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Lavering et al.

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[54] **ELECTRICAL INSULATOR ASSEMBLY**

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[52] **U.S. Cl.** ..... **165/81,** 52/759, 165/185, 174/152 GM, 313/18, 313/30, 313/46, 315/3.5, 315/5.38, 403/179

[51] **Int. Cl.** **F28f 7/00,** H01j 1/02

[58] **Field of Search** ..... 174/DIG. 5, 13, 15 R, 16 R, 174/50.61, 50.63, 138 R, 152 GM; 165/81, 180, 181, 185; 287/189.365; 313/18, 21, 30, 39, 42–46; 315/3.5, 5.38; 52/759; 403/179

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[57] **ABSTRACT**

An electrical insulator body is supported from a surrounding structure via the intermediary of a plurality of yieldable support members. The yieldable support members, in a preferred embodiment, are annular truncated conical members bonded to the outside surface of the insulator body and to the inside surface of the surrounding member. In a preferred embodiment the conical support members are made of a copper clad or copper plated alloy of nickel, cobalt and iron to provide increased thermal conductivity between the insulator body and the surrounding structure.

12 Claims, 3 Drawing Figures

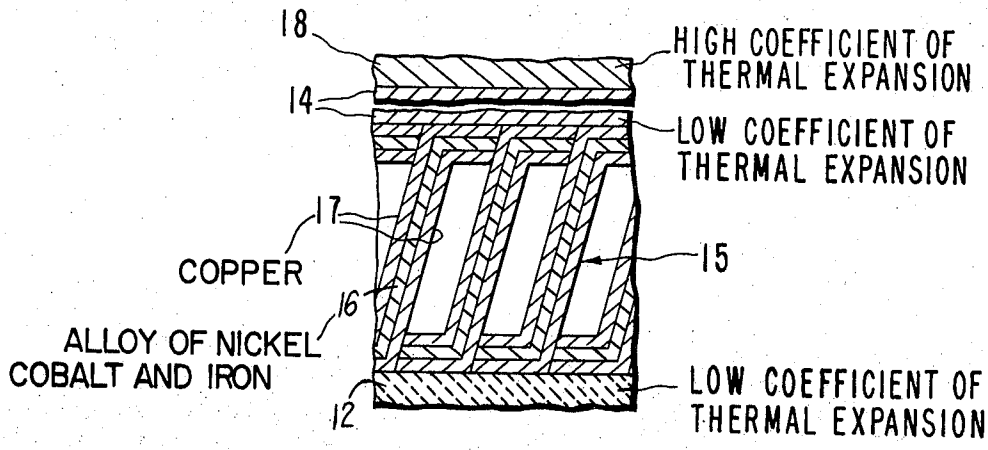


FIG.1

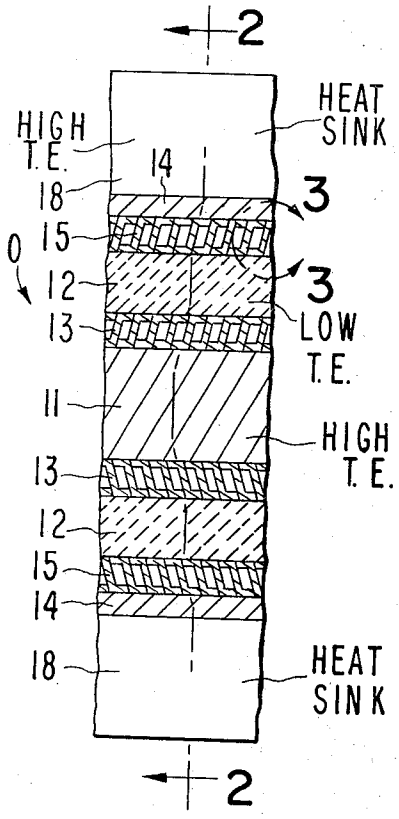


FIG.2

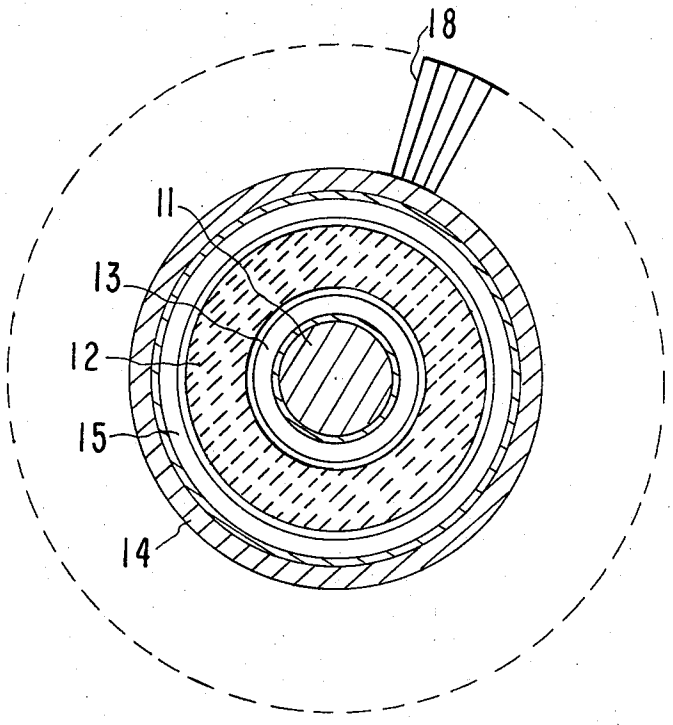
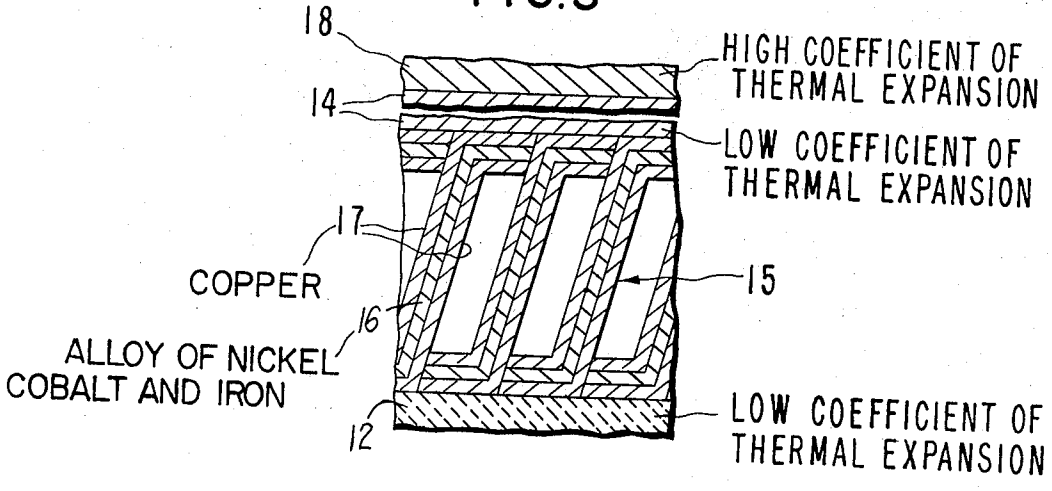


FIG.3



ELECTRICAL INSULATOR ASSEMBLY

DESCRIPTION OF THE PRIOR ART

Heretofore, it has been proposed that an inner conductive member, as of copper, could be supported from a surrounding electrical insulator body, as of ceramic, via the intermediary of a plurality of yieldable truncated conical ring members, as of copper, brazed at their inner ends to the inner conductive member and at their outer peripheries to the inside wall of the surrounding insulator member. Such a structure is conveniently made by metalizing the inside wall of the surrounding insulator body and brazing the copper conical members, at their inner diameters to the inside conductive member, and at their outer diameters to the inside wall of the insulator body. The brazing step is readily accomplished since the yieldable truncated conical members have a higher coefficient of thermal expansion and will expand outwardly against the inside wall of the surrounding insulator body to form a firm brazed joint between the support members and the inside wall of the surrounding insulator body. If an attempt were made to braze the inner conductor directly to the inside wall of the surrounding insulator body, i.e., without the yieldable support members, the differences in thermal expansion between the surrounding insulator body and the inner metallic member would produce fracture of the insulator body.

However, placing the yieldable support members between the inside electrical conductor and the outer insulator body permits the stress produced by the difference in thermal expansion to be taken up in the yieldable support members. The yieldable support members also facilitate removal of heat from the inner conductor to the surrounding insulator body. Such a structure wherein an inner conductor is supported from an outer insulator body by means of a plurality of yieldable support rings is disclosed and claimed in copending U.S. Application Ser. No. 135,472 filed Apr. 19, 1971, now U.S. Pat. No. 3,746,087, and assigned to the same assignee as the present invention.

While the aforecited prior art insulator assembly has numerous applications such as in the beam collector structure for a traveling wave tube, in a coaxial line feed through structure, and the like, it is desirable to provide means for removing the heat from the surrounding insulator body. However, if one were to attempt to merely braze the insulator body into a bore in a metallic heat sinking member, the inside wall of the bore would expand away from the insulator body during the brazing step, thereby preventing the formation of a proper brazed joint between the insulator body and the surrounding metallic heat sink. Also, even if a brazed joint were achieved, the differential thermal expansion between the insulator body and the surrounding metallic heat sink would produce excessive stress in the insulator body producing fracture thereof.

SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of an improved electrical insulator assembly.

In one feature of the present invention, an electrical insulator body is supported within a bore in a surrounding member via the intermediary of a plurality of yieldable support members bonded to the outside surface of said insulator body and to the inside surface of said surrounding member.

In another feature of the present invention, the yieldable support members interposed between the insulator body and the surrounding member are annular and made of a copper clad alloy of nickel, cobalt and iron, which alloy is available commercially under the trademark Kovar.

In another feature of the present invention, the yieldable support members are metallic having a thermal conductivity in excess of that of the Kovar alloy and arranged with the spacing between adjacent support members being less than the thickness of said support members, whereby relatively high thermal conductivity is achieved through said yieldable support members between said insulator body and said surrounding member.

In another feature of the present invention, the member surrounding the insulator body is made of the Kovar alloy.

Other features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a section of length of an insulator structure incorporating features of the present invention,

FIG. 2 is a transverse sectional view of the structure of FIG. 1 taken along line 2—2 in the direction of the arrows, and

FIG. 3 is an enlarged detail view of a portion of the structure of FIG. 1 delineated by line 3—3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2, there is shown an insulator structure **10** incorporating features of the present invention. The insulator assembly **10** includes an internal electrical conductor **11** made of a material having a relatively high coefficient of thermal expansion such as copper, aluminum, etc. The conductor **11** is supported from a surrounding hollow cylindrical insulator body **12** as of glass, alumina, or beryllia via the intermediary of a plurality of yieldable truncated conical members **13** as of copper brazed at their inner diameter to the outside surface of the center conductor **11** and at their outer diameter to the inside wall of the insulator body **12**.

As thusfar described, the insulator assembly **10** is that as disclosed and claimed in the aforecited copending U.S. Application Ser. No. 135,472, now U.S. Pat. No. 3,746,087. The inside array of annular truncated conical members **13** provides a relatively low impedance thermal path from the internal conductor **11** to the surrounding insulator body **12** while absorbing and dissipating the thermal stress generated due to the difference in thermal expansion between the insulator **12**, which has a relatively low coefficient of thermal expansion, and the inner conductor **11**, which has a relatively high coefficient of thermal expansion.

The cylindrical insulator body **12** is supported from a surrounding cylindrical member **14**, which could be made of an alloy of nickel, cobalt and iron available commercially under the trademark Kovar, via the intermediary of a plurality of truncated yieldable support

members **15**, which could be made of copper clad Kovar alloy (see FIG. 3). In a typical example, the yieldable support members **15** are formed of truncated conical members **16** as of 0.004 inch thick Kovar alloy sheet material. The Kovar alloy conical support members **16** are coated or clad with copper as of 0.005 inch to 0.010 inch thick and the axial spacing between adjacent surfaces of the yieldable support members **15** should preferably comprise less than 30 percent of the axial spacing between the centers of adjacent Kovar alloy members **16**. The copper cladding **17** serves to greatly increase the thermal conductivity between the ceramic insulator **12** and the surrounding tubular member **14**.

An array of radially directed thermally conductive fins **18**, as of copper, are brazed to the outer surface of the cylindrical member **14**. A fluid coolant, such as air, is directed through the spacing between adjacent fins **18** for carrying away the heat conducted thereto via the fins.

In an alternative embodiment, the yieldable support members **15** which are interposed between the cylindrical insulator **12** and the surrounding metal tube **14** comprise pure copper members **16** which are retained, during the brazing step, by the Kovar alloy sleeve **14** such that proper brazed joints are obtained between the yieldable support members **15** and the adjacent insulator body **12** and surrounding keeper **14**.

In another alternative embodiment, the pure copper yieldable support members **15** are brazed to the outer surface of the insulator body **12** while being retained within a cylindrical keeper member **14**, as of molybdenum, which is not brazed during the brazing operation to the outer periphery of the yieldable support members **15**. The subassembly is then inserted within a bore in a heat sinking member as of copper, steel, or beryllia ceramic and brazed therein to form a bonded brazed joint between the outer periphery of the yieldable support members **15** and the inner bore of the heat sinking member.

The yieldable support members **13** and **15** are formed in the shape of deformable cones to accommodate both radial and longitudinal differential expansion between the members on opposite sides of the deformable support members. Expansion occurs during brazing and in subsequent system operations.

In a preferred embodiment a gas tight seal is obtained at the bonded joints between the support members and the insulator body **12** and surrounding member **14** and a small hole is included in all but one of the annular support members **13** and **15** in order to prevent virtual gas leaks in the assembly.

The yieldable support members **15** and **13** can be designed for good thermal conductivity as by being made of relatively thick copper for dissipating heat through the support structure or, in the alternative, may be designed for thermal isolation by utilizing relatively thin stainless steel conical members **13** and **15** as would be required for a cryogenic feed through. Thus the yieldable conical support members can offer a useful means for either conducting heat from a high temperature electrical conductor or for thermally isolating a low temperature (cryogenic) electrical conductor from the surrounding support structure **14** or **18**.

What is claimed is:

1. A metal and ceramic assembly comprising a ceramic body, a member surrounding said ceramic body in radially spaced relation therefrom to define a region of space therebetween, a yieldable support member interposed in said space between said ceramic body and said surrounding member, said support member comprising a first metal portion having a coefficient of thermal expansion substantially higher than that of said ceramic body and a second metal portion having a coefficient of thermal expansion substantially closer than that of said first metal portion to that of said ceramic body, said first portion having a substantially higher coefficient of thermal conductivity than said second portion, said first portion being bonded to the outside surface of said ceramic body and to the inside surface of said surrounding member and forming a substantially continuous heat conductive path from said ceramic body to said surrounding member, said second portion being disposed to restrain separation of said first portion radially outward from said outside surface of said ceramic body during heating of said assembly.

2. The assembly of claim **1** wherein said surrounding member comprises a metal having a coefficient of thermal expansion substantially closer than that of said first metal portion to that of said ceramic body.

3. The assembly of claim **2** wherein the metal of said surrounding member comprises substantially the same material as the metal of said second portion of said support member.

4. The assembly of claim **3** wherein said metal material comprises an alloy of nickel, cobalt and iron.

5. The assembly of claim **1** wherein said yieldable support member extends generally angularly at other than a right angle from said outside surface of said ceramic body to said inside surface of said surrounding member whereby stress produced in said support member by the difference in thermal expansion between said ceramic body and said surrounding member during heating of said assembly is relieved by deformation of said angularly extending support member.

6. The assembly of claim **5** further comprising at least one other yieldable support member to form a plurality of substantially similarly configured support members, said support members being adjacently disposed with respect to each other so that said first metal portion of one support member is in thermally conductive surface contact with said first metal portion of an adjacent support member.

7. The assembly of claim **6** wherein at least one of said support members is annular about said ceramic body and is hole free to provide a gas-tight seal between said ceramic body and said surrounding member.

8. The assembly of claim **1** wherein said first metal portion of said support member comprises copper and said second metal portion comprises an alloy of nickel, cobalt and iron.

9. The assembly of claim **8** wherein said copper first portion comprises a cladding on said second portion.

10. The apparatus of claim **1** wherein heat sink means are affixed to the external surface of said surrounding member.

11. The assembly of claim **10** wherein said heat sink means comprises a heat-conducting fin extending outwardly from said surrounding member.

12. The assembly of claim **1** wherein said ceramic body comprises material selected from the group consisting of alumina and beryllia.

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