invention thus facilitates miniaturization in that comparable, or even greater, conductive capacities can be achieved utilizing conductor pins of much smaller sizes formed from any conductive material having a higher conductive capacity than the conductor pins currently in use.

The present invention may be utilized in conjunction with single or multiple pin terminals, or in constructions wherein the body or support for the conductor pins comprises an integral part of a housing or other sealed component to which electric current is to be supplied.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of an exemplary terminal construction in accordance with the invention, the illustrated terminal comprising a three-conductor header of the type used in compressors for refrigeration equipment.

FIG. 2 is a vertical sectional view taken along the line 2—2 of FIG. 1.

FIG. 3 is a bottom plan view of the terminal construction illustrated in FIGS. 1 and 2.

FIG. 4 is a vertical sectional view of a modified conductor pin in which the shoulders which engage the sealing material are undercut.

FIG. 5 is an elevational view of another form of conductor pin.

FIG. 6 is a vertical sectional view similar to FIG. 2 but illustrating a construction wherein the supporting body for the terminal is an integral part of a housing or like receptacle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 2 of the drawings, the terminal comprises a supporting member or body 1 which, in the embodiment illustrated, is of cup-shaped configuration, having an annular body wall 2 terminating at one end in an outturned mounting flange 3 and at its opposite end in a base 4 interrupted by spaced apart sleeves or sockets 5 lying within the confines of the annular body wall 2. The configuration of the body member 1 is conventional for a three-pin header and can be formed of any material suitable for the purpose, although for most installations a steel body is preferred since it is relatively inexpensive and can be easily formed into the desired shape. The particular material from which the body member is formed will be governed in large measure by the mode of installation of the terminal, de-

pending upon whether it is to be welded, soldered, brazed, threaded, press-fitted, or even adhesively secured in place.

The supporting member 1 mounts a plurality of conductor pins 6 which extend axially through the sleeves 5, the conductor pins being secured in place and hermetically sealed by means of the sealing member 7, which is a unitary member composed of a dielectric material molded in situ to the desired configuration.

The conductor pins 6 may be formed from substantially any electrically conductive material, although copper or copper alloy pins are preferred because of their high electrical conductivity. Since expansion and contraction of the pins does not pose a problem due to the manner in which the pins are mounted and the nature of the sealing material, a wide choice of conductor pin materials is available, depending upon the desired strength, size and conductive capacity of the pins.

The sealing member 7 is formed from a dielectric material capable of being molded in situ to the supporting body 1 and conductor pins. Key considerations in the selection of the molding compound are the provision of a material having sufficiently low resistance to flow so that its direction and extent of flow may be controlled during molding, and having a coefficient of linear expansion which is compatible with the coefficient of expansion of the conductor pins. Essentially, the direction of flow of the molding material is controlled by the design of the terminal, which takes full advantage of the normal shrinkage or contraction of the molding material during the molding operation. Epoxy molding compounds have been found to produce excellent results, particularly when fortified with mineral or glass fibers. By way of example, excellent results have been achieved using epoxy molding compounds manufactured by Allied Chemical Corporation under the trademark EPIALL. While the epoxy molding compounds are essentially rigid when cured, they are nonetheless compatible with conductor pins formed from copper or copper alloys insofar as their coefficients of expansion are concerned and an excellent hermetic seal results. However, distortable dielectric material, i.e., materials which are relatively soft and capable of being readily flexed, also may be employed, such as synthetic rubber. An example of a synthetic elastomer suitable for the purpose is chlorosulfonated polyethylene manufactured by E. I. DuPont de Nemours & Co. under the trademark HYPALON. It should be noted that where a material such as HYPALON is used, a bonding adhesive is required to insure a tight bond between the metal parts and the seal.

In order to take full advantage of the flow and shrinkage characteristics of the molding compound and insure a positive seal with the metallic components of the terminal, the following design considerations are important if a hermetic seal is to be achieved:

1. The sealing member 7 includes annular portions 8 which surround the sleeves 5 of the supporting body, so that contraction of the outer portions 8 of the sealing member during curing will cause the sealing material to tightly bond to the outside surfaces of the sleeves. In addition, the annular portions 8 of the sealing member are relatively thin in cross-section and hence will readily expand and contract with the metallic sleeves without separation of the tight bond which has been formed. If the annular portions 8 were massive, i.e., relatively thick in cross-section, the added mass would

tend to hold the portions 8 against compliant expansion and contraction.

2. The conductor pins 6 are provided with a plurality of shoulders 9, 10, and 11 which increase the bonding surface area of each conductor pin and assist in controlling the location and degree of contraction of the sealing member, particularly the intermediate portion 12 thereof lying within the confines of the sleeve 5. Thus, the shoulders 9 and 10, which may be conveniently defined by annular flanges machined in the conductor pin, effectively lie at opposite ends of the sleeve 5 and act to anchor the sealing material within the confines of the sleeve, i.e., resist flow or creep of the sealing material axially of the sleeve, thereby rendering the intermediate portion 12 of the sealing member lying within the confines of the sleeve relatively unaffected by expansion and contraction of the conductor pin and the surrounding sleeve.

3. The shoulders 9 and 10, as well as the shoulder 11, serve to resist contraction of the larger masses of sealing material lying outwardly beyond the ends of the intermediate portion 12 in directions which would tend to elongate and hence contract the intermediate portion 12. The shoulders also serve as anchors to enhance the pull resistance i.e., axial displacement of the conductor pin.

4. The conductor pins are also preferably provided with a tapered or beveled section 13 positioned to encourage contraction of the relatively large external mass of sealing material toward the base 4 of the body member so as to effect and maintain a tight bond therewith.

5. Each conductor pin is also provided with a knurl 14, preferably positioned between the shoulders 9 and 10, the knurl 14 serving the dual function of preventing rotation of the conductor pin and at the same time increasing the surface area of the pin to which the sealing member bonds. Being positioned within the confines of the sleeve 5, the knurled portion 14 is effectively within the "tranquil" intermediate portion 12 of the sealing member whereby expansion and contraction of the sealing member is under maximum restraint.

6. On its undersurface and as best seen in FIG. 3, the sealing member is provided with an enlarged center portion 15 and mold ring portions 16 interconnecting the sleeve-surrounding outer portions 8, the portions 15 and 16 providing non-critical areas of the seal to which imperfections caused by entrapped gases or other contaminants may readily migrate. The portions 15 and 16 also assist in increasing the bonding surface between the sealing member and the supporting body 1, particularly on the undersurface of base 4 and hence effectively increase the strength of the bond in the critical areas of the seal.

7. It has also been found desirable to provide the sealing member with integral collars 17 and 18 surrounding the conductor pins at the point where the opposite ends of the pins emerge from the sealing member, such collars acting to relieve stress concentrations which could result in aging cracks in the peripheral areas immediately surrounding the conductor pins. The collars also serve as stops against which a plug or the like for receiving the conductor pins may be seated.

With the foregoing design considerations in mind, it will be evident that the size and dimension of the parts may be varied as required for a given application, inclusive of the spacing of the parts to provide the over-

surface distance required to meet Underwriter Laboratory requirements or other similar specifications. As will also be evident, the instant design is equally applicable to single or multiple pin terminals, which may be supplied in various body configurations and various pin configurations. For example, the pins may be provided with conductor tabs 19 at one or both ends, as required for any given installation.

FIG. 4 of the drawings illustrates a modified conductor pin construction wherein each of the shoulders 9, 10, and 11 undercut, as indicated at 20, the undercut surfaces acting to take further advantage of the contraction of the sealing member during curing. This is especially desirable where elastomeric seals are employed which are more readily distortable than the essentially rigid epoxy compounds. The undercuts also act as anchors to resist severe pull pressures axially of the pin.

FIG. 5 illustrates still another conductor pin construction in which the pin configuration has been greatly simplified, the pin having distal ends 21 and 22 separated by an intermediate portion 23 of lesser diameter, the innermost ends of the distal portions 21 and 22 defining shoulders 9a and 10a which will function in the manner of the shoulders 9 and 10 previously described. In order to increase the effective bond between the intermediate portion 23 and the surrounding sealing member, the portion 23 may be sandblasted to provide a roughened surface 24. Alternatively, the intermediate portion of the pin may be provided with a knurled portion similar to the knurled portion 14 illustrated in FIG. 2.

FIG. 6 illustrates an application of the invention wherein the support or body 1a of the terminal comprises an integral part of a housing or other receptacle containing an electrical component to be electrically connected to a source of current outside the confines of the receptacle. In this instance, the terminal illustrated has a single conductor pin 6 extending through the sleeve 5a formed as an integral part of the housing or receptacle 1a. It will be evident, however, that the sealing member 7a effectively surrounds the sleeve 5a, with the shoulders on the conductor pin acting to control the location and extent of contraction of the sealing member during molding. Obviously, any desired number of conductor pins may be mounted in the receptacle 1a, either independently or with their sealing members joined together as an integral seal.

It should be readily apparent that various additional changes and modifications may be made in the structural details of the terminals, within the scope of the appended claims, without departing from the spirit and purpose of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A hermetically sealed terminal comprising a support member having a base with at least one annular opening therein defining one end of a generally cylindrical sleeve projecting outwardly from one side of said base, an elongated conductor pin extending centrally through said sleeve and lying in spaced relation thereto, and a one-piece molded dielectric sealing member securing said conductor pin to said supporting member, said sealing member having an intermediate portion extending through said sleeve in sealing engagement with said conductor pin and the inner surface of said sleeve,

said conductor pin having a pair of spaced apart opposing shoulder-forming faces positioned near the opposite ends of said sleeve to restrain the intermediate portion of said sealing member against expansion and contraction, said sealing member having integral outer portions extending outwardly beyond said intermediate portion on both sides of said base, said outer portions being of larger diameter than said intermediate portion and surrounding said pin in sealing engagement therewith, one of said outer portions having a relatively thin annular wall portion completely surrounding said sleeve in sealing engagement with the outer surface thereof and in sealing engagement with said base in the area immediately surrounding said sleeve so as to encapsulate said sleeve therein, the other of said outer portions being in sealing engagement with the opposite side of said base in the area surrounding said annular opening.

2. The terminal construction claimed in claim 1 wherein said conductor pin has a central portion of reduced diameter as compared with its opposite end portions, said pair of spaced apart shoulder-forming faces being defined at the junctures of the outer portions of the pin with said reduced diameter central portion, said faces being of no greater diameter than the opposite end portions of said conductor pin.

3. The terminal construction claimed in claim 2 wherein the central portion of said conductor pin is roughened to enhance the engagement of said sealing member with the central portion of said pin.

4. The terminal construction claimed in claim 1 wherein said conductor pin has an inwardly tapered portion lying outwardly beyond the shoulder-forming face in closest proximity to the base of said supporting member.

5. The terminal construction claimed in claim 4 wherein said conductor pin includes a third shoulder-forming face lying within the confines of the outer portion of the sealing member which surrounds said sleeve.

6. The terminal construction claimed in claim 5

wherein the outer portions of said sealing member terminate at their outermost ends in integral collars surrounding said pin.

7. The terminal construction claimed in claim 1 wherein said supporting member has a plurality of sleeves projecting outwardly from one side of said base, wherein a conductor pin extends centrally through each of said sleeves, and wherein said one-piece sealing member has intermediate and outer portions associated with each of said sleeves.

8. The terminal construction claimed in claim 7 wherein the outer portions of said sealing member which completely surround said sleeves in sealing engagement with the outer surfaces thereof are interconnected by a mold ring portion in sealing engagement with said base.

9. The terminal construction claimed in claim 8 wherein said relatively thin annular wall portions of said sealing member are also interconnected by an integral portion in sealing engagement with said base and spaced inwardly from said mold ring portion.

10. The terminal construction claimed in claim 7 wherein the base of said supporting member terminates outwardly in an annular wall surrounding said sleeves, and wherein the relatively thin annular wall portions of said sealing member which surround the outer surfaces of said sleeves are free from contact with the annular wall of said base.

11. The terminal construction claimed in claim 1 wherein said sealing member is essentially rigid.

12. The terminal construction claimed in claim 11 wherein said sealing member is composed of an epoxy molding compound.

13. The terminal construction claimed in claim 1 wherein said sealing member has a coefficient of expansion compatible with the coefficient of expansion of said terminal pin.

14. The terminal construction claimed in claim 13 wherein said terminal pin is formed from copper.

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