

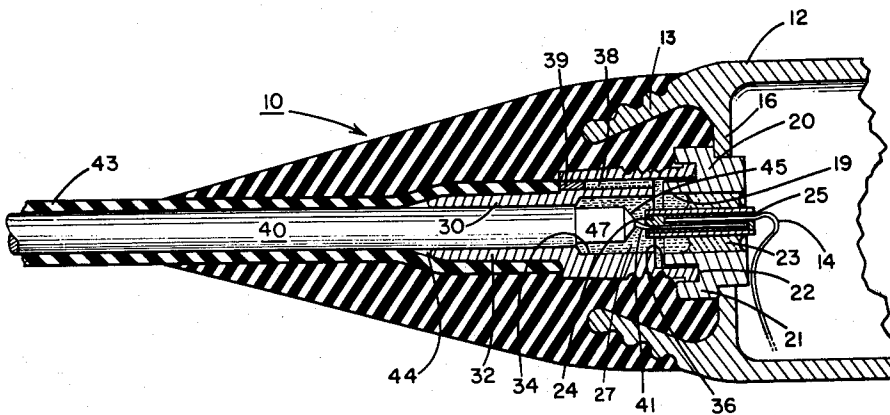
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HERMETIC SEAL

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HERMETIC SEAL

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This invention relates to an hermetic seal and more particularly to an apparatus and a method for hermetically sealing a connection between electric conductors, the device being adapted to prevent moisture molecules from penetrating toward surfaces having critical electrical resistance characteristics.

It is an object of this invention to provide a moisture free connection between an electric cable and a lead wire constituting part of a moisture sensitive device, for instance accelerometers comprising piezoelectric transducing elements, as disclosed in co-pending application Serial Number 14,295 filed March 11, 1960 and assigned to the same assignee as the present invention.

It is a further object of this invention to provide an hermetic seal adapted to protect a given area to maintain substantially the same degree of electrical resistivity over a substantial period of time despite severe external climatic conditions, for instance 95% humidity at tropical temperatures.

The present state of the art in missile components and the like requires a high degree of accuracy and sensitivity. More particularly, such instruments as piezoelectric accelerometers are drastically reduced in sensitivity where penetration of moisture molecules into the unit occurs. This causes enumerable problems because of the difficulty to maintain a high degree of constant resistivity in the surrounding area where the lead wires are stripped of all insulation. The order of magnitude in resistance herein considered is well beyond 100 megohms. While devices of the prior art have been able to establish resistivity of such magnitude, they have not been able to maintain a resistivity in the region of 300 megohms or higher for extensive periods of time. For instance, devices in accordance with the prior art when exposed to a humidity environment of about 95% with temperatures ranging from 68° F. to 160° F. for a period of ten to fifteen days or longer have consistently absorbed moisture molecules, which in turn appreciably affected the degree of resistivity reducing the same 10% or more. The present invention has been subjected to tests indicating a constant resistivity of 1000 megohms for seventeen days, at which time the tests were terminated. The tests indicated that the resistance of the conducting parts surrounding the exposed lead wires did not vary more than a few ohms during and after the test period.

A major problem encountered is that of preventing the penetration of moisture molecules into the device and particularly along the "non-conducting" portions so as to effect the resistivity by establishing a conducting film of moisture along these "non-conducting" parts.

The present invention accomplishes this high degree of constant resistivity by providing an hermetically sealed electrical connection which includes a housing which has a central opening and a sealing member having an inner and an outer cylinder concentrically disposed with respect to each other. The outer cylinder is peripherally mounted within the opening of the housing and an intermediate cylinder formed of non-conducting material is mounted between the inner and the outer cylinders. An electric cable comprises a conductor enveloped by multiple outer wrapping layers. Also provided is a tubular anchor member, one end of the anchor member sealingly engaging the aforementioned outer cylinder and the opposite end of the anchor member being interposed between layers of the

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cable. The conductor has an unwrapped portion extending axially into the tubular anchor and into the inner cylinder. A moisture resistant material is solidly packed within the tubular anchor.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the drawing, the single FIGURE is a longitudinal sectional view through an hermetic seal shown attached to a housing.

Referring to the drawing, the hermetic seal of this invention is generally designated as 10. It includes an arrangement in combination with a housing 12 which is part of an instrument not shown, for instance an accelerometer as aforesaid, having a lead wire 14 extending toward the junction of housing 12 and seal 10. The housing is substantially tubular and has an internal shoulder 16 on one end to rigidly receive a sealing member 20 therein. A conically tapered hollow extension 13 having a ribbed surface is formed on the housing. The sealing member 20 is adapted to engage an anchor device 30 which is secured to a cable 40.

The sealing member 20, preferably made of brass, has an internal bore 19 and a circumferential rim portion 21 substantially circular in cross-section dimensioned for a press fit into the housing shoulder 16. A glass insulation bead 23 is sealingly mounted in bore 19 and the bead has a central bore 24 to receive a rigid tubular member 25. The tubular member 25 is made out of a non-corrosive material such as stainless steel, or out of a suitable high nickel alloy, and the member 25 carries lead wire 14 from housing 12 and a lead wire 41 extending from electric cable 40.

Preferably, the abutting surfaces of the shoulder 16 and the peripheral portion 21 of the sealing member 20, and particularly the edges adjacent thereto, are suitably soldered all around, or bonded together using epoxy cement or the like. The portion of the sealing member 20 facing the anchor device 30 has a radial receiving groove 22 to retain the anchor device 30 therein after the unit has been assembled.

The anchor device 30 is made out of suitable rigid material and links the cable 40 to the sealing member 20. The anchor device 30 is tubular, extending through it is a longitudinal bore of non-uniform diameter consisting of bore sections 32, 34 and 36; the bore diameter of the individual sections being progressively larger toward the location of the sealing member 20. At the location of the bore section 36 there is provided a wall section of suitable thickness to fit into the groove 22 of the sealing member 20. The center bore section 34 provides a cavity substantially adjacent the end of the insulating glass bead 23 and the tubular member 25; that is to say, the cavity is defined at one end by the sealing member and at the opposite end by the bore section 32 which receives the cable 40 snugly therein. The outside diameter of the wall defining the bore section 32 is smaller than the outside diameter of the wall defining the bore section 34 to establish a longitudinal bore 38 therebetween, the bore 38 extending into the cavity and being adapted to receive a closure plug 39 for reasons hereinafter further explained.

To assemble the device the sealing member 20 is inserted into the housing 12 and soldered thereto. Thereafter, cable 40 is suitably prepared, that is to say rubber jacket 43 is pushed back from one end of the main cable exposing 2 or 3 inches of braid 44. The amount of exposure varies with individual applications. Care must be taken not to scuff or to crack the jacket in the process. The tip 45 of the exposed braid 44 is cut off at an angle

of 45°, the ends of the braid are then smoothed down and the anchor device 30 is slipped on and disposed under the jacket. A sufficient length of the wire tip is pulled out and exposed; and so is a Teflon insulation 47 which surrounds the wire. When a low-noise cable is utilized the Teflon is usually covered with graphite at its outer surface and the insulation is cut back as illustrated in the drawing. The exposed wires 41, 14 are polished and tinned in preparation for attachment.

To couple the wires the tinned portion of the wire 41 is melted into the center opening 24 of the tubular terminal 25 alongside the wire 14 from the housing 12. The tubular terminal is fully soldered and closed with tin.

When thus prepared the anchor device 30 is moved longitudinally on the braid toward engagement position with the terminal groove 22 and secured thereto by cementing the circumferential portion of the anchor device at that end with epoxy all around the anchor device and the adjacent sealing member surfaces. The opposite end of the anchor device 30 is then rigidly secured by soldering to the braid 44. This serves to substantially relieve stresses in the cable 40 ahead of the electrical connection and accommodates the transfer of such stresses through the rigid anchor device onto the housing 12. This arrangement prevents substantially any stress in the lead wire 41 which may be due on account of an external influence exerted on the cable 40. The bore 38 projecting into the cavity, formed by bores 34 and 36, is used to load the cavity with a suitable moisture proof substance 27, for instance grease, rubber, plastic, etc. The loading may be accomplished by utilizing a hypodermic needle which is inserted into bore 38 to squirt the substance into the cavity. After the cavity is entirely filled, the needle is removed while still applying pressure to make sure that the entrance portion of the bore 38 is also properly filled. A small tapered brass plug 39 is thereafter inserted into the opening 38 with a press fit, and preferably thereafter the plug 39 is soldered to seal the opening.

The whole outside area is then thoroughly cleaned with a primer in preparation for the application of a molded rubber-like substance, the latter may be of a kind generally commercially available. The external portions of the subject device are carefully coated with bits of this rubber compound so as not to trap air. Thereafter some additional coating of this rubber-like material is placed upon the assembly and a mold (not shown) is attached thereto in the conventional manner with clamps holding the mold tightly in place. The assembly is then set to dry. The drying condition depends of course on the type of compound used.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention. For example, the invention may be utilized when connecting broken lines, for instance telephone wires exposed to the weather. In such an application a sealing member is of course not necessary. Similarly, the invention may be worked without the external rubber-like coat. It is therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim as our invention:

1. A method for making a seal adapted to hermetically protect a connection between a multiple layer cable carrying a wire and a housing having a wire therein, which comprises the steps: of rigidly securing a sealing member including a tubular member thereof into said housing; exposing wire portions of said cable for insertion into said tubular member; securing an anchor device between layers of said cable; tinning portions of said wires; soldering said wires into said tubular member; rigidly attaching said anchor device to said sealing member; injecting a

moisture proof substance with a hypodermic needle into a cavity defined by the relative location of said anchor and said wire; and applying a rubber-like molding compound around said seal assembly.

2. A method for making a seal as described in claim 1, wherein the hypodermic injection needle remains under pressure even while being removed from said cavity.

3. A method for making a seal adapted to hermetically protect a connection between a cable carrying an electric first wire and a housing having therein a second wire, said housing having an opening therein which comprises the steps of: rigidly securing a sealing member having a tubular opening therethrough within said opening in said housing, exposing a wire portion of said cable and inserting it into said tubular opening, securing between layers of said cable an anchor device with said anchor device being spaced away from the cable at the location of said exposed wire portion to form a cavity, affixing said first and second wires within said tubular opening and sealing shut said opening, suitably securing said anchor device to seal the space between said housing and said device, filling said cavity with a moisture resistant substance, and thereafter molding moisture resistant material around the seal assembly.

4. A hermetically sealed electrical connection comprising, in combination; a housing having an opening therein; a sealing member having an inner and an outer cylinder concentrically disposed with respect to each other, said outer cylinder being peripherally mounted within said opening, and an intermediate cylinder formed of non-conducting material and mounted between said inner and outer cylinder; an electrical cable comprising a conductor enveloped by multiple outer wrapping layers; a tubular anchor member, one end of said anchor member sealingly engaging said outer cylinder and the opposite ends of the anchor member being interposed between said layers of said cable; said conductor having an unwrapped portion extending axially into said tubular anchor and into said inner cylinder; and a moisture resistant material solidly packed within said tubular anchor.

5. A hermetically sealed electrical connection comprising, in combination; a housing having an inner bore; a sealing member having an inner and an outer cylinder concentrically disposed with respect to each other, said outer cylinder being peripherally mounted within said inner bore, and an intermediate cylinder formed of non-conducting material and mounted between said inner and outer cylinder; an electrical cable comprising a conductor enveloped by multiple outer wrapping layers; a tubular anchor member having stepped cylindrical walls, one end of said anchor member sealingly engaging said outer cylinder and the opposite end of the anchor member being interposed between said layers of said cable; said conductor having an unwrapped portion extending axially into said tubular anchor and into said inner cylinder; a second conductor, the conductor being secured within the housing and extending into the inner cylinder to electrically couple with the cable conductor; an electrically conducting material within the inner cylinder substantially filling the latter; a moisture resistant material solidly packed within said tubular anchor excluding air bubbles, said material surrounding all portions of said unwrapped conductor within the anchor and the side surfaces of said sealing member adjacent to said anchor; and a rubber-like continuous coating surrounding portions of said housing, sealing member, anchor and said cable.

6. A hermetically sealed electrical connection comprising, in combination; a housing having an inner bore and providing on one end a conically tapered hollow extension; a sealing member having an inner and an outer cylinder concentrically disposed with respect to each other, said outer cylinder being peripherally mounted within said inner bore, and an intermediate cylinder formed of non-conducting material and mounted between

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said inner and outer cylinder; an electrical cable comprising a conductor enveloped by multiple outer wrapping layers; a tubular anchor member having stepped cylindrical walls and forming a passageway for inserting a compound therethrough, the passageway extending substantially parallel with respect to the central axis of said tubular anchor, one end of said anchor member engaging said outer cylinder and the opposite end of the anchor member being interposed between layers of said cable; said conductor having an unwrapped portion extending axially partly unwrapped into said tubular anchor and into said inner cylinder; a second conductor secured within the housing and extending into the inner cylinder to electrically connect with the cable conductor; electrically conducting material within the inner cylinder substantially filling the latter; a moisture resistant material solidly packed within said tubular anchor, said material surrounding all portions of said unwrapped conductor within

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the anchor and the side surfaces of said sealing member adjacent to said anchor; and a rubber-like continuous coating having an inverse conically-tapered extension and surrounding portions of said housing, the sealing member, the anchor member and said cable.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,082,291

March 19, 1963

David B. Parkinson et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 9, for "a cable carrying an electric" read
-- an electric cable carrying a --; line 36, for "ends" read
-- end --.

Signed and sealed this 3rd day of December, 1963.

(SEAL)

Attest:
ERNEST W. SWIDER

EDWIN L. REYNOLDS

Attesting Officer

Acting Commissioner of Patents