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[54] **THERMAL COMPENSATING MOUNT**

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Related U.S. Application Data

[63] Continuation of Ser. No. 168,065, Mar. 14, 1988, abandoned.

[51] **Int. Cl.**[4] **G02B 7/18;** G02B 27/64

[52] **U.S. Cl.** **350/287;** 350/500

[58] **Field of Search** 350/287, 286, 500, 533, 350/588, 252, 631, 253, 254

[56] **References Cited**

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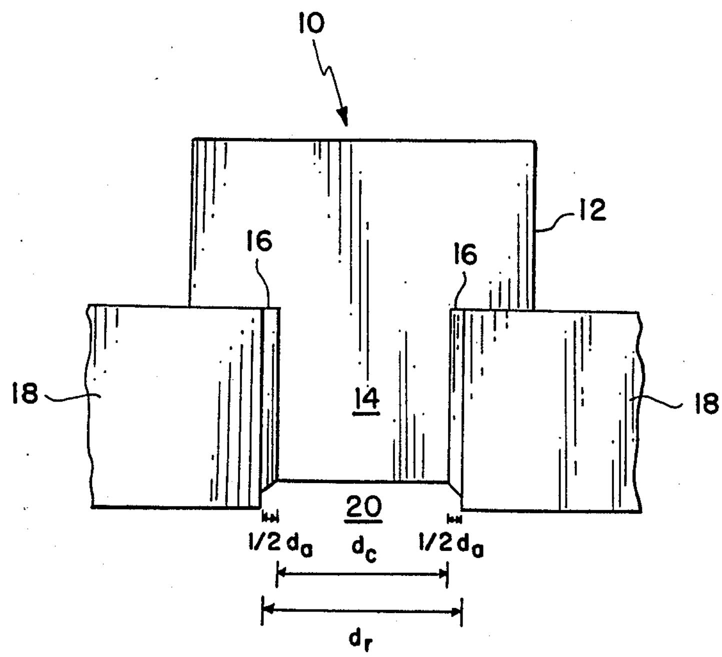
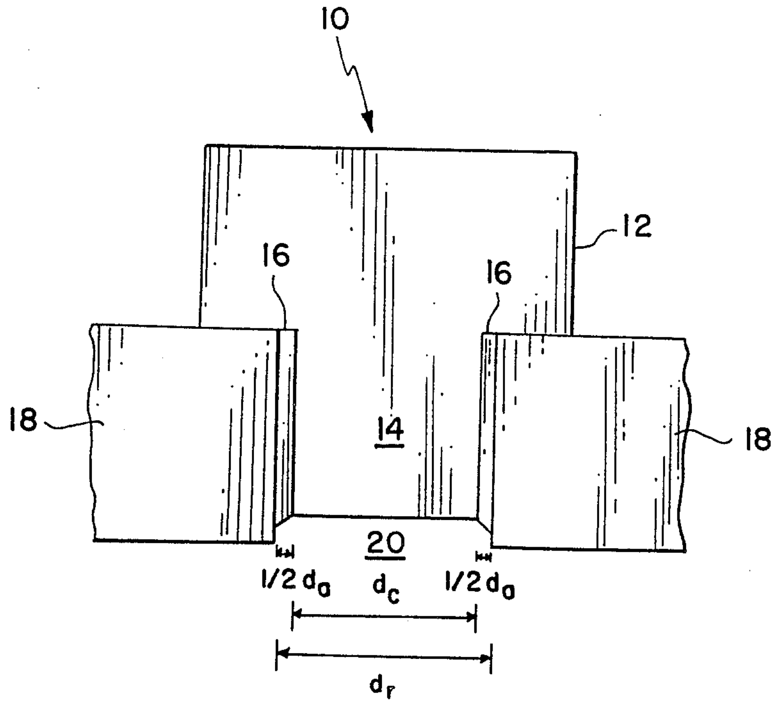
[57] **ABSTRACT**

A thermal compensating mount **10** is provided for an alignment sensitive component **12.** Thermal compensating **10** mount comprises a cylindrical extension **14** which is formed integral to and has the same coefficient of thermal expansion as alignment sensitive component **12.** A cylindrical receptacle **20** is formed into mounting surface **18.** Cylindrical extension **14** secured within cylindrical receptacle **20** that surrounds the cylindrical extension. The difference between the diameter of cylindrical extension **14** and cylindrical receptacle **20** is such that the differential thermal expansion across cylindrical extension **14** and the edges of cylindrical receptacle **20** is exactly compensated for by the thermal expansion of the surrounding adhesive **16.**

4 Claims, 1 Drawing Sheet




10
12
16
16
18
18
14
20
1/2 d_a
d_c
1/2 d_a
d_r

THERMAL COMPENSATING MOUNT

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part application of Ser. No. 07/168,065, Filed Mar. 14, 1988, now abandoned.

ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA Contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, as amended, Public Law 85-568 (72 Stat. 435; 42 USC 2457).

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to support structures for alignment sensitive components and more particularly to a thermal compensating mount for such components.

BACKGROUND OF THE INVENTION

Certain components such as optical components must maintain their alignmental integrity in order to be effective. A change in the ambient temperature can result in thermal expansion or contraction of the device and/or its mounting surface. Accordingly, lateral and/or angular displacements of the alignment sensitive component result. For example, optical components such as laser optical-path folding prisms are fixed to the mounting surface by a small amount of epoxy adhesive. When a change in temperature occurs, the unequal temperature coefficients of expansion of the prism, adhesive and mount cause undesirable angular and lateral displacements of the prism.

Accordingly, it is an object of this invention to provide a device for maintaining the alignmental integrity of an alignment sensitive component over a wide range of temperatures.

It is a further object of this invention to accomplish the above result simply and inexpensively.

SUMMARY OF THE INVENTION

According to the present invention, the foregoing and additional objects are obtained by providing a thermal compensating mount. A cylindrical extension is integrally formed to the alignment sensitive component. Both the extension and component share the same coefficient of thermal expansion. The cylindrical extension is placed into a cylindrical receptacle in a mounting structure which has a diameter greater than that of the extension. An adhesive secures the cylindrical extension to the mount. The difference between the diameters of the cylindrical extension and the cylindrical receptacle is such that the differential thermal expansion across the extension and the receptacle edges is exactly compensated for by the thermal compensation of the adhesive between them. Accordingly, the alignment sensitive component does not change position when subjected to temperature variations.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent in the specification and drawings wherein:

FIG. 1 is a pictoral view of the thermal compensating mount.

DETAILED DESCRIPTION OF THE INVENTION

As illustrated in FIG. 1, a thermal compensating mount **10** for an alignment sensitive component **12** is seen to comprise a cylindrical extension **14**, an adhesive **16**, a mounting surface **18**, and a cylindrical receptacle **20**.

Cylindrical extension **14** is integrally formed to alignment sensitive component **12** to aid in the alignment stability. Cylindrical extension **14** is composed of either the same material as alignment sensitive component **12** or a material with equivalent thermal expansion properties. The cylindrical shape of cylindrical extension **14** results in symmetrical expansion and flexibility in the azimuthal direction of alignment sensitive component **12**.

The sizing of cylindrical extension **14** depends upon the size of the alignment sensitive component **12**. The height of cylindrical extension **14** should be minimized. Accordingly, the diameter d_c of cylindrical extension **14** is the design parameter which provides support for alignment sensitive component **12**.

Cylindrical extension **14** is placed concentrically into a cylindrical receptacle **20** which is provided in mounting surface **18**. Adhesive **16** surrounds and secures cylindrical extension **14** within the cylindrical receptacle **20**. When a change in temperature occurs, misalignment of alignment sensitive component **10** will result unless the thermal expansion properties of cylindrical extension **14**, mounting surface **18**, and adhesive **16** are considered. To have no misalignment of alignment sensitive component **12**, the thermal expansion of mounting surface **18** must be equal to the combined thermal expansion of cylindrical extension **14** and adhesive **16**. Thus, stresses which cause misalignment may be avoided since the entire thermal compensating mount expands on contact at the same rate. The desired relationship may be expressed by

$$A_r*2(t_{cm})=A_c*2(t_{cc})+A_a*2(t_{ca}) \quad (1)$$

which may be simplified to read where

A_r is the area of cylindrical receptacle **20**,

A_c is the area of cylindrical extension **14**

A_a is the area of the gap between cylindrical receptacle **20** and cylindrical extension **14** which is filled by adhesive **16**,

t_{cm} is the coefficient of thermal expansion for mounting surface **20**,

t_{cc} is the coefficient of thermal expansion for cylindrical extension **14**, and

t_{ca} is the coefficient of thermal expansion for adhesive **16**. Obviously,

$$A_a=A_r-A_c \quad (2)$$

combining equations (1) and (2),

$$A_r*t_{cm}=A_c+t_{cc}+(A_r-A_c)*t_{ca} \quad (3)$$

Since A_c is the design parameter for cylindrical extension **14** (see discussion above), it is helpful to express diameter A_r of cylindrical receptacle **20** in terms of A_c. Dividing both side of equation (3) by t_{cm}, we obtain

$$A_r = \frac{A_c * t_{cc} + (A_r - A_c) * t_{ca}}{t_{cm}} \quad (4)$$

Collect A_r, terms, we obtain

$$A_r - A_r * \frac{t_{ca}}{t_{cm}} = A_c * \left[\frac{t_{cc} - t_{ca}}{t_{cm}}\right] \quad (5)$$

or

$$A_r * \left[1 \frac{t_{ca}}{t_{cm}}\right] = A_c * \left[\frac{t_{cc} - t_{ca}}{t_{cm}}\right] \quad (6)$$

Solving for A_r, we obtain

$$A_r = \frac{A_c * \left[\frac{t_{cc} - t_{ca}}{t_{cm}}\right]}{\left[1 = \frac{t_{ca}}{t_{cm}}\right]} \quad (7)$$

or

$$A_r = A_c * \left[\frac{t_{cc} - t_{ca}}{t_{cm} - t_{ca}}\right] \quad (8)$$

or

$$d_r = d_c * \text{SQR}\left[\frac{t_{cc} - t_{ca}}{t_{cm} - t_{ca}}\right] \quad (9)$$

Thus, mounting surface **18** is provided with a cylindrical receptacle **20** with a diameter d_r.

In a particular embodiment of the present invention, alignment sensitive component **12** is a quartz prism for folding the optical path of laser. Cylindrical extension **14** has a diameter d_c of 10 millimeters. The coefficient of thermal expansion of quartz in $0.4\times10E^{-6}$/deg. C. The mounting surface **18** is aluminum, which has a coefficient of thermal expansion of $24\times10E^{-6}$/deg. C. The adhesive **16** may be any commercially available adhesive with sufficient strength to support alignment sensitive component **12**. For example, this adhesive may have a coefficient of thermal expansion of $90\times10E^{-6}$/deg. C. Substituting these values into equation (9), we obtain

$$d_r = 10 \text{ mm} * \text{SQR}\left[\frac{0.4 \times 10E^{-6} - 90 \times 10E^{-6}}{24 \times 10E^{-6} - 90 \times 10E^{-6}}\right] \quad (10)$$

or, approximately

$$d_r = 11.65 \text{ mm} \quad (11)$$

Thus cylindrical receptacle **20** requires a diameter of 11.65 mm. Such a sizing according to equation (9) maintains the alignment integrity of the quartz prism. A misalignment of only a few microradians of the quartz prism results in a significant drop in the gain of a laser. Thus, the present invention allows a laser to be utilized in environments characterized by changes in ambient temperature. For example, a laser on a vehicle which operates in an orbital path around the earth will undergo temperature changes of a few degrees Celsius as the vehicle travels from the dark to the light side of the earth. The present invention compensates for any expansion or contraction caused by these thermal changes.

What is claimed is:

1. A thermally compensating mount for an alignment sensitive component comprising:
   - a cylindrical extension integrally formed to the alignment sensitive component and having the same coefficient of thermal expansion as the component;
   - a mounting structure;
   - a cylindrical receptacle in said mounting structure which has a diameter d_r determined by the following equation:

$$d_r = d_c * \sqrt{\left(\frac{t_{cc} - t_{ca}}{t_{cm} - t_{cc}},\right)}$$

where d_c is the diameter of said cylindrical extension and t_{cc}, t_{ca} and t_{cm} are the respective coefficients of thermal expansion for said cylindrical extension, a means for adhering, and said mounting structure; and
   - a means for placing said means for adhering between said cylindrical extension and said cylindrical receptacle.

2. The mount of claim **1** wherein said alignment sensitive component is quartz.

3. The mount of claim **2** wherein said cylindrical extension is quartz.

4. The mount of claim **1** wherein said mounting structure is aluminum.

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