Fast Steering Mirror Performance

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A fast steering mirror actuated with electromagnetic voice coils has been designed and built, shown in Figure 1. The mirror diameter is 100 mm, and made with 19 mm thick fused silica. Since only 1 milliradian angular deflections are required in typical astronomical applications, the mirror is held in place with a stiff, two-dimensional flexural pivot. Voice coil actuators are arranged in push-pull pairs about two orthogonal axes, resulting in a high torque against the mirror, but negligible piston excitation. To further control the system performance, a reaction mass inside the optical head cancels most of the external vibration.

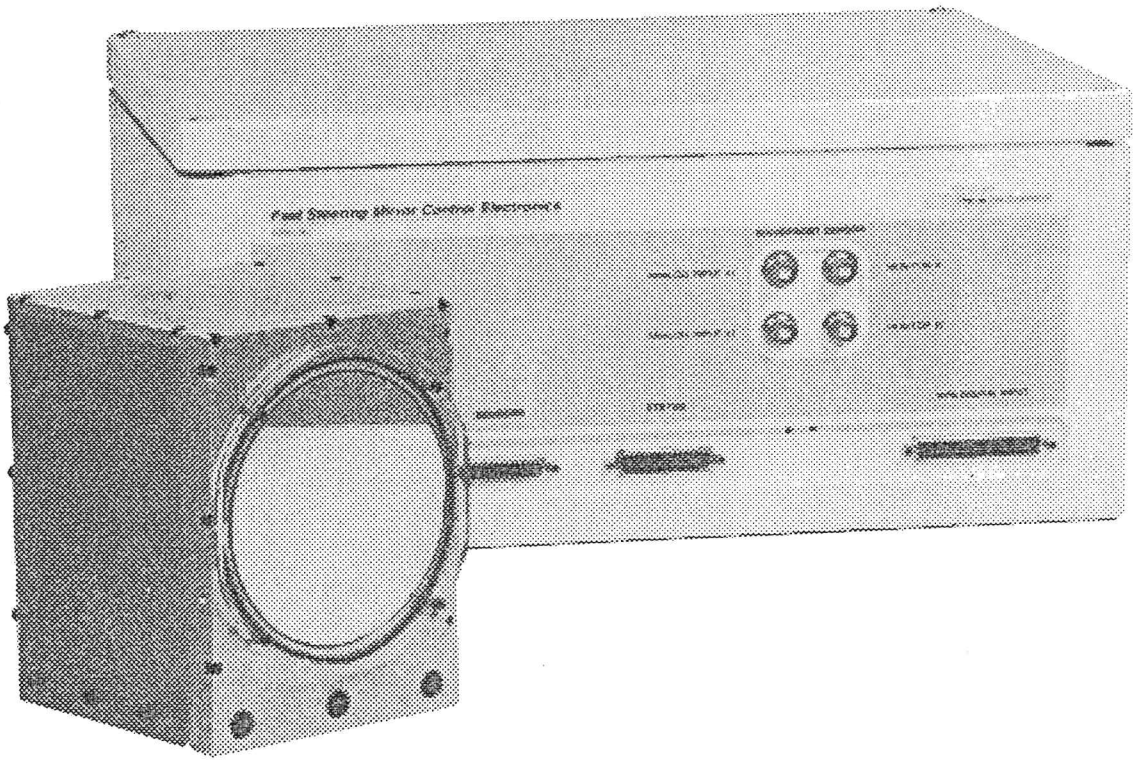

Figure 1. Fast steering mirror optical head and electronics unit.

Differential capacitance-based position sensors on the mirror back side measure the angular position of the mirror in an internal closed loop feedback system. The optical head contains the capacitance sensor electronics, but the voice coil drivers are located in the electronics unit, separated by 3 meter cables. Also contained in the electronics unit are the controls for the feedback loop, controls to electronically rotate the driving axes, and the input board. The mirror position can be driven from analog ± 10 volt signals, or a 24 bit wide parallel digital word can be used, 12 bits for each axis.

The mirror response to a square wave was measured to have a rise time of 1.3 msec. This value can be modified, depending on the amount of overshoot. The angular noise is less than 10 nanoradians/$\sqrt{\text{Hz}}$ from DC to 200 Hz. Nonlinearity is less than 1%, due to the differential signal processing which cancels most error sources.