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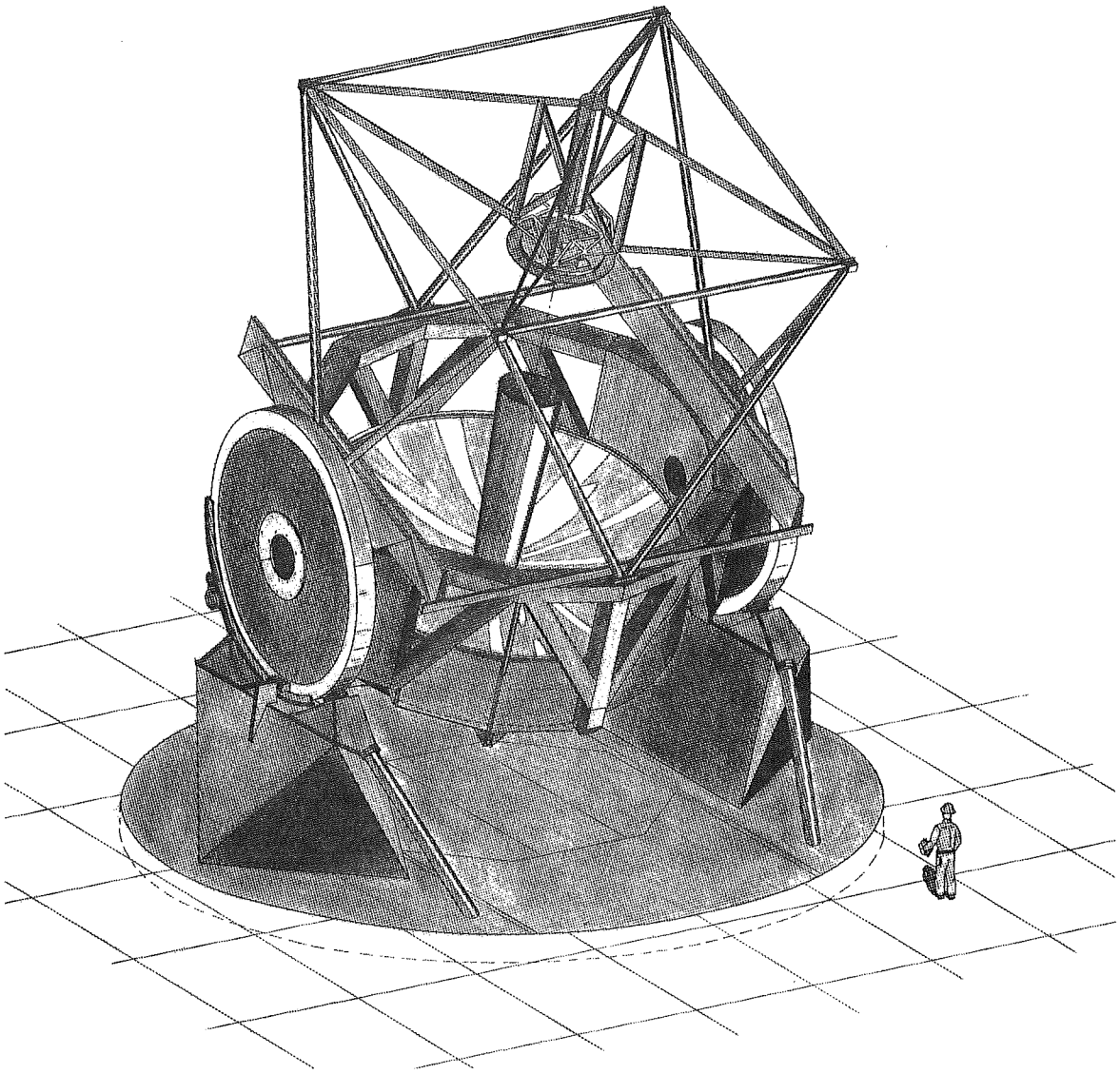

Performance of a Prototype Focus/Collimation Actuator

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INTRODUCTION

Servo controlled actuators will be used to position the secondary mirror of the Magellan Project Telescope for focus and collimation. These actuators were originally described in Magellan Report No. 13. Since the publication of that report, a prototype actuator has been built and tested in the Santa Barbara Street lab. This report presents a summary description of the as-built actuator and the resulting performance data.

ACTUATOR DESCRIPTION

Figure 1 is an assembly drawing of the actuator. A roller screw is the central element of the actuator, with the nut driven by a friction disk and capstan. In this arrangement, only the nut rotates, while the screw advances or retracts with a 1 mm pitch over a total stroke of 10 mm. The screw is supported at one end by a type X bearing, and at the other end by an arrangement of flexures that restrict the screw motion to translation only.

The design includes an LVDT to measure the position of the screw relative to the actuator body. In practice, this sensor would be used to center the actuator at start-up and as a end of travel sensor. For the lab tests, the LVDT was used as a high resolution (0.01 um) position sensor. Not shown is a glass-scale indicating head that is used for stable, low resolution (1 um) position measurements.

A simple, robust servo was closed around both the drive motor tachometer and the LVDT. This servo has no particular demands placed on it except that it have "adequate" repeatability and that it not pass excessive high frequency noise (for the sake of the bearing and roller screw). The results presented below show that the repeatability is more than adequate for positioning a secondary mirror.

ACTUATOR CHARACTERISTICS

For the performance tests, the actuator was loaded in tension with 1000 lbs. Figure 2 is a photograph of the actuator in the test setup. The main characteristics of the actuator are listed below.

Stroke . . . . . +-5 mm

Weight, including motor . . . . . 46 lbs.

Maximum tension load	1300 lbs.[1]
Maximum compression load	200 lbs.[2]
Axial stiffness	385,000 lbs./in.
Motor static power dissipation	< 0.04 watt[3]
Positioning resolution and repeatability	< 0.03 um[4]
LVDT zero drift (0-25 degrees C)	+-2.5 um[5]
As-built closed-loop positioning bandwidth	0.8 Hz[6]

POSSIBLE IMPROVEMENTS

If needed, this actuator could perform with considerably higher bandwidth than was demonstrated in the lab tests. The present closed-loop bandwidth is limited entirely by the servo electronics. With different electronics, the actuator should easily be capable of a 10 Hz small signal bandwith, and possibly quite a bit more. In this event, care should be taken to avoid premature wear in the bearing and roller screw due to repetitive small amplitude motions.

The maximum tension load is currently limited to 1300 lbs. by the support bearing. The

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[1] Tension load is limited by bearing capacity. Roller screw capacity is 7000 lbs. static, 4000 lbs. dynamic.

[2] Compression load limited by internal spring preload.

[3] To hold a position, the motor need not apply any torque since the roller screw is self locking.

[4] Positioning resolution and repeatability are measured by the LVDT when the LVDT is used as feedback sensor. These results indicate the performance of the actuator mechanism and servo electronics and do not reflect the substantial thermal drift of the LVDT electronics.

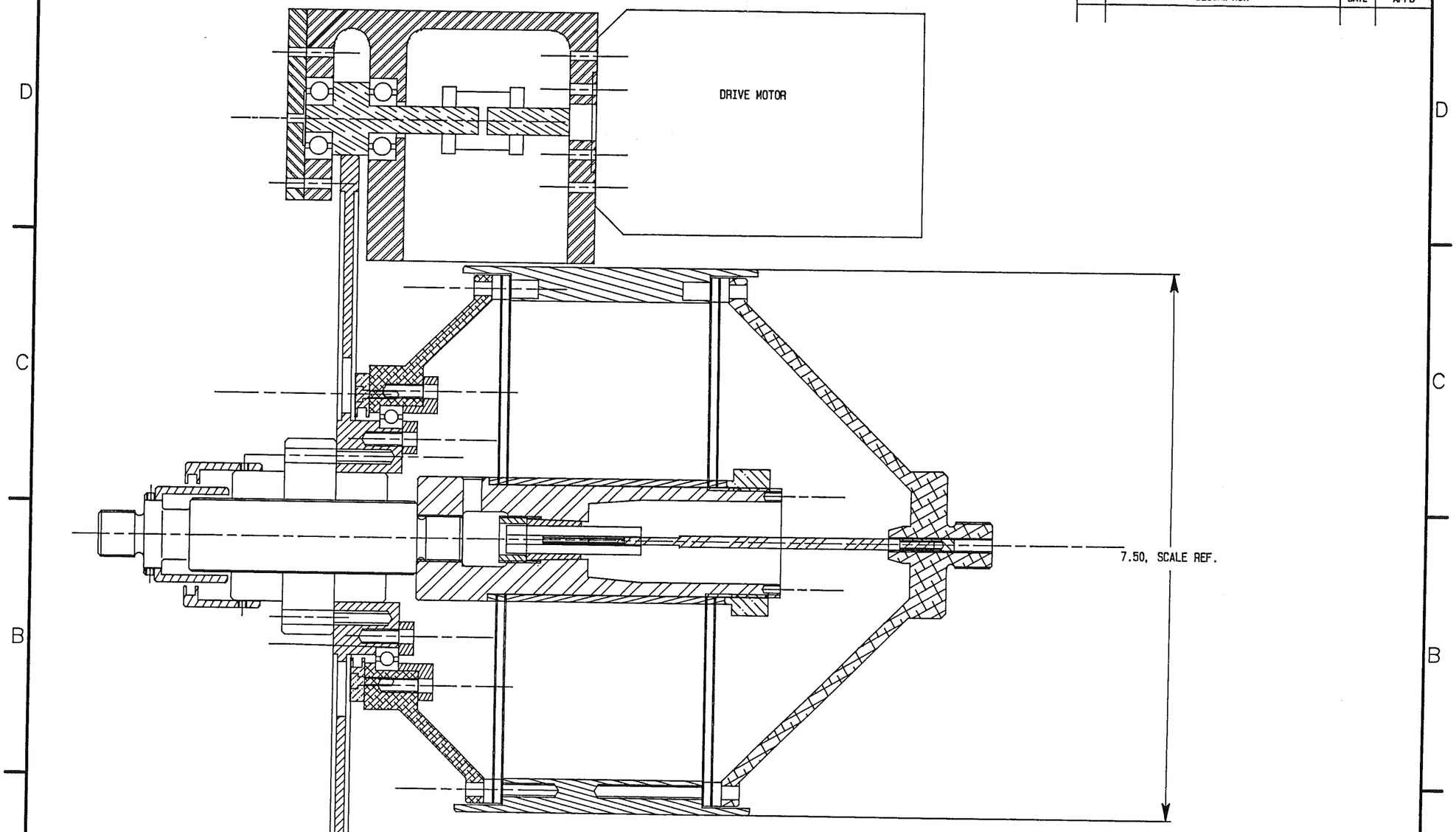
[5] Zero drift primarliy due to LVDT demodulator/amplifier electronics.

[6] Closed-loop bandwidth is primarily a function of the servo electronics. No effort was made to achieve wideband performance. The machanism is capable of small signal response of at least 10 Hz.

roller screw itself is rated to 4000 lbs. and 7000 lbs. for dynamic and static loads respectively. The capacity of the actuator could therefore be safely increased by using a larger bearing.

Lastly the allowable compression load is determined by a preload spring within the actuator. When the compression load equals the preload force, the load on the bearing reverses, and the actuator stiffness is then only that of the preload spring. The allowable compression load could be increased by increasing this preload.

REVISION			
LTR	DESCRIPTION	DATE	APPD



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APPROVED	DATE	TITLE FOCUS/COLLIMATION ACTUATOR, SECTIONED ASSEMBLY VIEW			
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Figure 1: Sectioned assembly view of prototype actuator.

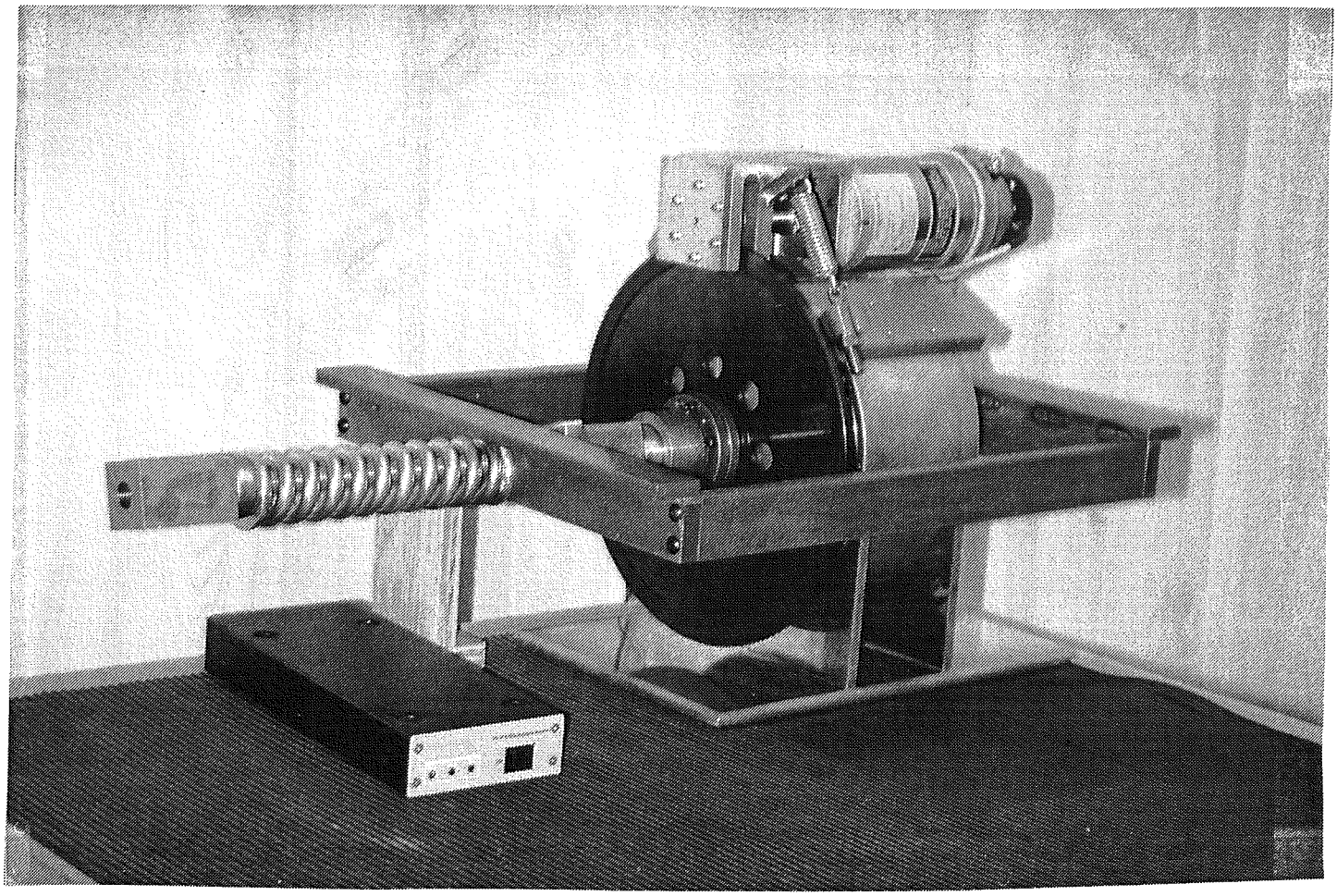

Figure 2: Picture of prototype actuator in test setup. The frame surrounding the actuator and the large spring at the front are used to apply a tensile load to the actuator. The box to the left is the LVDT demodulation electronics.