A vacuum-tight seal that has a substantially uniform coefficient of thermal expansion.

1 Claim, 3 Drawing Figures
3,857,005

VACUUM SWITCH ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to vacuum switch assemblies and more particularly to vacuum switch housing members having sealing means with a substantially uniform coefficient of thermal expansion and a method of forming the same.

2. Prior Art

Hollow cylindrical ceramic bodies sealed at their ends by metal plates carrying switching contacts, with intermediate flange rings composed of an iron-nickel-cobalt alloy attached to the plates and vacuum-tightly sealed to the ceramic body are known, for example, from German Auslegeschrift 1,244,914. Such known vacuum switch housing members are composed of stellite (a ceramic talc material) and are metallized at both ends thereof to enable soldering of the flange rings thereon. The flange rings are suitably attached to the metal end plates, as by welding.

The solder connection or seal between flange rings and a ceramic body is relatively weak and cannot withstand thermal stresses. Even when the flange rings are composed of an iron-nickel-cobalt alloy, which is readily connected to a stellite body, difficulties are encountered because the coefficient of thermal expansion of the metal and the ceramic are dissimilar and temperature changes cause cracks or separations to occur in the area of contact. Further, there is insufficient adherence between the ceramic body and the metallized layer thereon so that a desired vacuum seal between the flange rings and the ceramic body cannot be properly attained.

In order to avoid the thermally caused stresses in such vacuum switch housing members, it would be desirable to form the insulator (housing) portion of such members of glass. However, glass has less mechanical strength than ceramic and accordingly the insulator portion is preferably composed of ceramic.

In order to avoid thermal stresses in housings having vacuum switches composed of ceramic and metal, prior art provided a sealing ring at the area of connection between the ceramic housing and the metallic end plate to balance the different coefficients of thermal expansion, for example, see German Auslegeschrift 1,267,305. However, such sealing rings are very expensive to produce and thus disadvantageous. Further, a metallizing of the ceramic body is required to enable the formation of a proper vacuum-tight connection between the sealing ring and the ceramic housing. However, ceramic bodies that are to be metallized must be formed of highly purified metal oxide ceramic materials. Such highly purified ceramic material are uneconomical and thus disadvantageous.

SUMMARY OF THE INVENTION

The invention provides a vacuum switch assembly including an economic housing composed of a ceramic sealed to metal portions without metallization of the ceramic. The contact area or seal between the ceramic and the metal portions is capable of safely withstanding mechanical and thermal stresses.

The invention generally comprises a hollow ceramic housing member joined to iron-nickel-cobalt alloy flange rings by a fused glass layer between the flange surfaces of the rings and the end surfaces of the ceramic housing so that the sealed area comprised of ceramic, glass and iron-nickel-cobalt alloy has a substantially balanced or uniform coefficient of thermal expansion.

In one specific embodiment of the invention, ceramic counter rings are attached, as by fusion, to the glass layer on the flange surfaces away from the ceramic housing to relieve any stresses between the ceramic-metal connections that may be developed during operation and thereby assure proper operation of a vacuum switch means within such a housing.

In its method embodiments, the invention generally comprises providing a layer of glazed or fused glass on at least one face of the flange surfaces of the flange rings, grinding the end surfaces of a ceramic housing for intimate contiguous contact with the glass layer, mounting the glass-coated flange rings onto the ground ceramic surfaces and placing the flange ring-ceramic housing assembly into an oven heated at a temperature sufficient to fuse the glass layer with the ground ceramic surface. Thereafter, metal end plates having switch contact means are attached, as by solder or welding, to the free ends of the flange rings and the so-assembled vacuum switch is ready for use. In embodiments where ceramic counter rings are utilized, they are attached to the flange surfaces in a substantially identical matter as set forth for attachment of the ceramic housing to such flange surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevated sectional view of an embodiment of a vacuum switch assembly constructed in accordance with the principles of the invention;

FIG. 2 is a somewhat similar view of another embodiment of a vacuum switch assembly of the invention, with portions omitted for sake of clarity; and,

FIG. 3 is an enlarged fragmentary view taken from the encircled portion III in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention provides a vacuum switch assembly comprised of a unitary hollow cylindrical housing member opened at both ends thereof and formed of a ceramic material. The ends of the cylindrical housing member are sealed with metallic end plates that are fused or glazed onto the ceramic member by an intermediate flange rings composed of an iron-nickel-cobalt alloy having a glass layer on at least the flange surface in contact with the housing member, as well as a method of producing the same.

The ceramic housing members of the invention do not need metallization thereof, maintain a vacuum-tight seal throughout vacuum switch operating conditions and are manufacturable from economically available ceramic materials. Further, the seal between the ceramic housing members and the alloy flange rings is capable of safely withstanding mechanical and thermal stresses normally encountered in vacuum switch operations. The ceramic material provides the desired mechanical strength and the coefficient of thermal expansion of ceramic, glass and the iron-nickel-cobalt alloy are sufficiently similar and/or balance against one another so as to withstand any thermal stresses encountered.

A notable feature of the invention is that no metallization of ceramic is needed in order to achieve a vacu-
um-tight connection between the ceramic member and the metallic members of the vacuum switch assembly. Nevertheless, ceramic can be utilized to provide the desired mechanical rigidity and strength to the assembly. Thus, the hollow cylindrical ceramic member can be formed of a relatively impure and economic ceramic material, for example, the ceramic material of the invention may comprise an Al₂O₃ ceramic material having only about 60% aluminum oxide therein.

In another embodiment of the invention, ceramic counter rings are provided on the flange surfaces of the flange rings away from the ceramic housing member to safely eliminate or avoid any minor residual stresses that may not be completely absorbed by the glass layer between the ceramic member and the flange rings. The ceramic counter rings are attached to the flange surfaces, as by fusing the glass layer on such flange surfaces with the mating surfaces of the counter rings. The counter rings cause a release or elimination of stress in the ceramic-metal connection or seal in a known manner and provide a guarantee that the vacuum switch assembly does not crack or separate at such seal area under operating condition and/or temperature changes.

The method embodiment of the invention includes applying a layer of glass onto at least one face of a flange ring surface, as by glazing in accordance with prior art methods. The end surfaces of the hollow ceramic member which are to contact the glass layer on the flange rings are ground for intimate contiguous contact with the glass layer. Of course, the grinding step may be omitted. Thereafter, the glass-coated flange rings are assembled with the ceramic member in the desired relation to each other and the thus formed assembly is placed in an oven heated to a temperature sufficient to fuse the glass layer with the adjacent contiguous ceramic surfaces. The oven is advantageously provided with an inert gas (N₂) atmosphere.

The finished vacuum switch assembly is obtained by soldering or welding metallic end plates having suitable switching contact means onto the upstanding or free ends of the flange rings.

Referring now to FIG. 1, wherein an embodiment of a vacuum switch assembly is illustrated and includes a hollow cylindrical member 1 composed of a ceramic material. The ends of the cylindrical member 1 are sealed from ambient atmosphere by metallic end plates 3. The plates 3 support suitable switch contact means 2, which may include a movable bellow-like portion 7 as well as a metallic protective wall 8, all of which are of minor significance to the invention. Accordingly, any prior art switch contact means constructed for operation in a vacuum switch assembly is suitable for use in accordance with the invention.

Flange rings 4 are provided between the end plates 3 and the ends of the cylindrical member. The flange rings 4 are composed of an iron-nickel-cobalt alloy and formed to have a vertical or upstanding ring portion and a horizontal or flange portion or surface. At least the face of the flange surface which is to contact the cylindrical member is provided with a layer 4a of glass. Of course, if desired the entire flange ring may be provided with a layer of glass. The glass forming layer 4a is selected so that its coefficient of thermal expansion is similar to the coefficient of thermal expansion of the ceramic material and the iron-nickel-cobalt alloy respectively. In this manner, a vacuum-tight fused ceramic-glass-metal seal or connection is attained without any metallization of the ceramic. Such a seal or connection is very stable under varying thermal and mechanical conditions.

In the embodiment illustrated at FIG. 2 ceramic counter rings 5 are provided on the flange surface faces away from the cylindrical member 1. As illustrated, both flange faces are provided with a layer of glass 4a. The ceramic counter ring 5 contacts 1 glass layer and the end surfaces of the ceramic member contacts and the other glass layer. The contiguous surfaces between the counter rings, the glass layers and the ceramic members are fused to one another so as to form a vacuum-tight seal. The counter rings 5 remove any possible stresses that might effect the seal between the ceramic members and the flange rings during temperature changes.

As is apparent from the foregoing specification, the invention is not limited to the exemplary embodiments discussed. The invention is susceptible of being embodied with various alterations, changes and modifications which may differ from those described hereinabove. For example, counter rings may be provided at only select ceramic-glass-metal seal areas, may be provided at all such seal areas or may be omitted altogether. Further, the metallic end plates may be attached to the flange rings by other means from those enumerated, etc. For this reason, it is to be fully understood that all the foregoing is intended to be merely illustrative and is not to be construed or interpreted as being restrictive or otherwise limiting of the present invention, excepting as is set forth and defined in the hereto-appended claims.

I claim:
1. A vacuum switch contact assembly comprising: a unitary hollow cylindrical member composed of a ceramic material and having flat end surfaces; a pair of metallic end plates for sealing the respective ends of said cylindrical member; switch contact means supported by said end plates;

a pair of flange rings composed of an iron-nickel-cobalt alloy in contact with said end plates and with said flat end surfaces of the cylindrical member, each of said flange rings having an upstanding surface in vacuum-tight contact with one of said end plates and a horizontal flat flange surface in contact with a flat end surface of said cylindrical member;
a pair of counter rings composed of a ceramic material, each of said counter rings having a flat end surface in contact with a flat flange surface of a flange ring away from said cylindrical flat end surface; and
layers of a glass having a coefficient of thermal expansion similar to the coefficient of thermal expansion of said ceramic material and said iron-nickel-cobalt alloy, said layers being located between contiguous flange ring and cylindrical member flat end surfaces and between contiguous flange ring and counter ring end surfaces respectively, so as to form a vacuum-tight seal between said end surfaces.

* * * * *