MAGELLAN PROJECT

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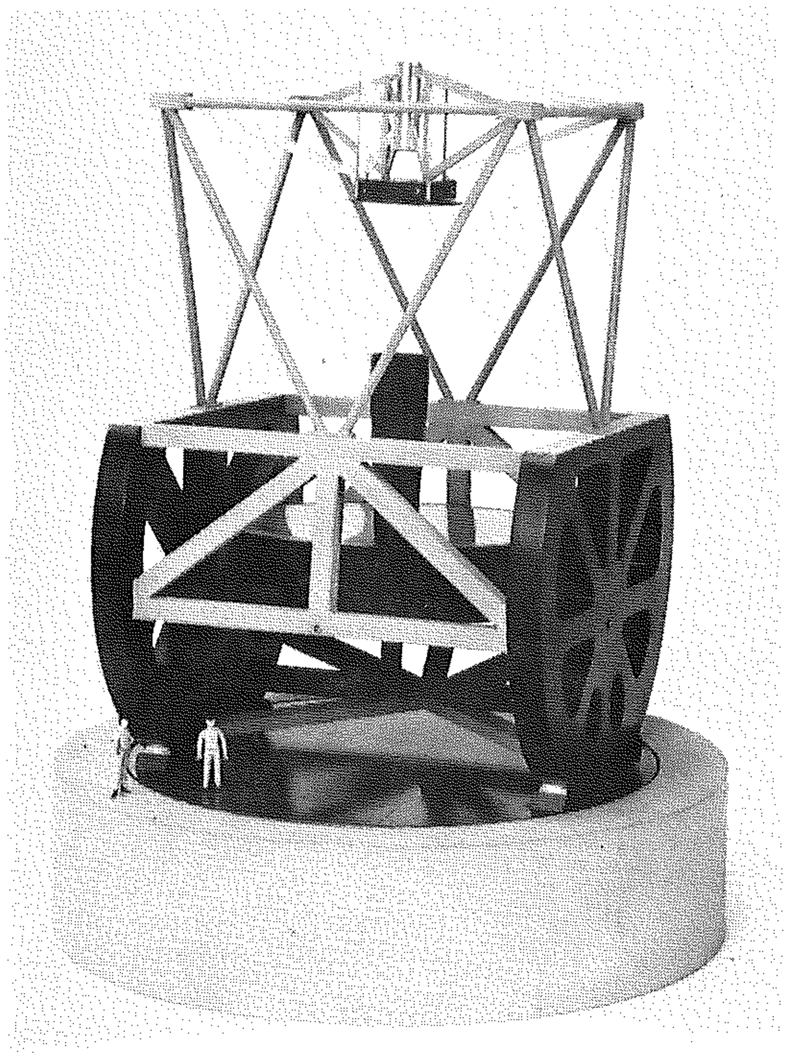

Universal Vane System
Magellan 8-Meter Telescope

Steven M. Gunnels
Consultant, L & F Industries
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During the early preliminary design phase of the Magellan 8-meter telescope, various secondary end support structures were considered. The primary goal has been a system which does not require separate headframe structures for the optical versus infrared/prime focus configurations. Other criteria have been:

1.) Low wind profile to minimize wind load pointing error and optical misalignments.

2.) Minimal radiation and diffraction effects in the infrared.

3.) High stiffness to limit the dynamic range required of a 5-axis secondary control system, and to effect reasonable modal performance at the secondary end.

4.) Minimal time and effort required to change between the prime focus, infrared and wide field optical configurations.

The Universal Vane System, shown in Figures 1, 2, and 3 that follow is a system which achieves the above goals.

As shown in Figure 1, the vane system consists of four planar trusses. They are supported at their outer ends by the square headframe and connected through the center by a tubular structure which also serves to support the prime focus and infrared (secondary) assemblies. Each of the truss planes then offers a "cantilevered" node toward the primary which is used to support the removable wide field secondary assembly.

In this way, and with the geometry shown, the gross pretension load at the end of the vanes then effects local pretension reactions in most individual vane elements. The exceptions are compression reactions in the central tube and the four slender rectangular tubes which parallel the optical axis.

The central tube has very high compression strength, since its outside diameter is virtually as large as that of the infrared secondary mirror. The slender rectangular tubes, as shown in Figure 3 and the related enlarged view are 8" by 2" by 3/8" wall rectangular steel tubes. They have adequate compression strength under their preload and yet offer little radiation when seen on end in the infrared.

Figure 2 is the view seen from the primary in the optical wide field configuration. The infrared assembly, central portion of the vanes, and the rectangular tubes are then hidden behind the optical assembly and its baffle.

Figure 3 shows the view from the primary in the infrared and prime focus configurations. All that is seen beyond the perimeter of the infrared mirror is the 1/2" thick vanes and the four rectangular tubes on end.

A handling fixture on the observing floor will be used to install or remove the optical secondary assembly. The infrared assembly is also removable for access to the prime focus.

Static and modal finite element analyses were run in both the optical and infrared configurations. Static analyses determined pointing errors and misalignments due to gravity and wind loading. Modal analyses were run of the complete telescope without the effects of vane pretension in order to establish the natural frequencies and modeshapes for the gross telescope structure. In addition, local models were run of the secondary end with vane pretension effects to establish natural frequencies and modeshapes locally within the secondary end.

In the optical configuration, the lowest resonant frequency at the secondary end was found to be 5.2 Hz. This was the "nearly degenerate" rotation about the optical axis of the secondary mirror assembly. This analysis used a 5,000 lb. optical assembly (mirror plus cell plus support system). However, a much lighter assembly is currently under study, which would raise this frequency. The next lowest frequency was 11.7 Hz. The 5.2 Hz could also be raised, if necessary, by the addition of antirotation wires.

In the infrared configuration, the lowest resonant frequency at the secondary end was found to be 5.9 Hz. This was the out of plane motion of the front "cantilevered" nodes of the vane system, and orthogonal modes. The next lowest frequency in the infrared configuration was the "nearly degenerate" rotation about the optical axis of the infrared secondary assembly, at 10.4 Hz.

Detailed results of static analyses and higher frequency vibrational modes are not presented herein, but are included in a separate report on the entire telescope.

In summary, it should be noted that it is the combination of the relatively fast primary f-ratio (f/1.2) and the relative f-ratios of the Cassegrain foci that allows the use of the universal vane system. That is, as the primary f-ratio and secondary mirror diameter increase, the optical secondary support nodes cantilever further out, decreasing the preload in that area of the vane system, and reducing modal performance.

Preliminary design of a 5-axis optical secondary control mechanism is currently underway. This will cause a slight change in the current vane geometry. This, in combination with the lighter secondary assembly and other optimizations in detail design will effect some additional improvement in the above referenced modal performance.

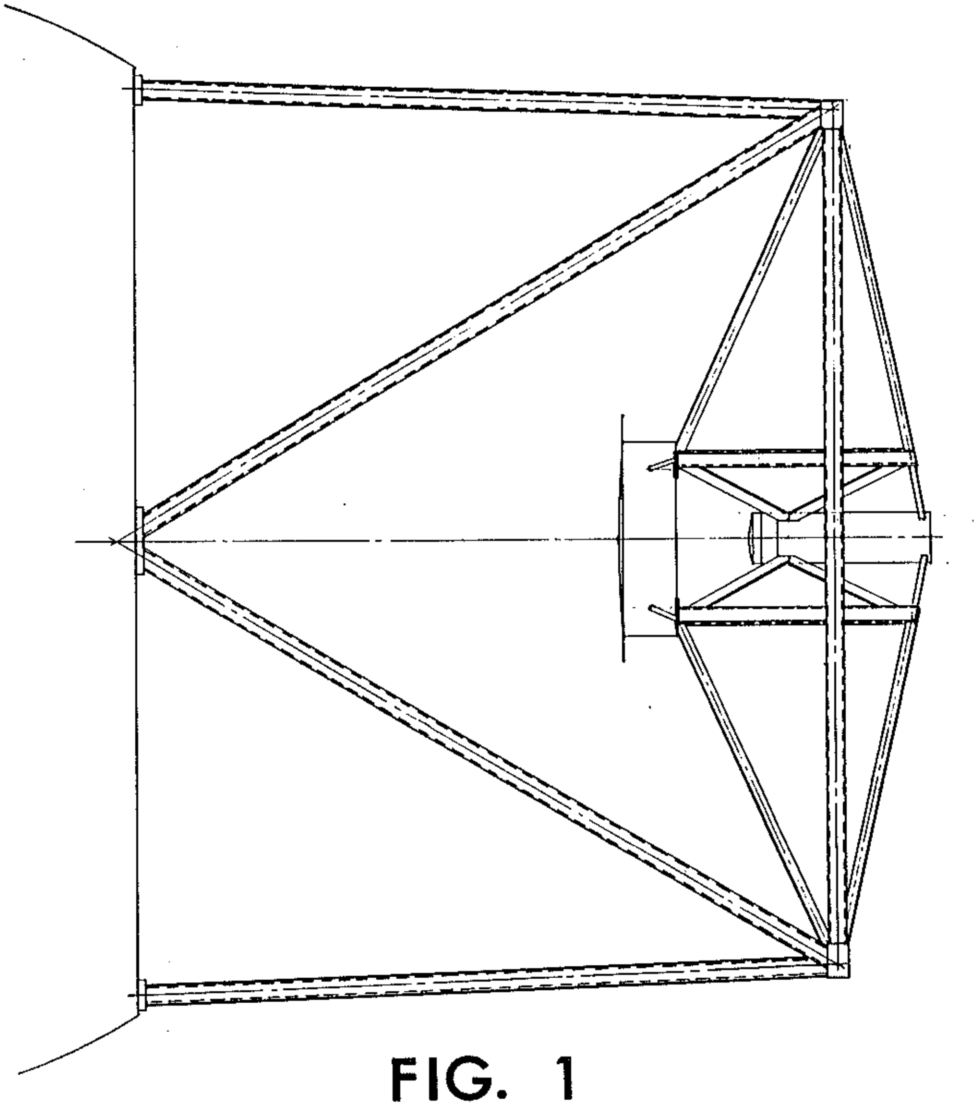

FIG. 1

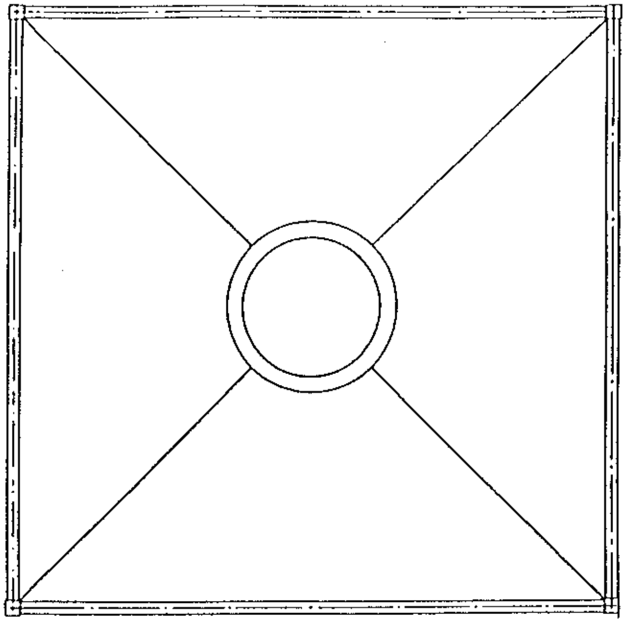

FIG. 2

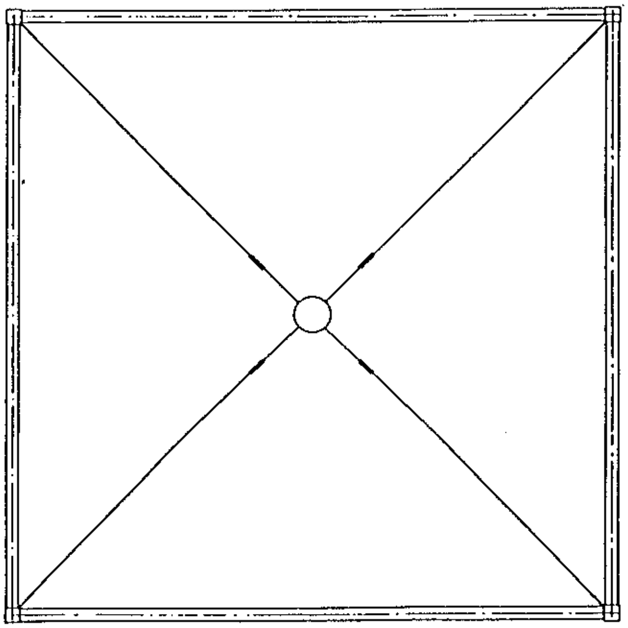

FIG. 3