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HIGH RESONANCE ADJUSTABLE MIRROR MOUNTS

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ABSTRACT

This paper presents two designs of adjustable mounts for high quality zerodur mirrors using stainless steel and aluminum hardware to meet stringent resonance and stability requirements. The mount for small-size mirrors uses an improved version of the traditional tangent-bar mounting scheme. This mount also provides the capability to move the mirror axially, in real-time, to control optical system characteristics. The second design is especially suitable for relatively large and heavy mirrors, and employs spherical bearings in place of flexured tangent bars. This alleviates the problem of mirror surface distortions due to reaction loads resulting from bending of the flexures. This mirror is also spring-loaded to minimize the surface distortions due to its own weight.

1. INTRODUCTION

The optimum optical mounts in high performance laser and electro-optical systems must provide fine alignment capability over a large range. The mounts must also have high resonance to retain optical image quality in the presence of system and environmental vibrations, and should have high stability to maintain alignment under shock loads during shipping and operation. Finally, the mounting configuration should also provide thermal compensation to retain the system alignment under varying ambient temperature.

Traditionally, mirrors have been mounted in cells or housings using well known tangent bar techniques[1]. The three tangent bars are equally spaced on the periphery of the mirror, each bar having a thin section to make it compliant in bending. Such a technique does provide an effective way to mount a mirror but has drawbacks. Namely, resonance of the mount has to be sacrificed to keep the distortion loads on the mirror, due to bending of the flexure blades, within an acceptable range. This problem is very significant in mounting large and heavy mirror_, and renders tangent bars unusable for such applications, since the flexures required to achieve the desired high resonance are inherently very stiff in bending. While they achieve a high resonance, the flexured tangent bars introduce excessive distortion loads into the mirror when it is adjusted axially or in tilt, or due to differential thermal expansion between the mirror and its housing. A number of other techniques for mounting large mirrors are described in references 2 and 3, but these mounting arrangements either do not provide adjustment capability for alignment purposes, or do not have high enough resonance to meet the requirements of high performance optical systems.

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2. ADJUSTABLE MOUNT FOR SMALL MIRRORS

Figure 1 illustrates a zerodur mirror mounted into an aluminum housing with three tangent bars. Each tangent bar has a pair of mutually orthogonal circular flexures at both ends. Based on the required resonance and weight of the mirror, the stiffness of these circular blades can be calculated by using the equations given in reference 4. These tangent bars have a very high axial stiffness and a very low bending stiffness. This mounting arrangement thus provides a very high resonance in the plane of the mirror, but allows the mirror to be tilted or moved axially without producing undesirable distortions in the mirror.

The micrometers, which act through the housing on the free ends of tangent bars as shown in Figure 2, provide the axial and tilt adjustments. These micrometers are acting against the spring-loaded invar buttons bonded to the mirror. This spring force is determined by the shock load requirements. Figure 3 is a side sectional view of the mirror assembly showing the mirror housing suspended by four long flexure blades. These flexures provide a support system which has high resonance frequency in the plane of the mirror, and also resists the torsional movement. This arrangement allows us to move the mirror along the optical axis for pure focus adjustment. A linear electro-mechanical actuator is used to move the mirror housing relative to the support structure, and the axial movement is monitored by a capacitance gage. A closed-loop servo system is used to move the mirror axially, in real-time, to control the system magnification without producing any misalignment.

3. ADJUSTABLE MOUNT FOR LARGE MIRRORS

A mirror is mounted to an aluminum housing through three tangent bars as illustrated in figure 4. Each tangent bar has two mutually orthogonal spherical bearing at each end. The advantage of using spherical bearings in place of flexure blades is that these bearings provide large angular motions with minimum friction and no bending moment. Figure 5 shows a typical sectional view through the end of a tangent bar attached to the mirror. A differential micrometer is acting against a spring-loaded invar button bonded to the mirror for making the axial and tilt adjustments.

The six spring assemblies, equally spaced on the mirror circumference, are provided to support the weight of the mirror. Three springs on the top half are tension springs pulling the mirror up, while the springs on the lower half are compression springs to push the mirror up. This loading arrangement minimizes the surface figure distortions due to self-weight of the mirror.

4. CONCLUSION

The two mirror mounts presented here are very versatile and can be employed in those optical systems, which require submicron adjustment capabilities to optimize their performance. Moreover, these methods allow us to use aluminum and steel hardware machined to fairly loose tolerances. These mounts have high resonance and are very stable against shock loads, and also are thermally compensated to retain the system alignments under changing ambient temperature.

5. ACKNOWLEDGEMENT

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6. REFERENCES

1. Chin, D., " Optical Mirror Mount Design & Philosophy", **Applied Optics**, Vol. 3, No. 7, pp. 895, July 1964.

2. Kowalskie, B. J., "A User's Guide to Designing & Mounting Lenses & Mirrors", **OSA Optical Fabrication & Testing Workshop**, 1980.

3. Crawford, D. L., Support & Testing of Large Astronomical Mirrors, **Kitt Peak National Observatory**, 1968.

4. Paros, J. M. and Weisbord, L., "How to Design Flexure Hinges", **Machine Design**, pp. 151-156, November 15, 1965.

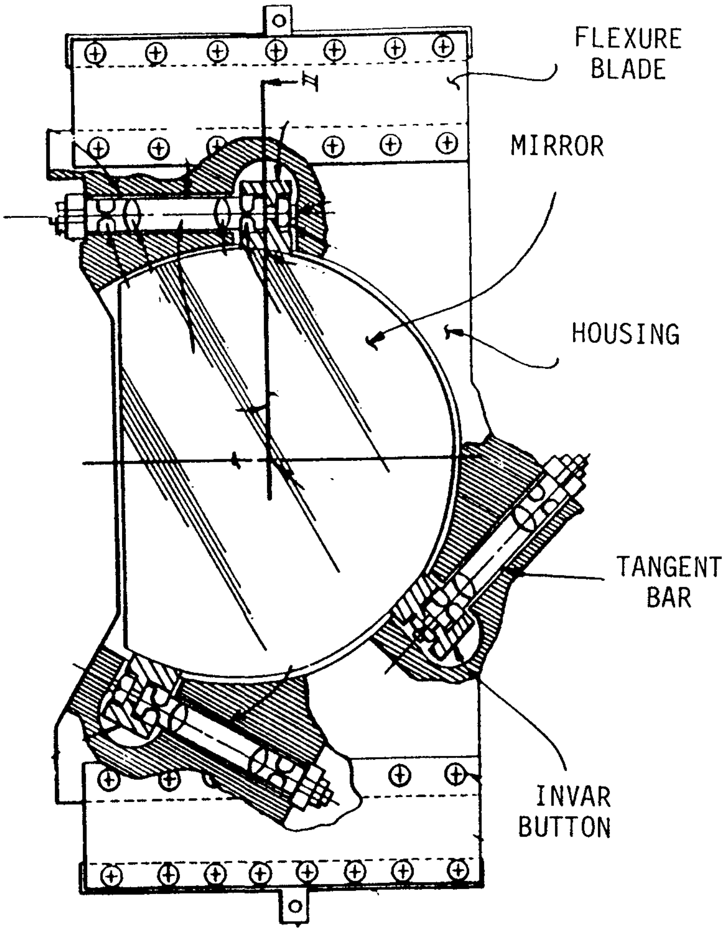

FIGURE 1 SMALL MIRROR MOUNT

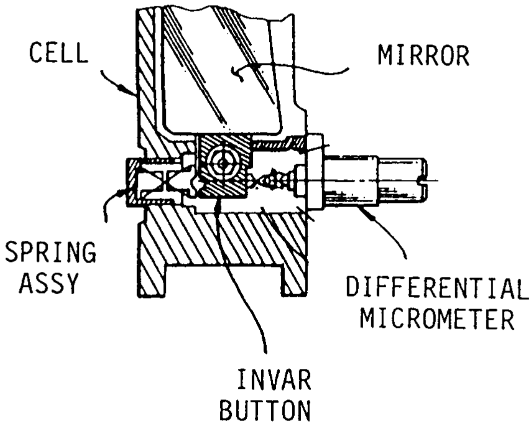

FIGURE 2 ADJUSTMENT SCHEME

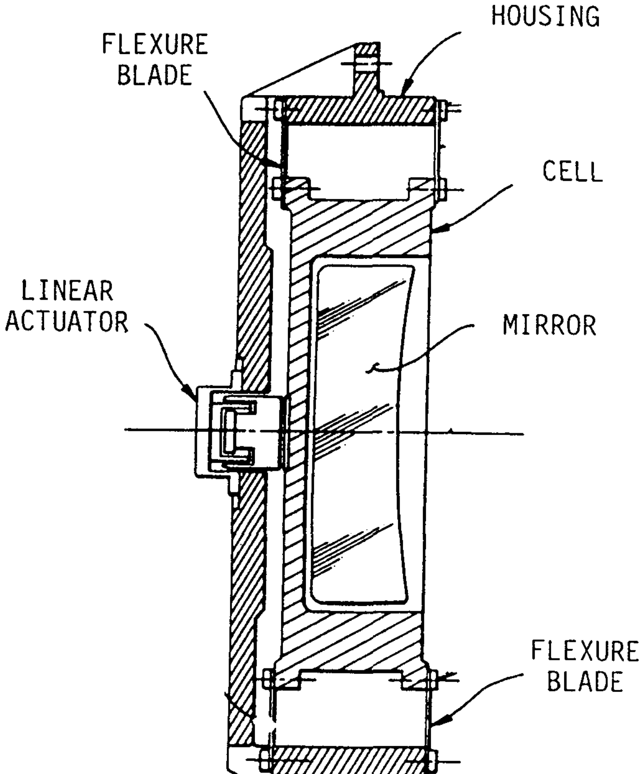

FIGURE 3 FOCUS ADJUSTMENT

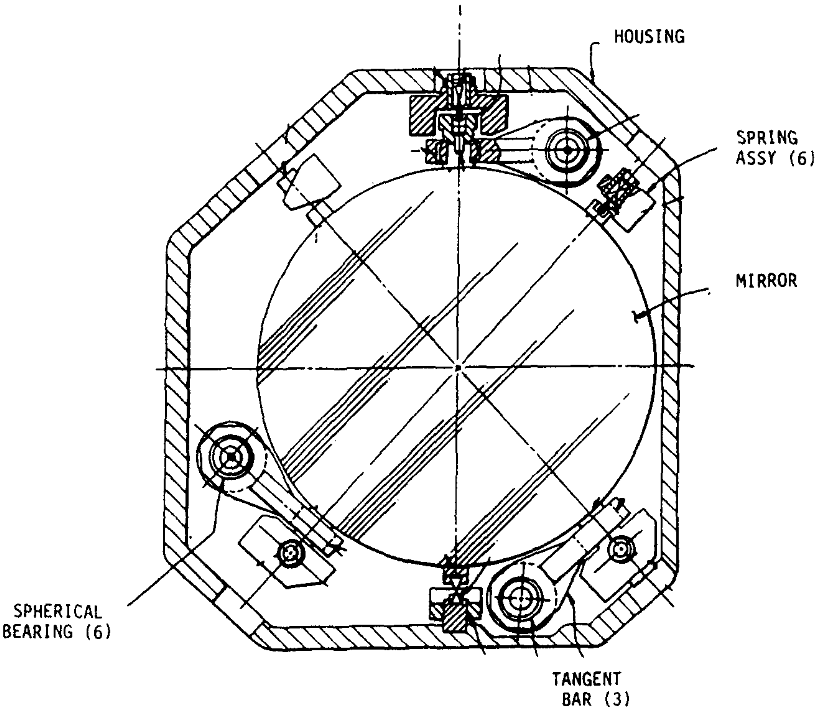

FIGURE 4 LARGE MIRROR MOUNT

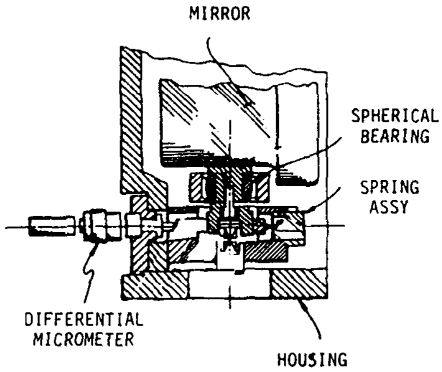

FIGURE 5 ADJUSTMENT SCHEME