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VACUUM SEAL FOR A THIN BERYLLIUM X-RAY WINDOW

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FIG. 2

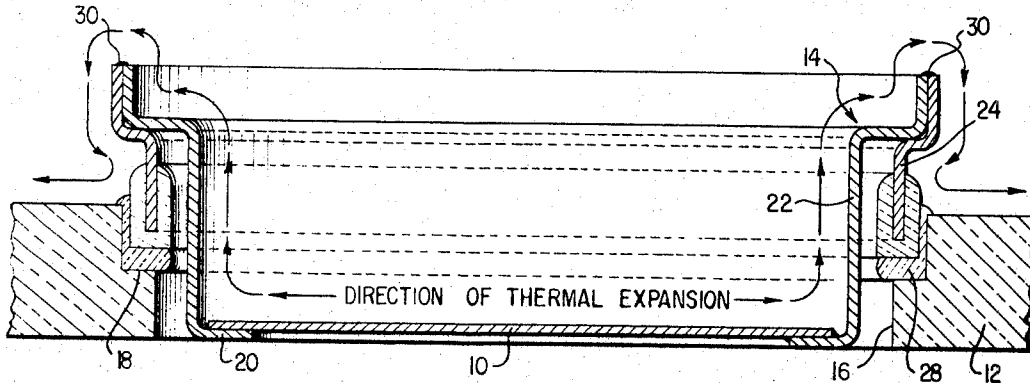


FIG. 1

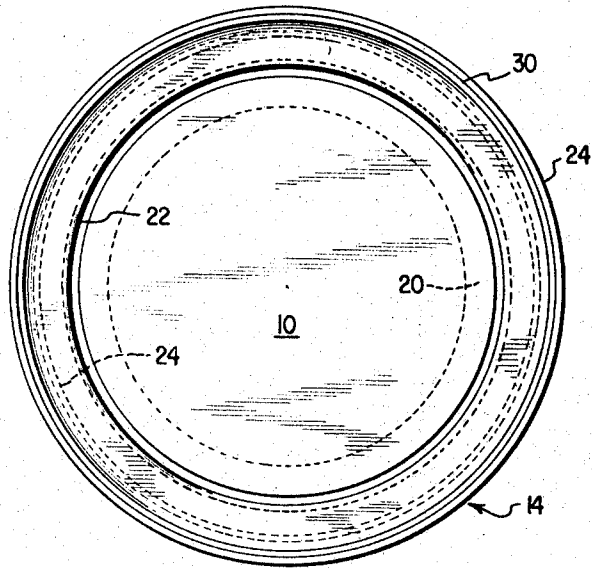
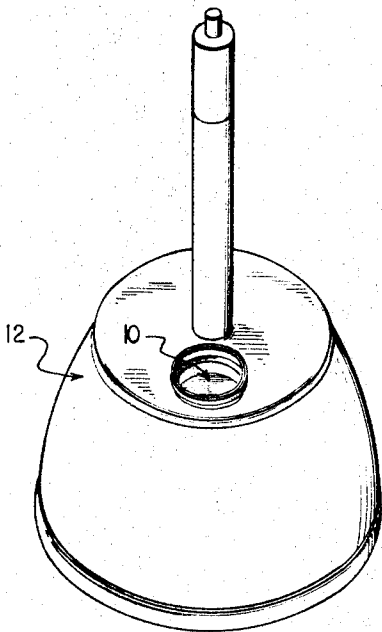


FIG. 3

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VACUUM SEAL FOR A THIN BERYLLIUM X-RAY WINDOW

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ABSTRACT OF THE DISCLOSURE

The invention pertains to a permanent vacuum-tight seal for beryllium windows used in X-ray apparatus. The sealing members allow for unequal expansion of parts without undue stress.

This invention relates to a support which has the characteristic of compensating for differentials in thermal expansion and more particularly to an improved support for permanently sealing a window in an X-ray device.

While there are undoubtedly many areas in which a support possessing the characteristic of compensating for differential thermal expansion can be utilized, I have found the application of the support to a window in an X-ray device to be of particular significance.

Since the discovery of X-rays, one of the major problems in the development of the X-ray tube art has been the transmission of X-rays through the tube wall. X-ray tube housings are constructed so as to contain all of the X-radiation with the exception of the particular core of radiation permitted to escape from the housing through a low X-ray absorption window.

The search for an efficient low X-ray absorption window began when A. F. and F. A. Lindemann devised the so-called Lindemann glass. Since then various other materials have been used for X-ray windows, such as cellophane, aluminum foil, and beryllium. The advantage of using beryllium possessing a low specific density and one of the lowest mass absorption coefficients per unit thickness is well known. Beryllium, however, also possesses a much higher coefficient of linear thermal expansion than glass. This variance in linear thermal expansion presents a major obstacle to the making of vacuum-tight seals of thin beryllium to glass envelopes, due to the likelihood of resulting breakage of the glass and seal. Consequently, permanent beryllium to glass seals capable of withstanding the large temperature variations of tube processing have been difficult to obtain. The severity of the problem is even greater as the diameter of the window increases.

While demountable mechanical seals for beryllium windows, utilizing soft metal gaskets to provide vacuum tightness, have been used in the past with some degree of success, they possess the disadvantages of high cost, consumption of space and lack of reliability.

In accordance with the present invention, these and other disadvantages of the prior art are overcome by the provision of a support providing a permanent vacuum-tight seal in which differences in thermal expansion between the materials sealed are attenuated.

Accordingly, it is a principal object of the present invention to provide a permanent seal which compensates for differentials in thermal expansion.

It is an object of the present invention to provide a support for a window in a housing which compensates for the difference in thermal expansion between the window and the housing.

It is an object of the present invention to provide a seal between a window having a high coefficient of ex-

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pansion and a body having a comparatively low coefficient of expansion.

It is an object of the present invention to permanently seal a large thin beryllium disc in a soft glass envelope.

It is an object of the present invention to provide a permanent vacuum-tight seal for a beryllium window in a soft glass envelope without the use of nuts and bolts and without the use of secondary seals or without the necessity of placing the beryllium behind another glass or mica panel.

It is an object of the present invention to provide a permanent seal for a beryllium window in a glass envelope which will withstand heat cycling from 0° to 425° C.

It is an object of the present invention to provide a permanent vacuum-tight seal for a beryllium window in a glass envelope wherein the sealing alloys and the geometrical design of the mating parts absorb the thermal expansion from beryllium to soft glass.

It is another object of the present invention to provide a permanent vacuum-tight seal capable of attenuating a coefficient of thermal expansion from 150×10^{-6} to 89×10^{-6} .

It is another object of the present invention to provide a permanent vacuum-tight seal for a beryllium window in a glass envelope wherein the material comprising the portion of the support providing the seal in direct contact with the beryllium has a coefficient of expansion approximately equal to the coefficient of expansion of the beryllium and the material comprising the portion of the support providing the seal in contact with the glass envelope has a coefficient of expansion approximately equal to the coefficient of expansion of the glass envelope.

It is another object of the present invention to provide a permanent vacuum-tight seal for a beryllium window in a glass envelope as described in the preceding paragraph wherein the expansion is attenuated by converting the linear expansion from the major axis of the beryllium window to the minor axis of the glass envelope through one or more 90° bends and long lines.

Other detailed objects and advantages of the present invention will become apparent from the following description of the present embodiment thereof, taken in conjunction with the drawings which accompany and form part of the specification.

In the drawings:

FIGURE 1 shows an embodiment of the present invention in a color television tube.

FIGURE 2 is a fragmentary sectional view of a structure made in accordance with the invention; and

FIGURE 3 is a plan view of the structure shown in FIGURE 2.

As shown in the drawings, a seal is provided for a window in a body, wherein the body has a low coefficient of expansion as compared to the window.

Referring to the drawings, numeral 10 denotes a beryllium window sealed in a glass envelope 12, such as a cathode ray tube used in color television. Although the glass used for TB tube envelopes provides satisfactory shielding from X-rays for operators and spectators, the thermal expansion of the glass is no match for a beryllium window. The coefficient of thermal expansion of glass is 89×10^{-6} as compared to 150×10^{-6} for beryllium. This is a 60% mismatch. Obviously, in order to permanently seal the beryllium window in the glass envelope it is necessary to provide some intermediate means for absorbing this high differential and thus avoid excessive strain and glass breakage during processing heat cycles of 30 to 400° C. I have found that breakage of the glass and the seal can be prevented by a seal having a geometrical design capable of absorbing the thermal expansion for beryllium to soft glass.

In my improved structure I have provided a frame 14 for mounting the beryllium window 10 in the glass envelope 12. The frame 14 is of such a configuration as to attenuate the difference in thermal expansion between the envelope and the window by converting the linear expansion from the major axis of the window to the minor axis of the envelope through one or more 90° bends and long lines.

The envelope 12 has an opening 16 therein. An annular recess 18 is provided about the opening 16 on the outer side of the envelope in which recess the frame 14 is mounted supporting the window across the opening.

The frame 14 has a circular flange 20 with a central opening therein. A thin sheet beryllium member 10 is mounted across the opening and has its edges overlapping and sealed to the circular flange 20.

The frame 14 is composed of a member 22 having a coefficient of expansion substantially the same or at least compatible to that of the window 10 and a member 24 having a coefficient of expansion substantially the same or at least compatible to that of the envelope 12.

In the present embodiment of the invention employing a beryllium window 10, the member 22 is made of a cupro-nickel alloy of the Monel type which has a thermal coefficient of expansion approaching that of beryllium. The beryllium window is sealed to the circular flange 20 of member 22 with a vacuum-tight seal by brazing.

The member 24 on the other hand is made of a chrome-nickel-iron alloy such as Sylvania #4 which has a thermal coefficient of expansion compatible with TV bulb glass. Member 24 is sealed in the annular recess 18 of the glass envelope with a vacuum-tight seal by a glass frit seal 28.

One of the essential features of the present invention is the configuration of frame members 22 and 24. Frame member 22 extends outward from the circular flange 20 and the surface of the envelope on a line perpendicular to the major axis of the window and the envelope surface, a distance at least equal to the radius of the beryllium seal. Member 22 is then provided with a right angle extending outward from its own central axis on a line parallel to the major axis of the window and the envelope surface until it comes in contact with member 24 extending outward from the recess of the envelope 18 and the frit seal 28 along the minor axis of the envelope surface at which point member 24 takes a right angle in order to conform with the surface of member 22, both members then join in a right angle extending outward from their own central axis and then outward perpendicular to the major axis of the envelope surface. Members 22 and 24 are heliarc welded together along their juncture 30 forming a vacuum-tight seal. It is noted that the juncture of members 22 and 24 is out of contact with the shoulder of the frit seal 28 allowing maximum flexibility of the frame.

The extension of the window frame along the minor axis of the surface of the beryllium window and the surface of the envelope, or in other words in a direction perpendicular to the major axis of the beryllium window and envelope surface, in combination with the matching of the thermal coefficient of expansion of frame members to the window and envelope as well as perfect annealing, provides for the absorption of the difference in thermal expansion between the glass envelope and the beryllium window.

Another factor that contributes to the success of my invention is the fact that tubes in which the structure is employed are normally under vacuum. Since the longest portion of the attenuation path is along the portions of the frame member extending outward perpendicular from the envelope surface, the vacuum tends to further attenuate the thermal expansion along this path.

While the present embodiment of the invention illustrated relates particularly to the sealing of a window having a high thermal coefficient of expansion in an enve-

lope having a low thermal coefficient of expansion, my invention can be easily adapted to a window having a low thermal coefficient of expansion in an envelope having a high thermal coefficient by providing a frame having members with interchanged characteristics so that the thermal expansion of the major axis of the envelope will be attenuated and applied to the minor axis of the window. I am aware that many other modifications thereof may be made without departing from the spirit of the invention. It is therefore appropriate that the appended claims be accorded that broad interpretation as is consistent with the spirit and scope of the invention.

What is claimed is:

1. A support providing a permanent vacuum-tight seal for a window having a substantially different thermal coefficient of expansion than the envelope in whose aperture it is mounted, comprising a frame means having a first and second member, the first of said members having an opening therethrough, said window extending across said opening with the peripheral edges thereof conforming with and sealed to the surface of said member forming said opening, said first member having substantially the same coefficient of expansion as said window, a peripheral edge of said second member conforming with and sealed to the surface of said envelope aperture, said second member having substantially the same coefficient of expansion as said envelope, said first and second members being joined together in a vacuum-tight seal along an edge remote from said window and said opening, said frame means being of such a geometrical configuration as to attenuate the differences in thermal expansion between the window and the envelope.

2. A support providing a permanent vacuum-tight seal for a window having a substantially higher coefficient of expansion than the envelope in whose aperture it is mounted, comprising a frame means having a first and second member, the first of said members having a circular flange with a central opening therein, said window extending across said opening with the peripheral edges thereof conforming with and sealed to the surface of said flange, said first member having substantially the same coefficient of expansion as said window, an annular recess about said aperture on the outer side of said envelope, a peripheral edge of said second member conforming with and sealed to the surface of said recess, said second member having substantially the same coefficient of expansion as said envelope, and said first and second members being joined together in a vacuum-tight seal along the edges remote from said window and said envelope.

3. A support as defined in claim 2, wherein a portion of said first member extends outward from and perpendicular to the major axis of said window and envelope surfaces a distance equal to at least half the distance across the window.

4. A support as defined in claim 3, wherein at the end of the portion of said first member extending outward from and perpendicular to the major axis of said window and envelope surfaces, said first member is provided with a right angle extending outward from its own central axis on a line parallel to the major axis of the window and the envelope surface until it comes in contact with said second member extending outward from said recess along the minor axis of the envelope surface, at which point both members then join in a right angle extending outward from their own central axis and then outward perpendicular to the major axis of the envelope surface.

5. An X-ray device including a sealed envelope, an aperture in said envelope, a window, a frame means having a first and second member, the first of said members having a circular flange with a central opening therein, said window extending across said opening with the peripheral edges thereof conforming with and sealed to the surface of said flange, said first member having substantially the same coefficient of expansion as said

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window, an annular recess about said aperture on the outer side of said envelope, a peripheral edge of said second member conforming with and sealed to the surface of said recess, said second member having substantially the same coefficient of expansion as said envelope, said first and second members being joined together in a vacuum-tight seal along their edges remote from said window and said envelope, and a vacuum contained within said envelope cooperating with said frame member so as to attenuate the differences in thermal expansion between the window and the envelope.

6. An X-ray device as defined in claim 5, wherein a portion of said first member extends outward from and perpendicular to the major axis of said window and envelope surfaces a distance equal to at least half the distance across the window.

7. An X-ray device as defined in claim 6, wherein the peripheral edge of said second member conforming with

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and sealed to the surface of said recess about said aperture on the outer side of the said envelope lies along the minor axis of said window and envelope surfaces.

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