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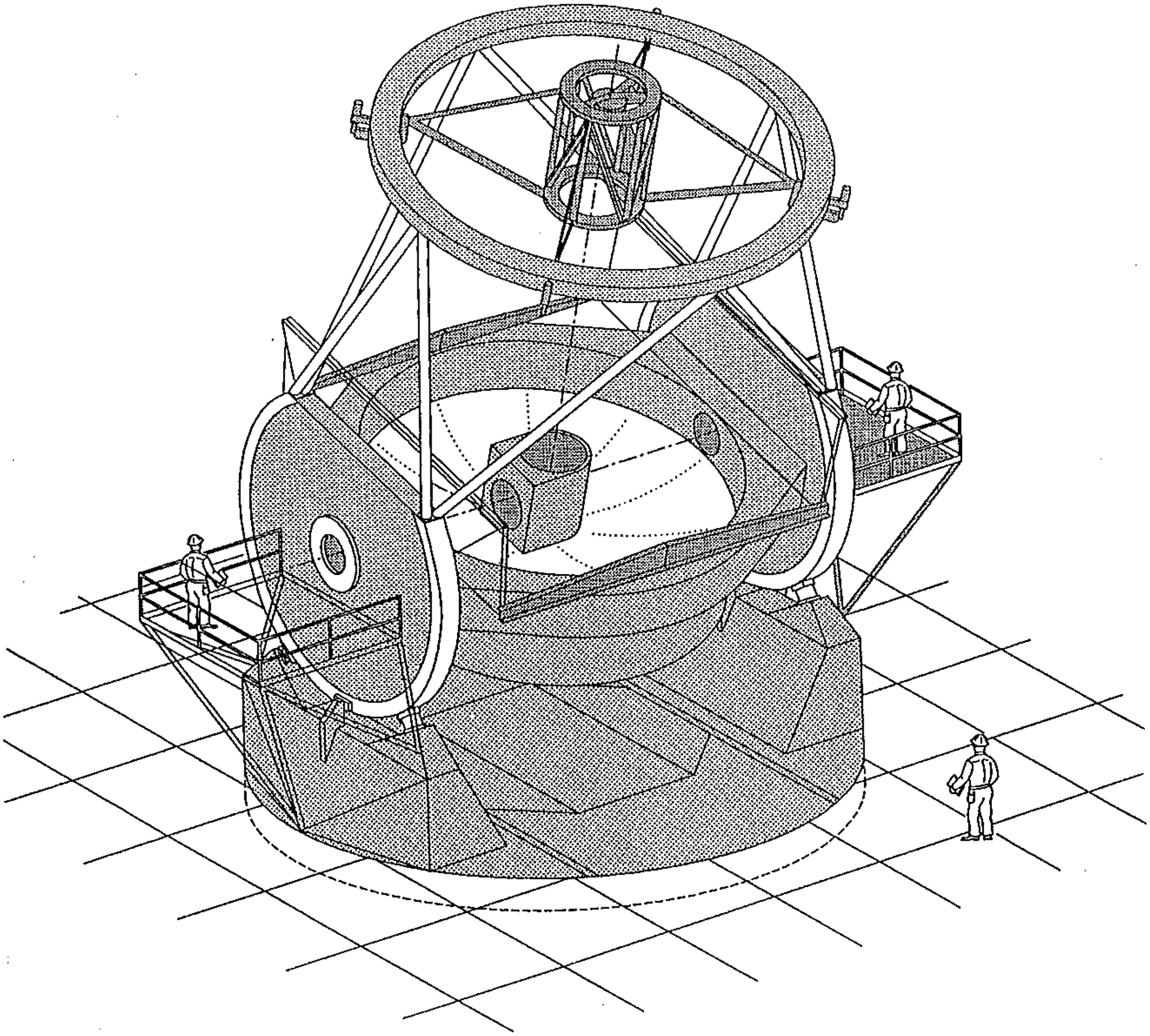

Summary of the Preliminary Design of the 6.5 Meter Telescope

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1.0 INTRODUCTION

This report summarizes the preliminary design of the Magellan Project 6.5 Meter f1.25 Telescope. The purpose of this work has been to define the telescope structure and major mechanical systems, and to summarize its expected modal performance.

2.0 STRUCTURAL AND MECHANICAL CONFIGURATION

2.1 SYSTEM DESCRIPTION:

The Magellan Telescope design summarized herein consists of an Alt-Azimuth mount, using hydrostatic bearings to define the altitude and azimuth axes. The system is shown on drawings E271067 (Rendering) and E271066 sheets 1 through 9 (System Layout). Sheet numbers below will be references to the multiple-sheet drawing, E271066. Graphics plots included as Figures 1 through 7 are also useful in understanding the structural design.

As illustrated in E271067, the mount can be considered a hybrid between a fork mount and the previously-considered Alt-Az Disk (ref. Report No. 5). The azimuth axis is defined using a large, round, thin disk (subsequently referred to as the "azimuth disk"), in combination with a large diameter plane bearing and stationary azimuth pintle/drive disk (ref sheet. 2).

The altitude axis is defined using two "altitude disks" in combination with two short structures, or "tripods". Although the tripods are not currently recognizable as such, each connects one side of the optics support structure (OSS) to the azimuth plane bearing at three points. Each tripod therefore consists of a plate tripod (a plate weldment), and two pillow blocks which support the OSS radial hydrostatic pads. The tripods permit the use of smaller diameter altitude disks than did the Alt-Az Disk. While this system may be closer to an Alt-Az Disk mount than a conventional fork mount, it is subsequently referred to as a Tripod Disk mount.

The two main rotating structural assemblies of the mount are the Optics Support Structure (OSS) and the azimuth structure.

The OSS Assembly (sheets 1, 2, 3, 6, and 8 and Figures 1 through 7) is estimated to weigh 165,000 lbs. (rotating weight of the complete assembly about the altitude axis). This assembly consists of three major subassemblies:

1.) The mirror cell assembly includes the cell structure, the primary mirror, and its support and ventilation systems. This structure is not yet defined in much detail, but has been assumed structurally as two 1/2" steel plates separated by a dimension of 24", with a perimeter shell as shown in Figure 6.

2.) The center section is a plate weldment made predominantly using 1/2" steel plate. The altitude disks bolt to the center section. The mirror covers attach to the center section, the counterweights to the altitude disks and center section.

3.) The secondary end includes the secondary main truss, circular end frame, vane end actuators, vanes, secondary center structure, and secondary mirror cell assemblies.

The (rotating) azimuth assembly is estimated to weigh 115,000 lbs and consists of the azimuth disk (as distinguished from the stationary azimuth pintle/drive disk) tripods, and Nasmyth platforms.

2.10 Optics configurations (E271066 sht. 3):

The 6.5 meter f/1.25 primary mirror is used with various secondary mirror assemblies to focus at either of 6 foci. These include the Cassegrain, the two Nasmyth foci, and three "folded port" foci on the perimeter of the center section (ref sht. 1). The Cassegrain and Nasmyth foci include instrument rotators. In the baseline design, the folded port foci do not include rotators, but do include a flange for bolting a non-rotating instrument or future instrument rotator.

The rotator concept shown (sht 3) consists of a heavy plate connected to the structure through a large (approximately 40 in. diameter) angular contact ball bearing pair. The annular plate contains tapped holes for bolting both small and large instruments. A friction drive with friction-driven encoder, though not shown, will be mounted at the perimeter of the rotator. The Nasmyth and Cassegrain rotators can be virtually identical.

As shown on sheet 3, the rotatable tertiary assembly contains two tertiary flats and a corrector. The large flat (TM1) can deflect light through the corrector or tilt to the stored position as shown. The small flat (TM2) can deflect light away from the corrector or tilt to its stored position. With both flats in the stored position, a light beam can pass through the tertiary assembly to the Cassegrain focus.

The baseline configuration for the telescope includes secondary mirror assemblies. The f12 optical Gregorian mirror can be used at either of the (2) Nasmyth or (3) folded port foci. Using the large flat with corrector effects a moderate field (24" field diameter at Nasmyth, 12" field diameter at the folded ports). Using the small flat without corrector yields a narrow field.

The f17.5 infrared Gregorian shown focuses at Cassegrain. Alternatively, this secondary may be a conventional mirror (with convex curvature) located at the lower end of the secondary center assembly.

The f5 wide field conventional optical mirror is a possible future configuration. It would require removal of the tertiary assembly. Even at this, the field light narrowly misses the tertiary support tube which in turn is quite close to the central hole of the primary mirror.

2.11 Primary mirror removal system (E271066 sheet 7):

The mirror cell cart consists of the lower aluminizing chamber mounted on four wheels and supporting three jacks. As shown in the projected elevation view and section B, guide rails are bolted to each tripod and the underside of the OSS. Bronze wear blocks bolted to the flange of the lower aluminizing chamber are at a level just below the bottom end of the guides when the cart is driven into place under the cell. When being transported between the telescope and the aluminizing locations, the fully retracted jacks (inverted mounting) clear the floor.

Three hard points in the azimuth structure and service building are located under each jack position to accept a compact short-stroke hydraulic jack as shown in C-C. The hydraulic jacks register to the screw of the mechanical jacks with a dowel pin, and the hydraulic jacks are registered to the floor as shown. The hydraulic jacks are positioned manually to engage the dowel pin as the mechanical screw is initially extended. With the hydraulic jacks fully collapsed, the mechanical, self-locking machine screw jacks are actuated. The protective tube on the top side of the jacks is square, so that a square bronze block bolted to the top of the moving screw guides on the inside of the tube, and therefore keeps the screw from turning as it extends or retracts. The three jacks are electric motor driven with a coarse servo control to keep the assembly level. Backup level switches are used for system shut-down should the assembly tilt to an attitude beyond that representing a reasonable servo error.

The system is guided (+/- 1/4") by the edge guides until within about 3" of the level at which the lower aluminizing chamber and mirror cell flanges make contact. At that level, more precise guides (bullet-nosed pins) engage to better control their alignment. When the screw jacks are fully extended (due to internal mechanical stops or as limited by controls) a nominal 1" gap remains. This is then closed by the use of the hydraulic jacks, which have a stroke of 2 3/8". The cell is then unbolted from the OSS, and the above procedure is reversed to lower the system.

This three-point lift system guarantees even loading of the jacks. In addition, the load equalizer supporting two of the wheels kinematically defines nearly equal loading on the four wheels during transport or while at rest on the rails. As shown, two wheels are driven and connected with a synchronizing jackshaft. Caliper brakes (not shown) will be used to hold position when at rest, especially in the event of an earthquake.

The entire assembly including mirror cart (with integral lower aluminizing chamber) and complete mirror cell assembly is estimated to weigh approximately 90,000 lbs.

2.12 Utilities distribution:

The azimuth utilities distribution is indicated on sheets 2 and 4. Utilities are draped from the pier to a (bulkhead connector) ring near the upper end of the maypole. The cables are then distributed to either of four cable trays in the utilities floor panel spanning the center hole of the azimuth disk. The utilities then wrap onto (or off of) the maypole as the telescope is rotated through its total 540° azimuth travel.

The hole through the 12" pipe maypole can be used for a future coude beam path.

The removable floor panels are relatively thin to minimize the moment arm of the telescope c.g. above the azimuth radial pad support plane. However, they are fabricated box sections which have adequate strength and stiffness to support live loads of 200 psf (lbs./ft.^{2}) over their 22-foot span. The cable trays in the center removable panel (and hydrostatic pads underneath) are fully accessible, having locally removable top panels.

Beyond this area, utilities are routed on the underside of the azimuth disk as required.

The maypole (coude tube) is a recent addition to the baseline telescope design. (It was previously planned to let the utilities twist +/-270° directly on the azimuth axis). There is some question as to the feasibility of doing this without a more elaborate system for controlling the cabling as it wraps onto the tube. Therefore, a scaled prototype of this may be necessary.

A utilities drape will be used to transfer to the optics support structure. Its size and location is yet to be determined.

2.13 Mirror cover:

As shown on sheet 8, the primary mirror cover consists of two bi-parting assemblies, each being a "rigid bellows" type. The panels are made of aluminum skins and aluminum (or other) honeycomb core. The 2 1/2" thick panels will have adequate strength and rigidity to support personnel when closed with the telescope at zenith, if required. The two panels in each assembly are connected using heavy piano hinges with a thin silicone rubber seal on the top side of the cover when closed.

The cover is edge-guided by track rollers as shown and has an approximately octagonal shape when closed. A silicone rubber seal mounted near the top inside corner of the structure seals to the cover when it is closed so that the mirror cavity can be purged with purified temperature controlled air when the telescope is not in use. Each assembly is actuated by a rotary actuator, electric motor driven.

The cover as shown is very similar in design to that being built for the WIYN 3.5 Meter Telescope. One minor distinction in this design is the requirement that the track slope up slightly (telescope at zenith) so that the closed cover will clear the top of the tertiary assembly. If the f5 wide field configuration should be adopted at some future date, its (tertiary) baffle, as well as the tertiary assembly, would have to be removed and installed with the f5 assembly.

2.14 Oil collection systems:

The azimuth oil collection system is indicated on sheet 2. The azimuth plane bearing uses gutters which are seal-welded to the inside and outside diameters of the plane bearing ring. This oil is collected at seal-welded drains and plumbed back to the hydraulic pumping unit for filtering and re-use.

The azimuth radial bearing involves another gutter which can be bolted to the underside of the azimuth pintle as shown. Local dams at each of the four radial hydrostatic pads assures that all oil on the azimuth disk side of the pads drains to the gutter. Oil from the pintle side will drip directly into the gutter. Oil is then collected as described above.

The OSS collection system, not shown on the drawings, uses a dam around the top of the plate tripod, with seal-welded drains as required. More intricate dams around the radial pad pillow blocks will be required. In addition, a rolled steel angle drip lip will be used on the faces of each altitude disk to preclude oil from running down the face of the disk.

2.15 Vane end actuators/secondary center assembly:

As indicated on sheets 1, 6, and 9 a new concept for defining and collimating the secondary mirrors has been developed for the Magellan telescope. Any of the (baseline or future) secondary mirror cells will be attached directly to the secondary center support structure (the infrared will attach through the fold mechanism shown). The secondary center assembly and vane system will then be positioned as a unit for focus and collimation by the vane end actuator system shown on sheet 9.

Each vane end assembly consists of an axial and radial actuator which controls the vane end node (intersection of lower and upper vane) through a lever. The axial actuator, referenced directly to the large circular end frame, moves the node (nearly) axially by pivoting the two-lever assembly around the bearing inside the frame. The radial actuator moves one lever with respect to the other around the external pivot to move the vane end node (nearly) radially. The slight arcs upon which the vane end nodes travel may require compensation by the control system.

Due to overconstraint (eight actuators defining 6 degrees of freedom), the force in the axial and radial systems must be monitored by the control system. This is accomplished by the load cells mounted as shown.

Due to the uniqueness of this concept and criticality of this system, a fairly detailed preliminary design has been developed, which was summarized in the weekly Engineering Summary, August 6 - September 14, 1992. A prototype and test of at least one (vane end) assembly is planned.

2.16 Ventilation of structure:

The ventilation of the telescope structure is accomplished by a simple and inexpensive system (ref. sheet 2). A blower exhausts the interior of the concrete pier. The blower can be mounted in a sheet metal duct which is connected to the pier and routed to an area which is generally downwind of the enclosure. A liquid filled moat seals the rotating interface between the azimuth disk and the pier (at their outside diameters, view A-A). With ventilation holes in the bottom plate of the azimuth disk, a negative pressure is established throughout the continuous volume of the azimuth structure.

The OSS interior can be connected to the azimuth structure by one or more flexible ducts. With numerous ventilation holes placed around the OSS, air will flow into the structure and be drawn down to the azimuth structure and eventually exhausted downwind of the system.

Alternatively, the OSS could be exhausted directly to the enclosure environment by strategically placed fans within the OSS. The best fan for the current wind direction and telescope position could be automatically selected by the control system so that the air is exhausted downwind of the light path, to be subsequently flushed from the enclosure interior by the wind. Each fan would require a controllable damper so that air is drawn from the top end of the structure down to the fan (and open damper) in use at a given time.

Either of the above two methods should significantly reduce the thermal time constant for the telescope structure.

2.17 Miscellaneous descriptions and subsystems:

As can be seen on sheet 1, the azimuth disk is made in four pieces bolted together as shown in H-H, sheet 5. The mirror cell cart wheels run on rails integral to the joint and therefore these high loads do not have to be spanned by the removable floor panels over the center hole in the azimuth disk (sheets 1, 2, and 4). The bolted joints are hidden beneath the surface of the 4" thick flooring system.

This system consists of panels of 3" steel decking covered with 1 1/8" tongue-and-groove plywood (in turn covered by linoleum) covering the azimuth disk. The flooring system (much of which looks directly at the sky) has relatively low thermal mass and a moderate insulation value. It therefore isolates the thermal mass of the azimuth disk structure from the air in the enclosure, as well as allowing the azimuth disk to be a thinner structure for a fixed azimuth lateral support plane. The only projections penetrating this observing floor surface will then be the plate tripods. It is estimated that the flooring system, including removable panels, will weigh approximately 12,000 lbs.

As indicated by hidden lines in the two elevation views of sheet 1, powered counterweights will be mounted in the altitude disk weldments. These provide balance due to any combination of removal or installation of the Cassegrain instrument and secondary mirrors. Two assemblies with 4,000 lb. weights each travelling approximately 80 in. are anticipated. OSS position locks mounted as shown in view A-A sheet 2, will also be provided at zenith, horizon, and desirable intermediate positions.

In an emergency situation, the telescope motion about both axes can be braked by sudden dumping of hydrostatic system pressure. The hydrostatic pads, which will be surfaced with bronze, will minimize damage to the bearing running surfaces due to such an event.

2.18 Nasmyth Instrument mounting:

As indicated on sheets 1 and 3, the provision for mounting and access to the Nasmyth Instruments is similar to that for the Cassegrain Instrument. That is, an instrument rotator is provided at each altitude disk which is a stiff annular plate connected to the altitude disk by a large precision bearing. The plate may have two instrument mounting bolt patterns; for large and small instruments. The rotator will be driven in rotation by a high-precision friction drive. The instrument is then cantilevered from its front mounting plane, just as the Cassegrain instrument.

Finite element analyses have predicted that the altitude disks have adequate local stiffness to limit sag of the (assumed infinitely stiff) instrument to less than 30 arcsec and 0.010 in. at the focal plane. The first resonant frequency due to this same local stiffness under the cantilevered instrument load is high.

A personnel platform will be available at each Nasmyth location. Instruments that do not require derotation in this alt-az mounting can either be used with the rotator drive turned off, thereby rotating with the altitude disks, or the drive can be controlled to keep the instrument from rotating about its horizontal axis if desirable to maintain constant gravity loading with respect to the instrument.

2.2 STRUCTURAL DESIGN:

The goals of the structural design have been high stiffness, low rotating mass, and ease of manufacture. High stiffness and low mass effect small deflections due to gravity and wind loading, and high structural resonant frequencies. In addition, the low mass may effect cost savings, but will also improve thermal response of the structure to ambient temperature changes. This will then have a beneficial effect on seeing.

As can be seen on the drawings and graphics plots herein, the telescope is constructed using spaceframes (secondary end structure) and monocoque, or plate fabrications (azimuth disk, tripods, altitude disk weldments, center section, and mirror cell). Plates used are predominantly 1/2" thick carbon steel. All weldments are to be thermally stress relieved.

2.21 Weight summary:

I. Rotating - OSS assembly:

Structure:

secondary central support structure	2,100
vanes	500
circular end frame	6,730
main truss	5,000
center section	18,000
primary mirror cell	30,000
altitude disks (total for 2)	52,500
Total OSS structure	114,830

Mechanical:

vane end actuator assemblies (4)	1,200
mirror cover	1,400
counterweights (2)	9,000
primary mirror	17,070
p.m. support and ventilation system	10,000
Cass instrument (average)	3,000
Nasmyth instrument (1, average)	3,000
tertiary assembly	1,500
miscellaneous	4,000
Total OSS mechanical	50,170
Total OSS rotating weight	165,000 lbs.

II. Rotating - Azimuth assembly:

Structure:

az disk side sections incl tripods (2)	68,000
az disk fore/aft sections (2)	30,000
Total azimuth assembly structure	98,000

Mechanical:

flooring system	12,000
Nasmyth personnel platforms (2)	2,500
miscellaneous	2,500
Total azimuth assembly mechanical	17,000
Total azimuth system rotating weight	115,000 lbs.
Total telescope rotating weight	280,000 lbs.

III. Non-rotating:

azimuth pintle/drive disk	30,000
azimuth plane bearing (@ 4 x 16 section)	21,000
moats, plenums, etc.	2,000
Total non-rotating weight	53,000 lbs.

2.3 BEARINGS:

Hydrostatic bearings will be used throughout the system. While the oil pads for these bearings may eventually be custom designed and built, the preliminary design has been tentatively based upon standard catalogue bearings. These bearings have spherical seats and self-aligning pockets to assure proper function against surfaces which are imperfect due to manufacturing tolerances and structural deflections. For purposes of the finite element modelling, film thicknesses of 0.003 in. were assumed, with flow control compensation.

2.31 Altitude Bearings:

The OSS is defined to the azimuth system using four radial pads and four lateral pads. The radial pads (that is, pointing radially toward the center of each altitude disk) are SKF 225 x 290 hydrostatic pads (or equal). They have a working load of 50,000 lbs. each, determined by the OSS weight and the support geometry. These pads have a load rating of 66,000 lbs. All four of these pads are "masters". That is, they do not have a floating hydraulic section but are rigidly mounted to the azimuth structure.

The four lateral pads (which "pinch" across the thickness of the altitude disks in pairs - ref sheet. 2) are also SKF 225 x 290 or equal. These pads are defining pads which do not support any significant external load. They are hydraulically preloaded to an assumed load of about 30,000 lbs. One of the four is a master. The other three are "slaves" (with hydraulic floating section). The hydraulic floating section will be fed pressurized oil through an orifice sized to provide stiffness under high frequency loading. This type pad is therefore subsequently referred to as a "high frequency overconstraint" (HFOC).

Therefore, of the eight hydrostatic pads used to define the OSS to the azimuth system, five are masters, defining five of the six degrees of freedom for the OSS. The sixth (rotation about the altitude axis) is defined by the drives.

2.32 Azimuth Bearings:

The azimuth structure is defined to ground using ten hydrostatic pads. Six pads are mounted under the azimuth disk and run against the large azimuth plane bearing while the other four define the system radially to the azimuth pintle (sheets 1 and 2).

The six vertically-acting pads are actually two sets of three, each set defining its tripod to ground locally. These pads support the vertical weight of the entire telescope. The outboard pads (one each side) are SKF 325 x 420 (or equal) and have a working load of 96,000 lbs. each. The inboard pads (two each side) are SKF 225 x 290 (or equal) and have a working load of 22,000 lbs. each. All six vertically-acting pads are masters. All six pads define only three degrees of freedom for the telescope: vertical translation, rotation about an axis parallel to the altitude axis, and rotation about the fore-aft horizontal axis. Therefore, there is obviously some overconstraint present. The overconstraint would be of no concern if the azimuth plane bearing were *perfectly* flat, since the geometry of the azimuth system would be invariant as the telescope is rotated around the azimuth axis. The plane bearing will not be perfectly flat. Therefore, the overconstraint is accommodated as follows (ref. E271067):

If one imagines the near side tripod as an absolute reference as the telescope rotates about azimuth, the degree to which the azimuth plane bearing is imperfect will cause the far tripod to:

1. Change elevation, which is accommodated by the fact that all connections to the OSS are free to articulate locally (spherical seats in hydrostatic pads plus articulated drives). In other words, the OSS angular position about a fore-aft horizontal axis can change relative to the reference tripod.

2. Rotate about an axis parallel to the altitude axis, which is accommodated by the fact that there is only one altitude encoder, and therefore the "rotating tripod" can rotate around the far altitude disk without twisting the OSS. Of course, the relatively thin azimuth disk must also twist to accommodate this motion.

3. Rotate about a fore-aft horizontal axis, which is accommodated by the articulated pads and the fact that only one of the four OSS lateral defining pads is a master. This therefore allows lateral motion of the pads at the far tripod relative to its altitude disk. Of course, since three of the four lateral pads have high frequency overconstraint, this is true only for low frequency relative motion of the far tripod. Since these effects would be due to tracking or slewing rotation about the azimuth axis and thermal effects, they are very low frequency. The azimuth disk must also bend out-of-plane to accommodate this motion.

The loading on the six vertical azimuth hydrostatic pads is defined by the tripod geometry. Due to the low out-of-plane bending stiffness of the azimuth disk the load on the pads (and therefore the stiffness) is predictable.

The four azimuth radial pads (sheets. 1, 2, and 4) define two degrees of freedom for the telescope; the two horizontal translations. Therefore, two (at 90° to each other) are masters, the other two slaves with HFOC. They are SKF 225 x 290 or equal, and are preloaded to 50,000 lbs. each, accomplished by the slave pad preload pressure.

2.4 DRIVES:

Friction drives are planned for both telescope axes. The altitude axis will use one "Direct Friction Drive" (ref. Report No. 18) for each altitude disk. The drives will be mounted near the back top corner of each tripod. They will drive against either the altitude disk directly or a replaceable drive arc. The drives designed and tested for the 8 Meter system, although larger than required, may be used for the 6.5 Meter system.

The azimuth axis drive concept uses two drives at 180° to each other driving against the stationary pintle/drive disk (sheets. 1 and 2, and View E-E sheet 5). The drives are mounted to the azimuth disk and therefore rotate with the telescope. The drives are discussed in some detail in report no. 18 (March 1990).

In the case of both drives (altitude and azimuth) the drive boxes have stiff restraints only in the tangential (drive) direction. They are otherwise free to articulate except that they are guided by rollers registering against the edge of the drive disks which is perpendicular to the drive surface, and the dual preloaded-roller feature prevents rotation of the unit about an axis parallel to the rotation axis.

3.0 FINITE ELEMENT ANALYSIS

3.1 INTRODUCTION:

Numerous finite element analyses have been performed since Magellan changed to a 6.5 meter aperture. However, these have generally related to local areas of the structure, such as the "flip secondary" and various main trusses and secondary end frames. Extensive optimizing has not been done since the requirement of 10 hz (for the lowest telescope primary mode) is relatively easy to achieve with this mount. Also, many optimized features of the 8 Meter design have already been incorporated in the 6.5 Meter design.

However, a modal analysis was performed in the most recent configuration, with the OSS zenith-pointing. Graphics plots of this model TD65M37 are shown in Figures 1 through 11, and results are summarized below.

These should be considered preliminary-design level models. They are not highly meshed, although should be adequate for their intended purpose: optimizing and first-order prediction of modal performance. The final modal analyses included:

TD65M37

2141	nodes
2691	plate elements
228	beam elements
12,700	degrees of freedom

3.2 OPTICS, INSTRUMENT, AND TELESCOPE WEIGHTS:

The following weights were used in, or resulted from, the finite element models:

Primary mirror - 17,070 lbs. (U of A)
Primary mirror support and ventilation systems - 9,300 lbs. (assumed)
Instrument mounting base - 3,000 lbs.
Cassegrain Instrument - 3,000 lbs.
Counterweight assemblies - 10,060 lbs. (total for 2)

OSS Assembly - 165,000 lbs.:
    6.2E6 lb-sec^2-in (altitude axis)
    8.3E6 lb-sec^2-in (optical axis)
    1.0E7 lb-sec^2-in (perpendicular)

Telescope (rotating) Assembly:
    280,000 lbs.
    1.83E7 lb-sec^2-in (azimuth)

3.3 MODAL ANALYSIS:

The following modal performance is from model TD65M37, with the OSS in the zenith position. The first four modeshapes are shown and described in Figures 8 through 11.

MODE	FREQUENCY hertz	MODESHAPE DESCRIPTION
1	8.5	Optical Axis Rotation (of secondary assembly)
2	10.6	First Altitude Rotation
3	11.0	Lateral Translation
4	13.3	Locked Encoder Azimuth
5	17.1	Altitude Disk Lateral
6	18.3	Top End Vertical Translation
7	18.4	Azimuth Disk Local Plates
8	18.5	Azimuth Disk Local Plates

4.0 SUMMARY AND CONCLUSIONS

The preliminary design has been defined and modal performance predicted for the Magellan Project 6.5 Meter Telescope. The first primary mode (that in which a large portion of the telescope mass vibrates around an axis parallel to the altitude axis) is estimated to have a frequency of 10.6 hz. This exceeds the objective value of 10 hz required for good telescope pointing and tracking control.

Significant changes in the design since the last complete telescope design summary (Report No. 26) include:

1. Reduced aperture (6.5 meter f1.25, previously 8 meter f1.2).
2. More compact azimuth system, including tripod height and azimuth disk, hydrostatic plane bearing, and pier diameters.
3. Revised optical configurations, including optical Gregorian at Nasmyth and folded ports. (Operationally) more convenient changes between optical and infrared.
4. Vane-end actuator system, which allows one set of actuators to accommodate all baseline and future secondaries.

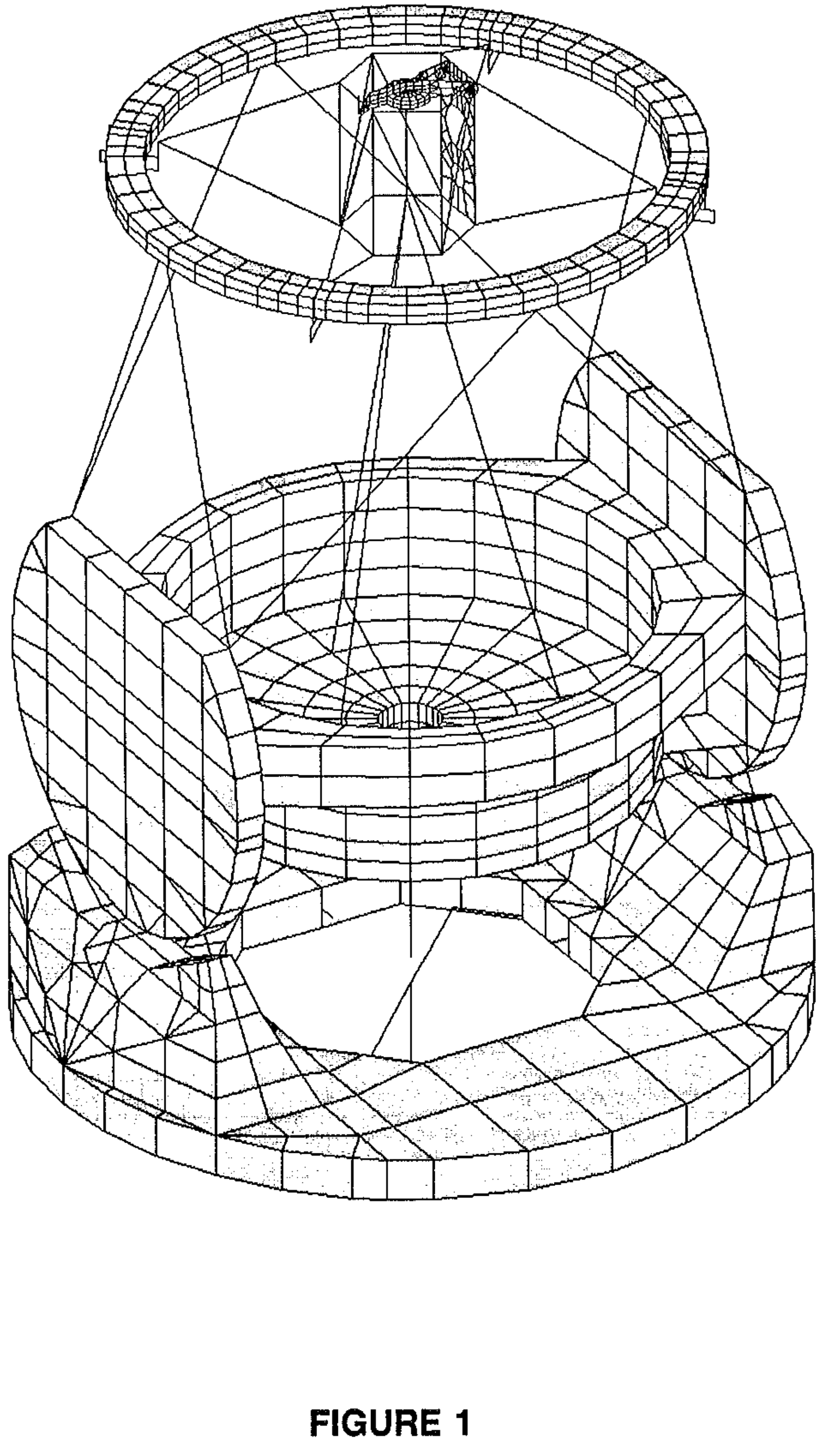


FIGURE 1

Model TD65M37, the 6.5 Meter modal analysis model.

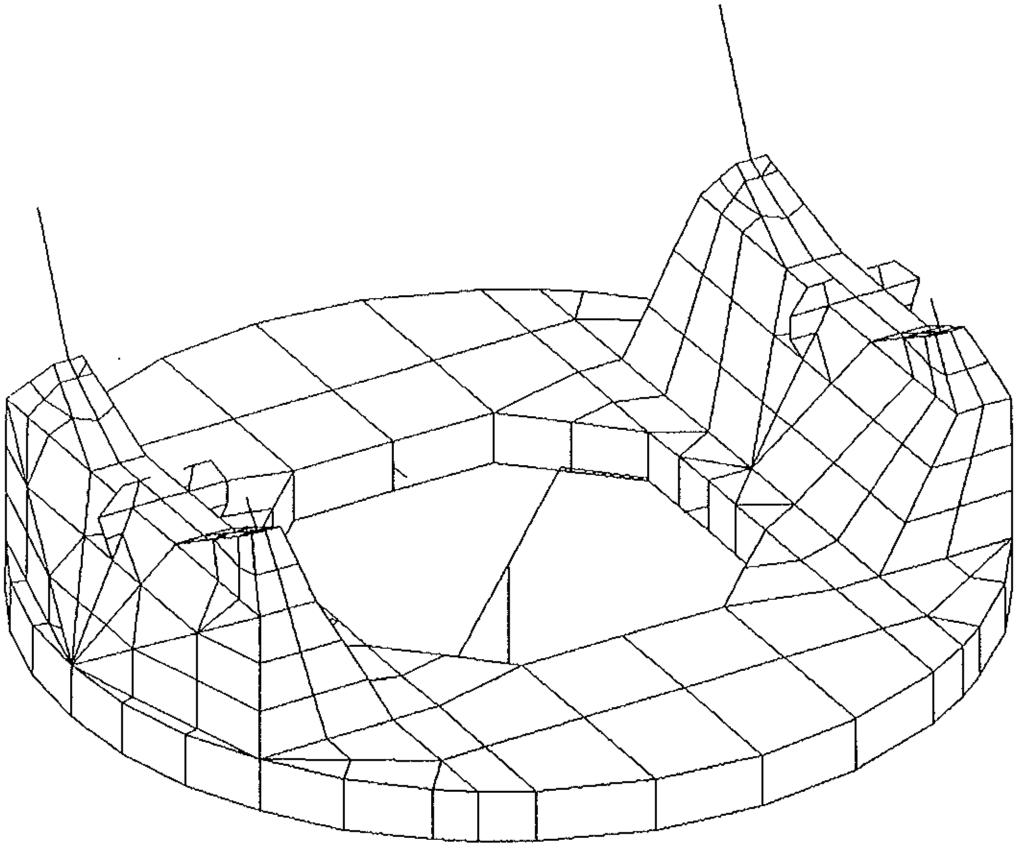


FIGURE 2

Azimuth system plate and beam elements.

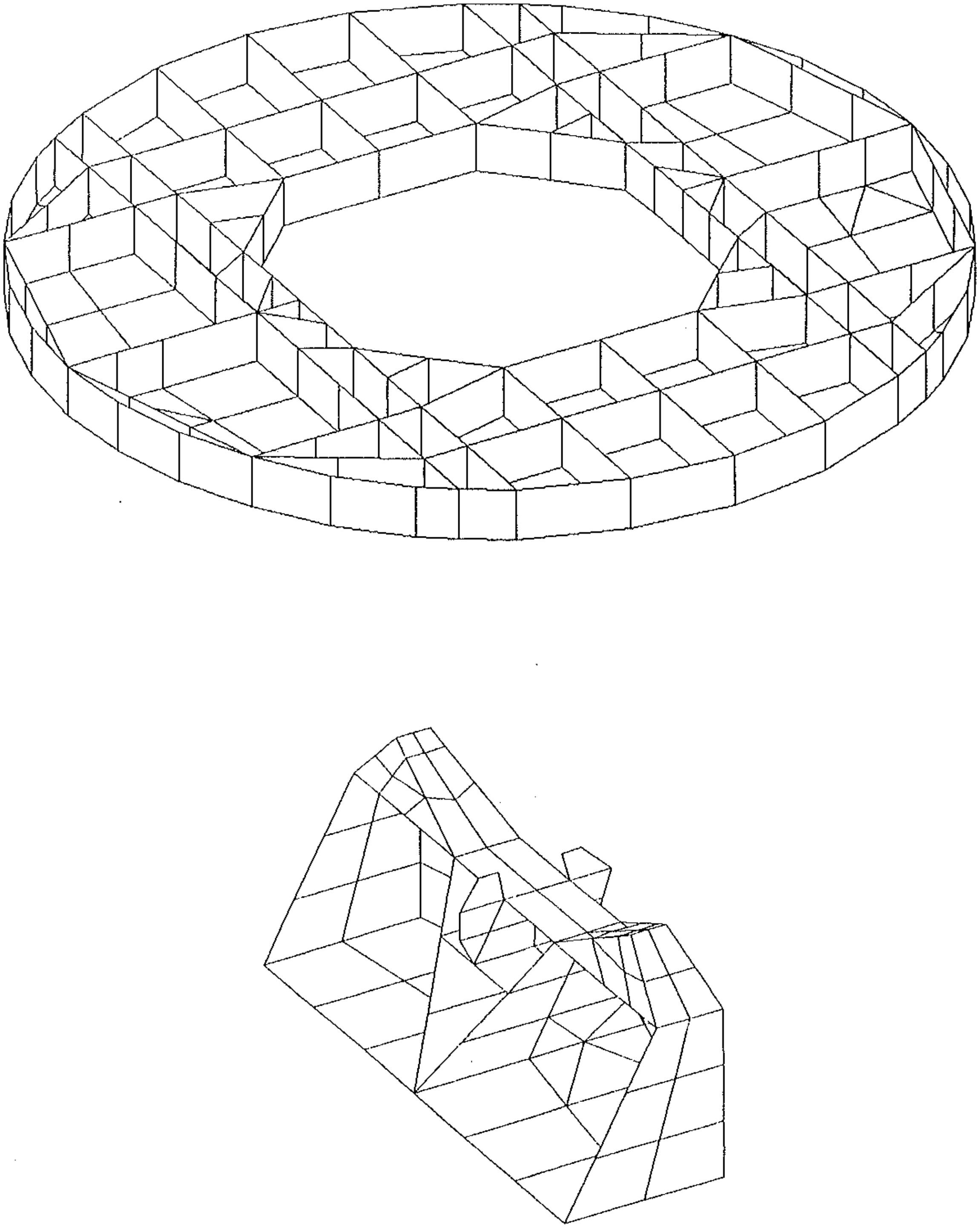


FIGURE 3

Azimuth disk and tripod plate elements, near plates removed.

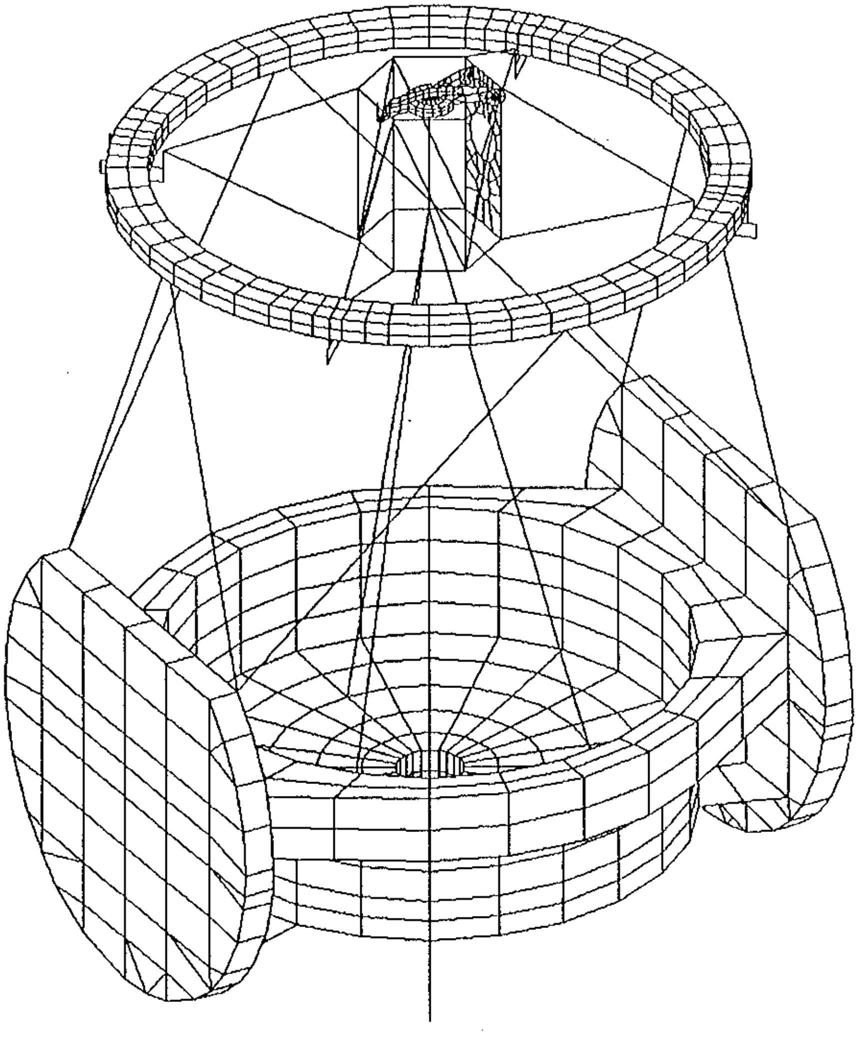


FIGURE 4

Optics support structure (OSS) plate and beam elements.

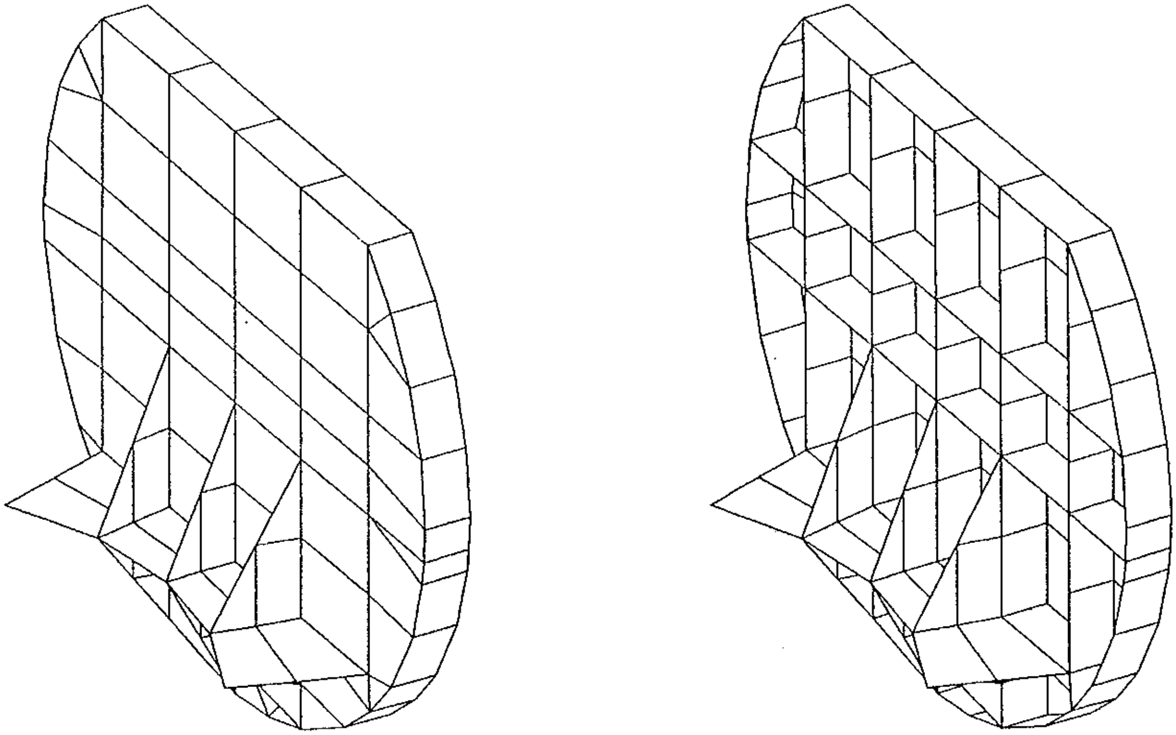


FIGURE 5

Altitude disk plate elements with and without near elements.

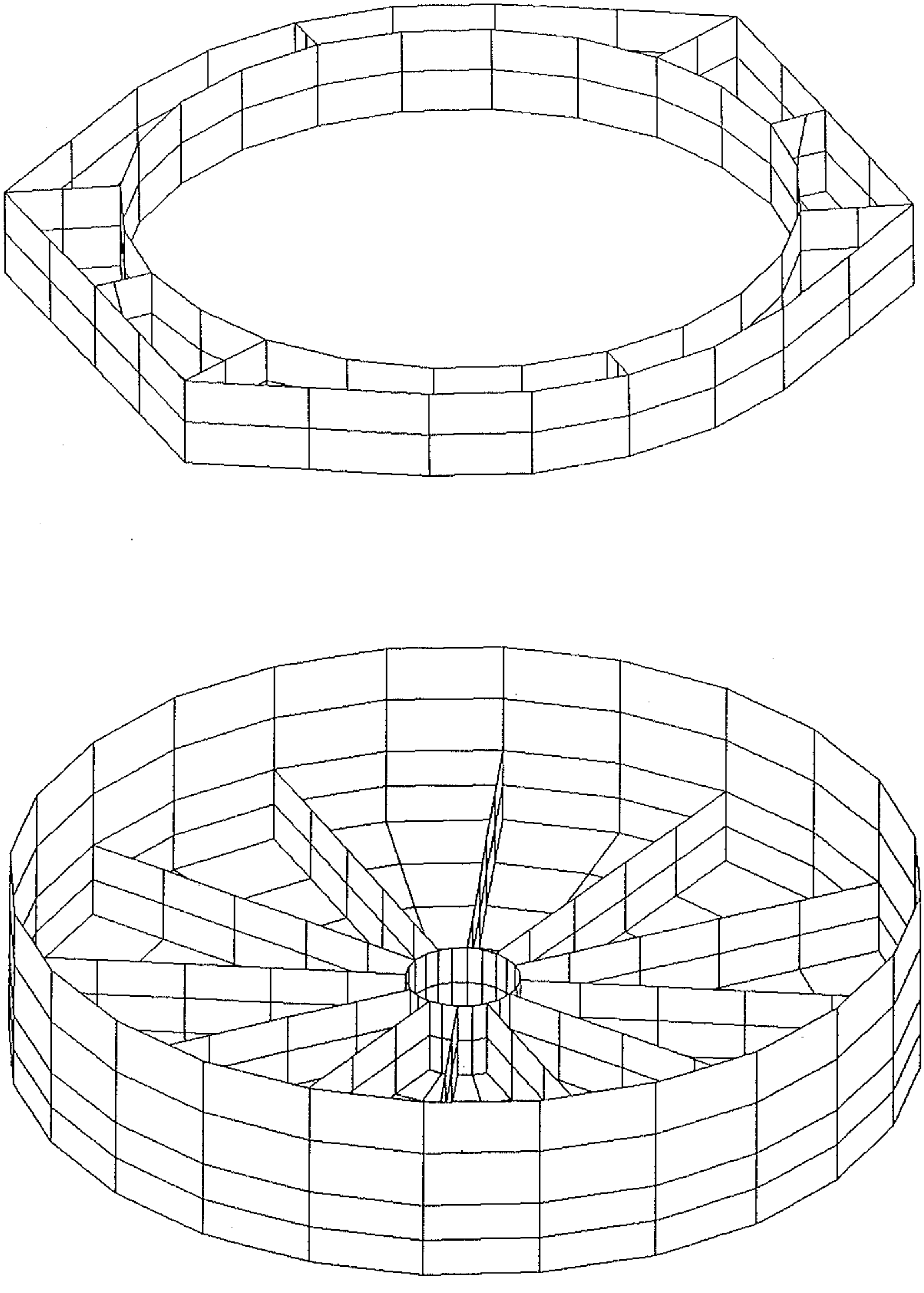


FIGURE 6

Mirror cell and center section plate elements, near plates removed.

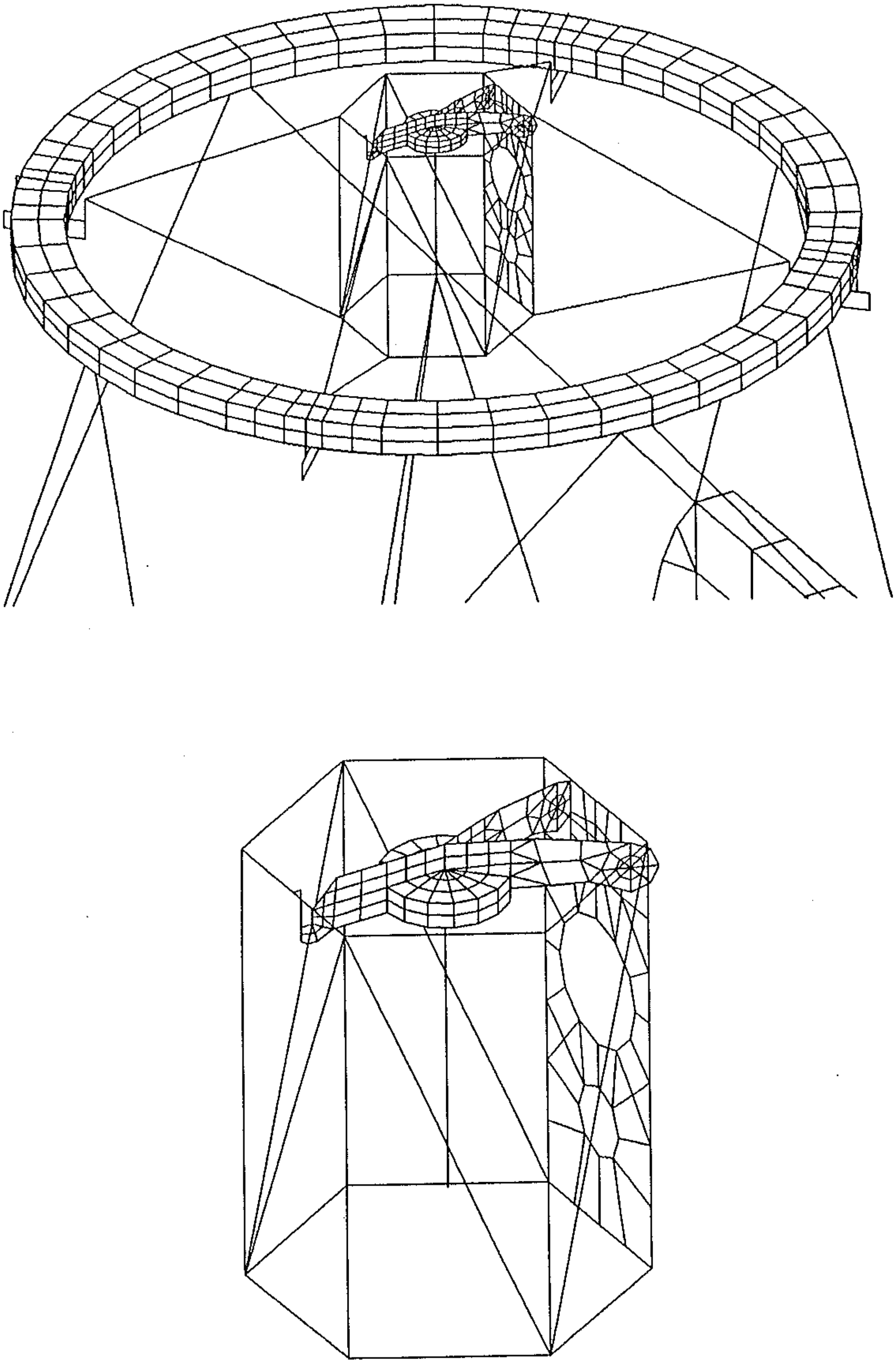


FIGURE 7

Secondary end plate and beam elements.

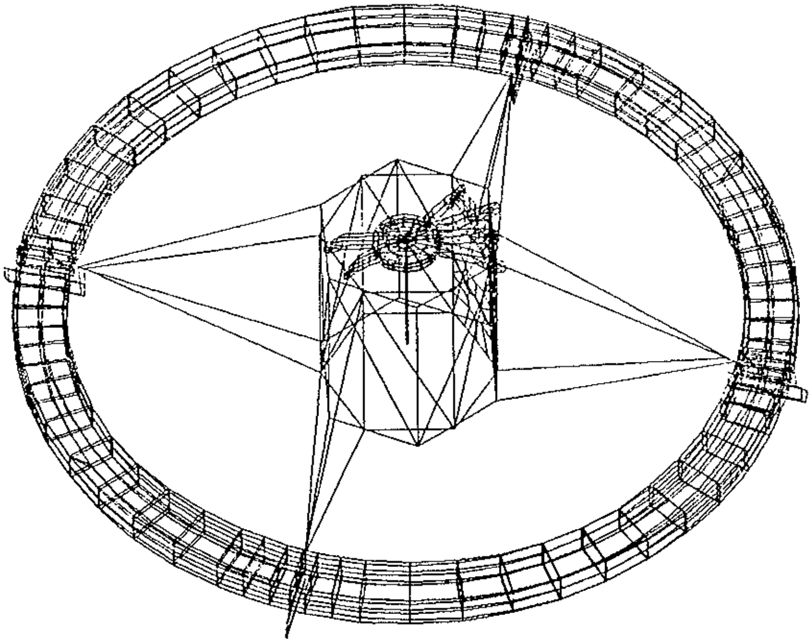


FIGURE 8 - Mode 1, rotation of the secondary assembly around the optical axis, at 8.5 hz.

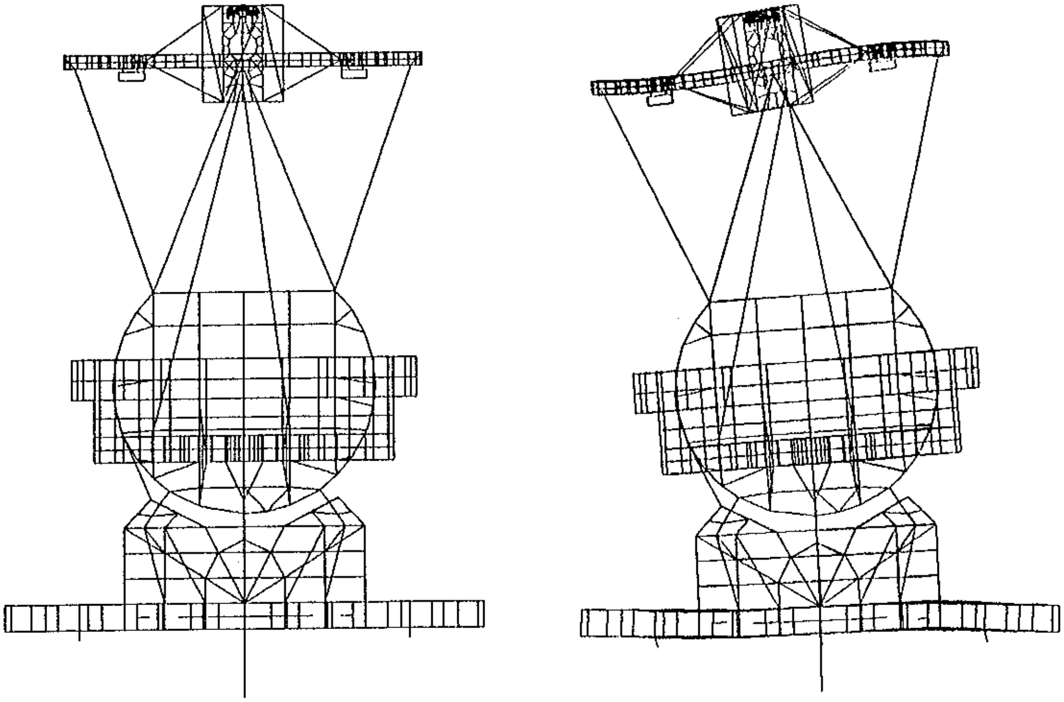


FIGURE 9 - Side view of model TD65M37, the telescope modal analysis model. The left view is of the undisturbed telescope. The right view is of mode 2, the first primary modeshape (first altitude rotation), with a frequency of 10.6 hz. Although difficult to tell here, the OSS and azimuth system are in phase here, both having displaced aft (to the left). The OSS motion (rotation about an axis parallel to the altitude axis) is dominant.

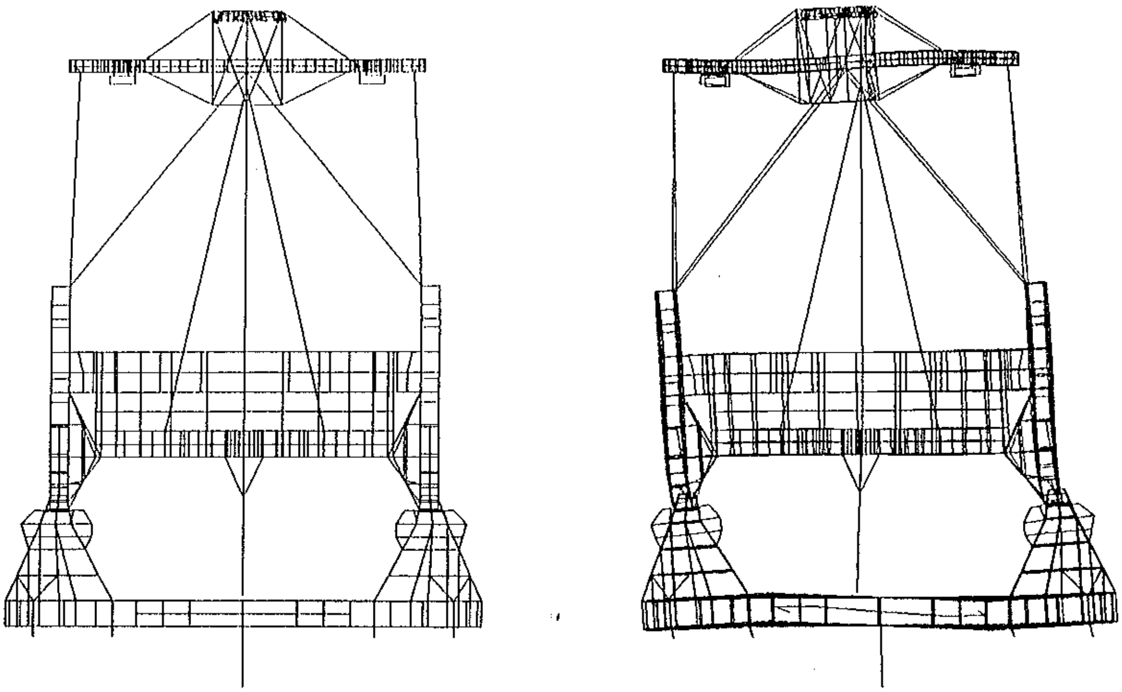


FIGURE 10 - Front view of mode 3, lateral translation, at 11.0 hz. Note that, while this mode may not couple to either locked encoder mode, there is a significant rotation of the primary mirror target, and a significant decenter of the secondary mirror.

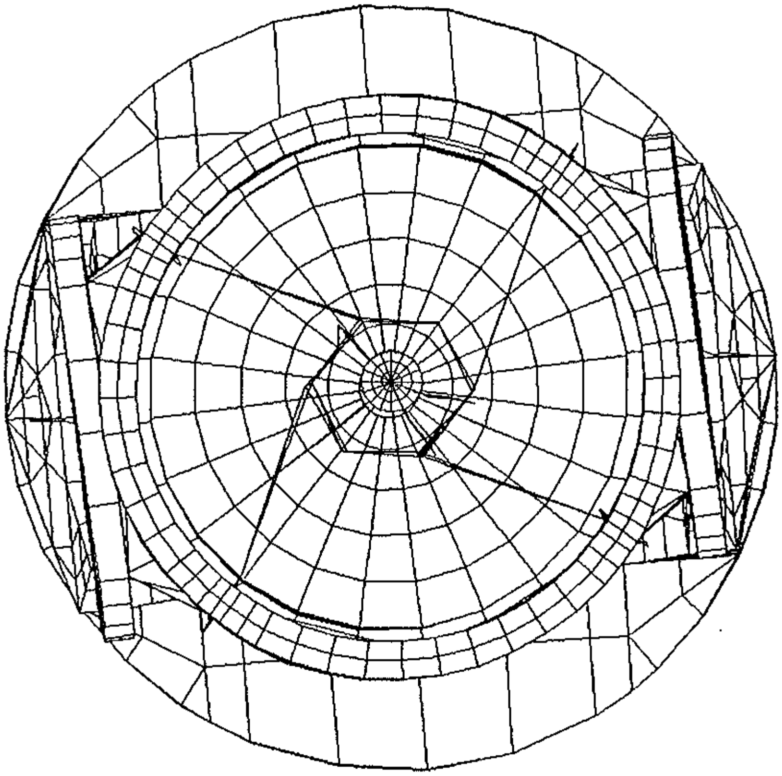
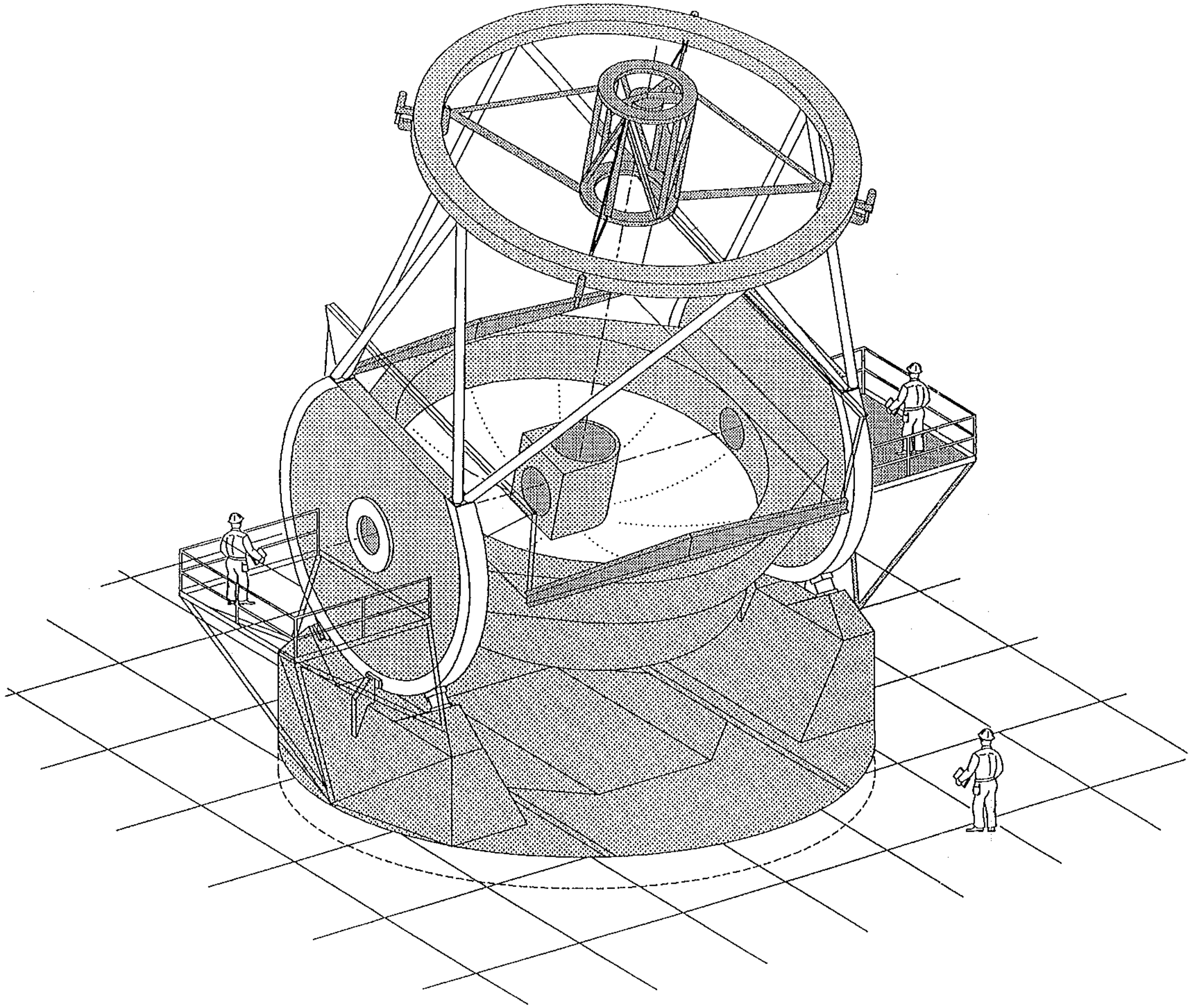


FIGURE 11 - Top view of mode 4, locked encoder rotation about the azimuth axis, at 13.3 hz. Note that the azimuth structure and most of the OSS has rotated counterclockwise here. This is the second rotation mode for the secondary end, so it is out of phase with the rest of the telescope (clockwise rotation).



L&F INDUSTRIES
HUNTINGTON PARK, CA

NEXT ASSEMBLY
(PRELIMINARY DESIGN)

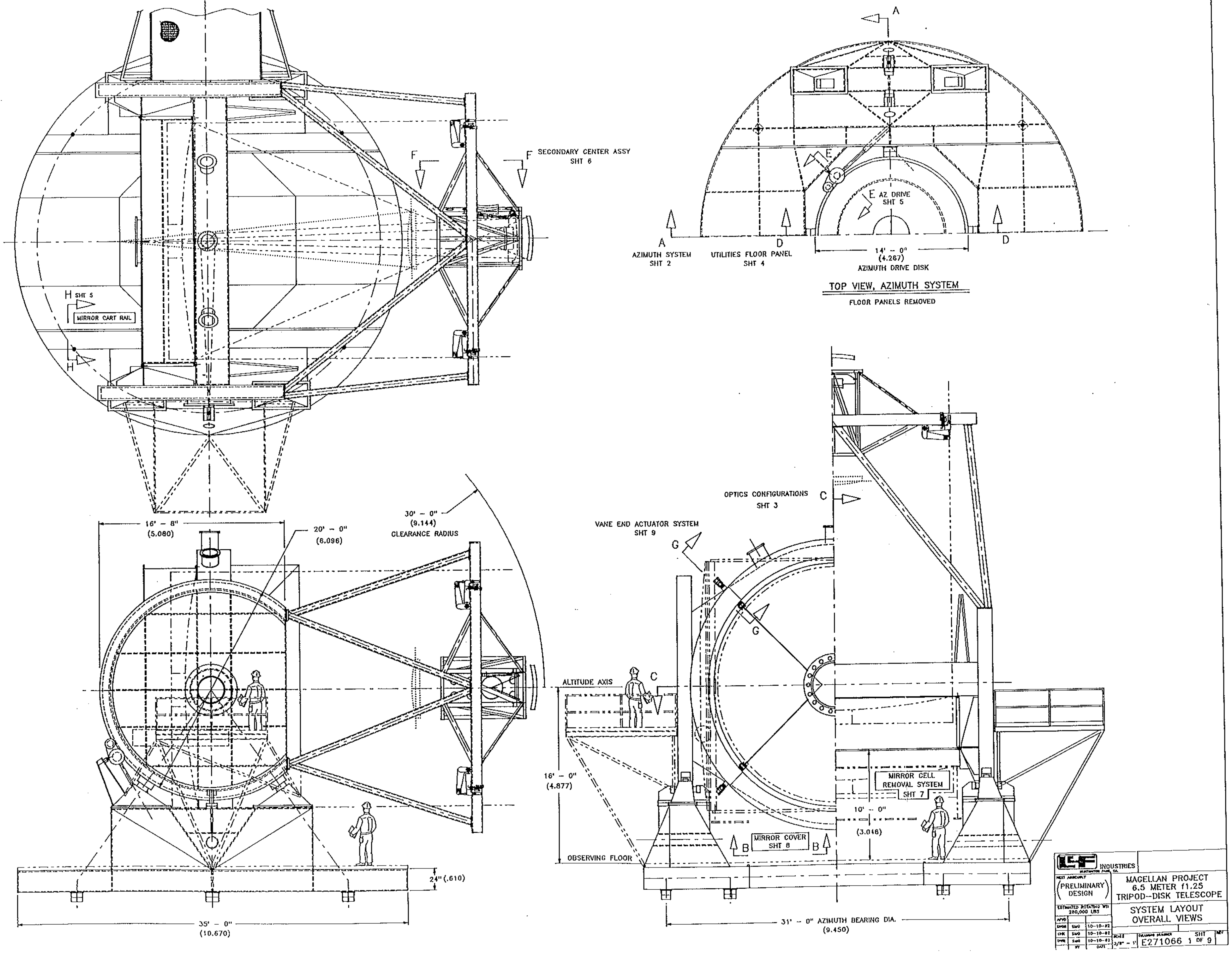
ESTIMATED ROTATING WT
260,000 LBS

APVD		
ENGR	SMG	10-10-91
CHK	SMG	10-10-91
DWN	SMG	10-10-91
	BY	DATE

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD-DISK TELESCOPE

RENDERING

SCALE 1" = 1'
DRAWING NUMBER E271067
REV



L-F INDUSTRIES
HUNTINGTON PARK, CA

NEXT ASSEMBLY
(PRELIMINARY DESIGN)

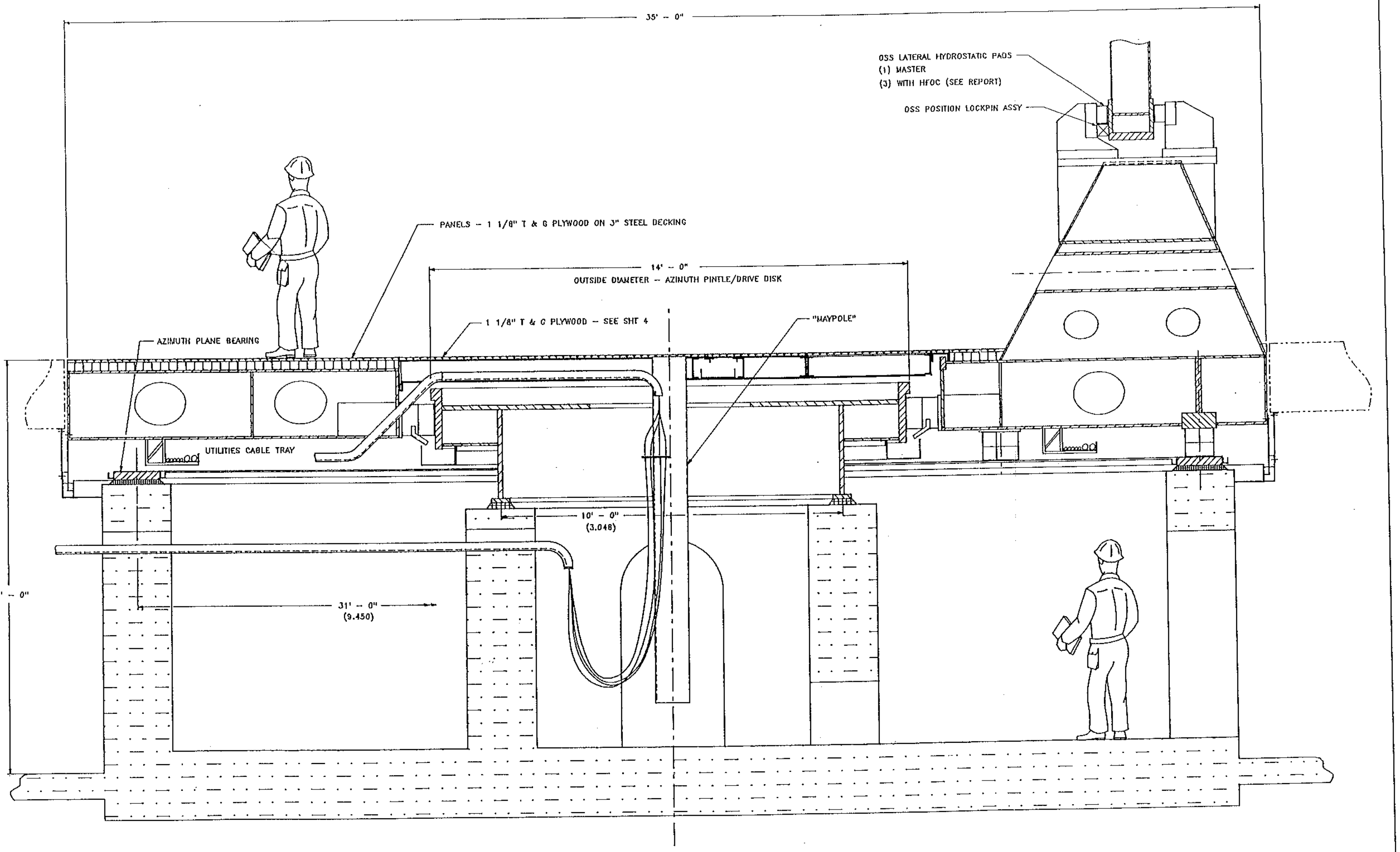
ESTIMATED ROTATING WT
280,000 LBS

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD–DISK TELESCOPE

SYSTEM LAYOUT
OVERALL VIEWS

	BY	DATE
APVD		
ENGR	SWQ	10-10-92
CHK	SWQ	10-10-92
DWN	SWQ	10-10-92

SCALE 3/8" = 1'
DRAWING NUMBER E271066
SHT 1 OF 9
REV



SECTION A--A SHT 1

SCALE: 1" = 1' – 0"

L&F INDUSTRIES

NEXT ASSEMBLY

(PRELIMINARY DESIGN)

ESTIMATED ROTATING WT 280,000 LBS

APVD		
DRWN	SWB	10-10-91
CHK	SWB	10-10-91
ENG	SWB	10-10-91
	BY	DATE

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD-DISK TELESCOPE

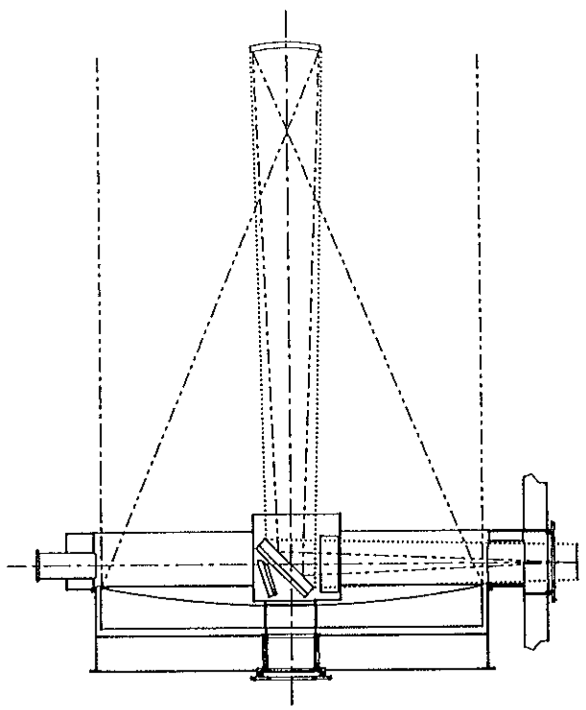
SYSTEM LAYOUT
AZIMUTH SYSTEM

SCALE 1" = 1'

DRAWING NUMBER E271066

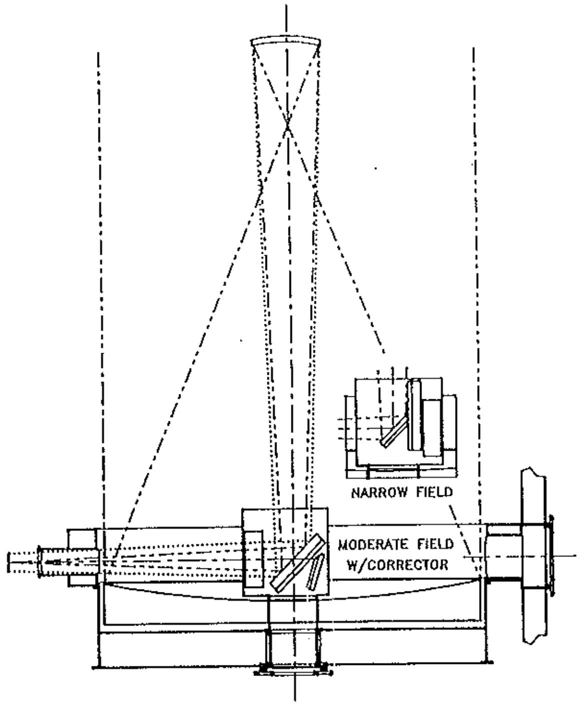
SHT 2 OF 9

REV



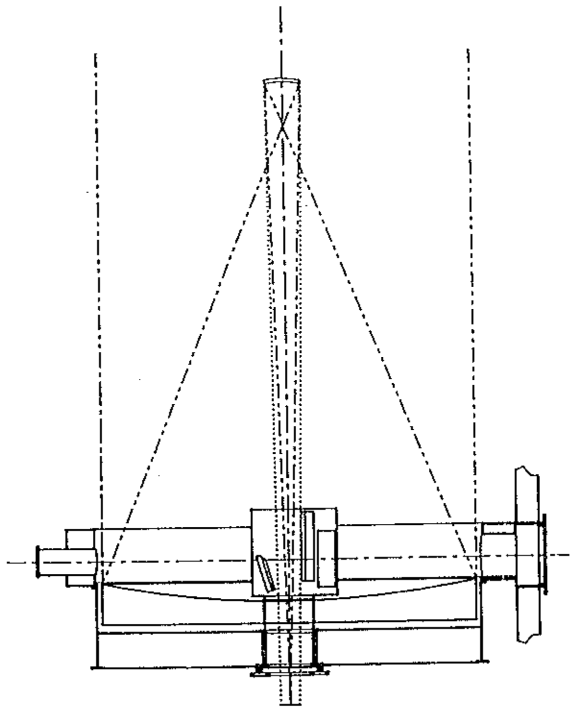
f12/OPTICAL/GREGORIAN/NASMYTH 1, NASMYTH 2

SCALE: 1/40



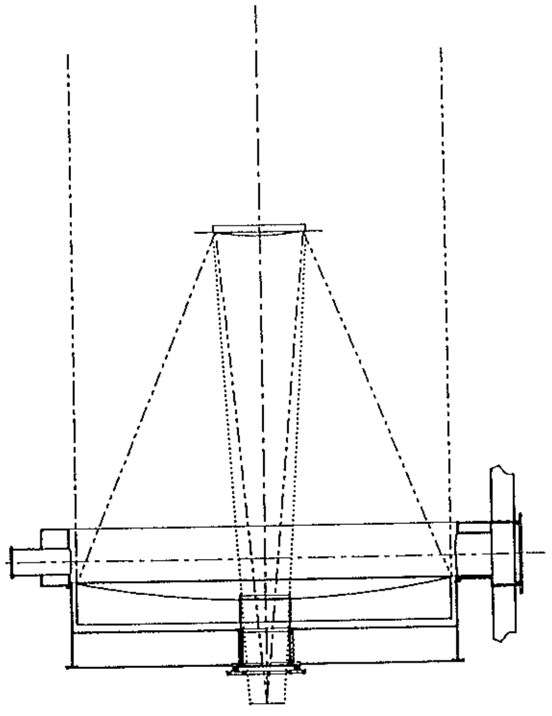
f12/OPTICAL/GREGORIAN/FOLDED PORTS 1–3

SCALE: 1/40



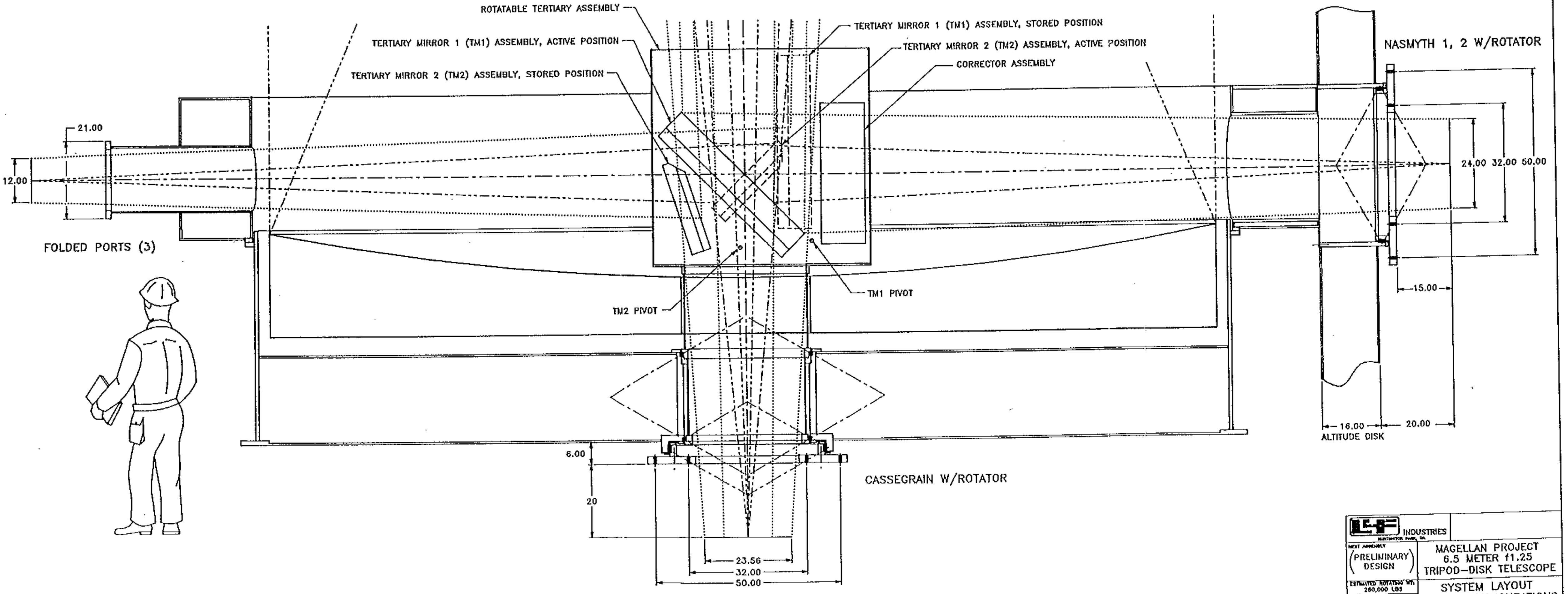
f17.5/INFRARED/GREGORIAN/CASSEGRAIN

SCALE: 1/40



(FUTURE) f5 WIDE FIELD/OPTICAL/CONVENTIONAL/CASSEGRAIN

SCALE: 1/40



COMPOSITE VIEW

SCALE: 1/10

INDUSTRIES
HUNTINGTON PARK, CA

NEXT ASSEMBLY
(PRELIMINARY DESIGN)

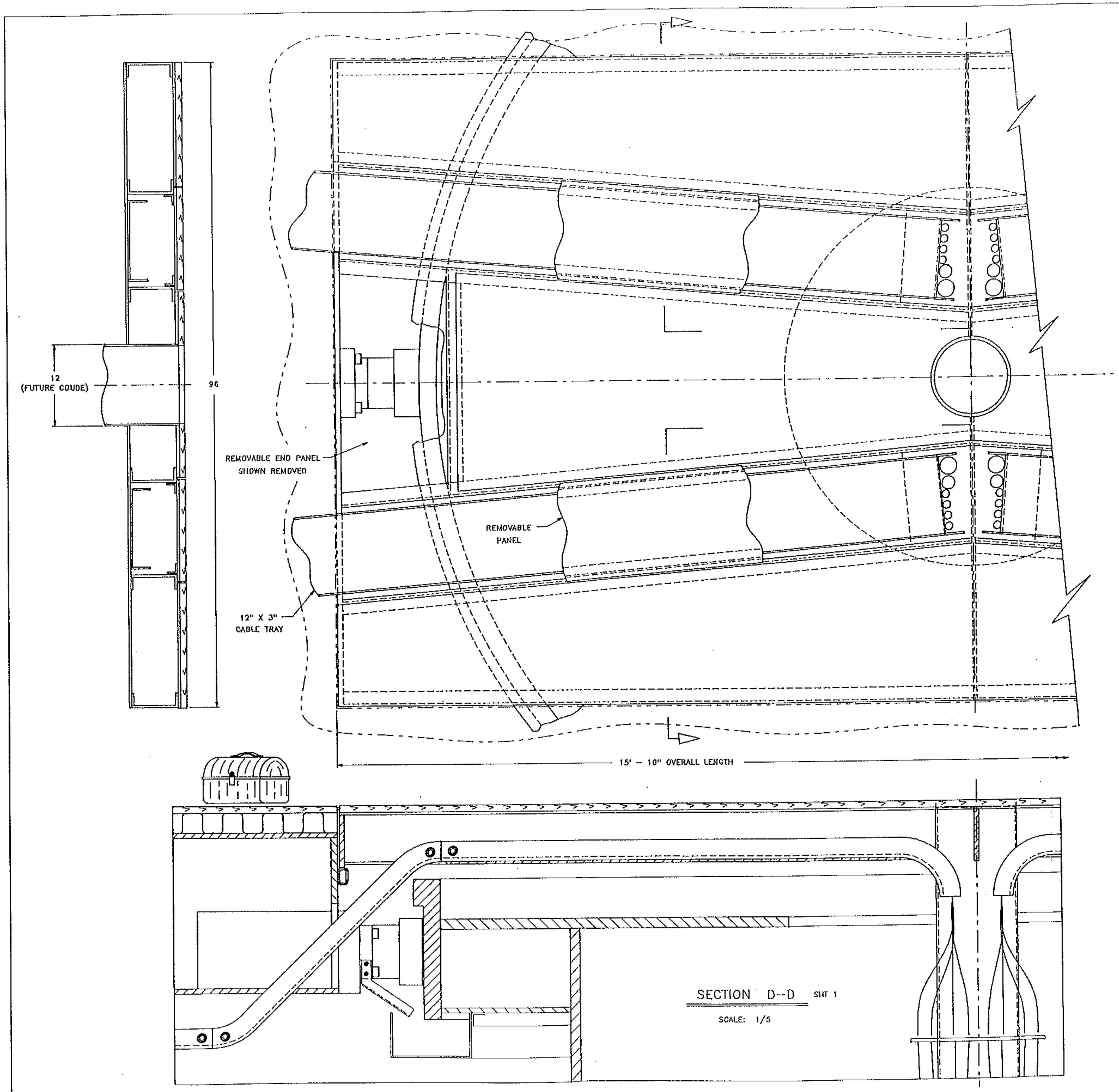
ESTIMATED ROTATING WT.
260,000 LBS

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD–DISK TELESCOPE

SYSTEM LAYOUT
OPTICS CONFIGURATIONS

	BY	DATE
APVD		
ENGR	JMQ	10-10-92
CHK	EMN	10-10-92
DWN	JMQ	10-10-92

SCALE NOTED
DRAWING NUMBER E271066
SHT 3 OF 9
REV



SECTION D–D SHT 1

SCALE: 1/5

L&F INDUSTRIES

NEXT ASSEMBLY

(PRELIMINARY DESIGN)

ESTIMATED ROTATING WT
200,000 LBS

MAGELLAN–PROJECT
6.5 METER f1.25
TRIPOD–DISK TELESCOPE

SYSTEM LAYOUT
UTILITIES FLOOR PANEL

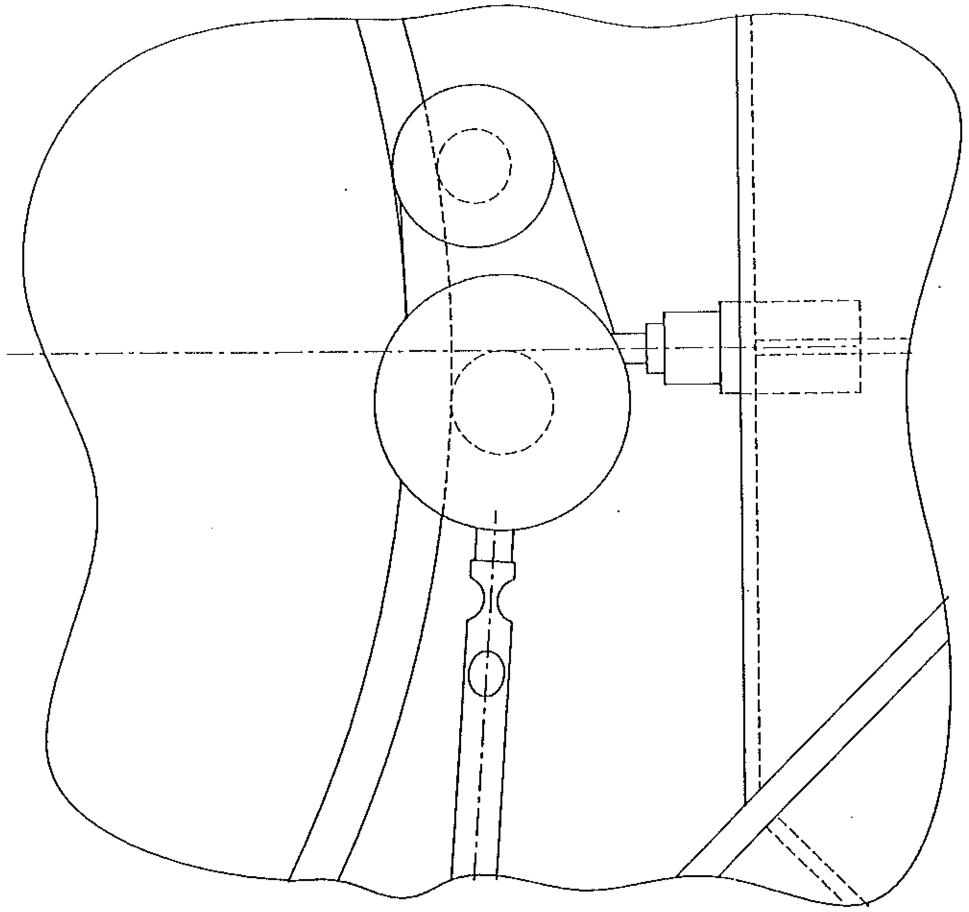
	BY	DATE
APVD		
ENGR	[illegible]	10-10-92
CHK	[illegible]	10-10-92
DWN	[illegible]	10-10-92

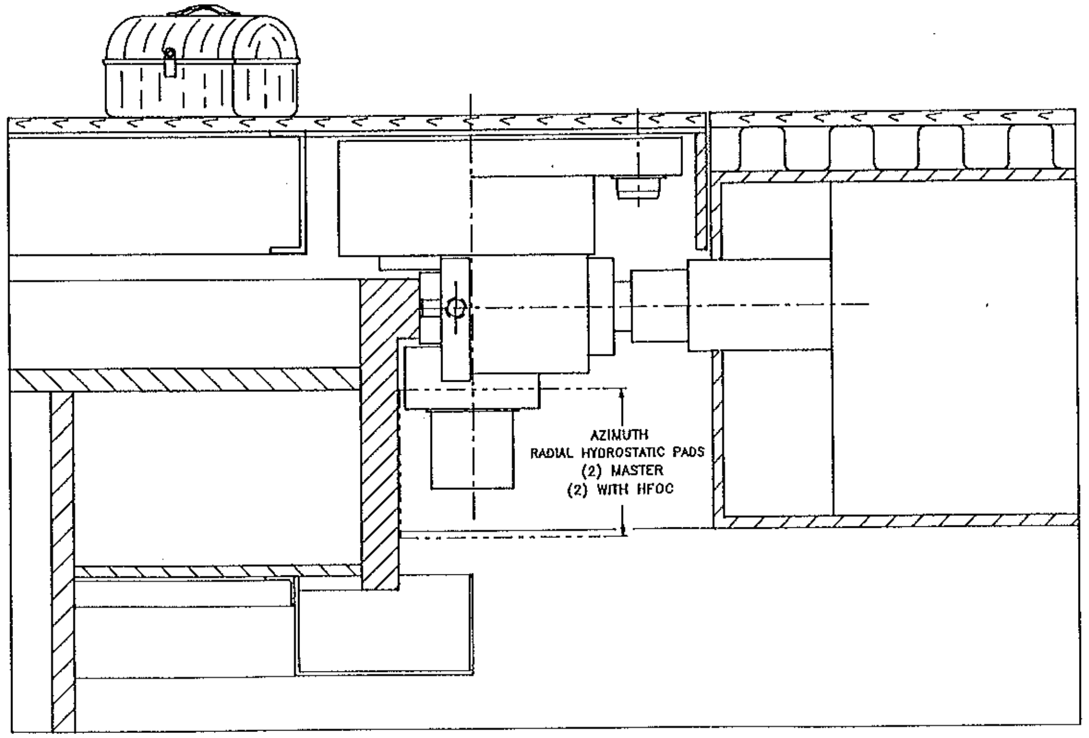
SCALE 3/8" = 1'

DRAWING NUMBER E271066

SHT 4 OF 9

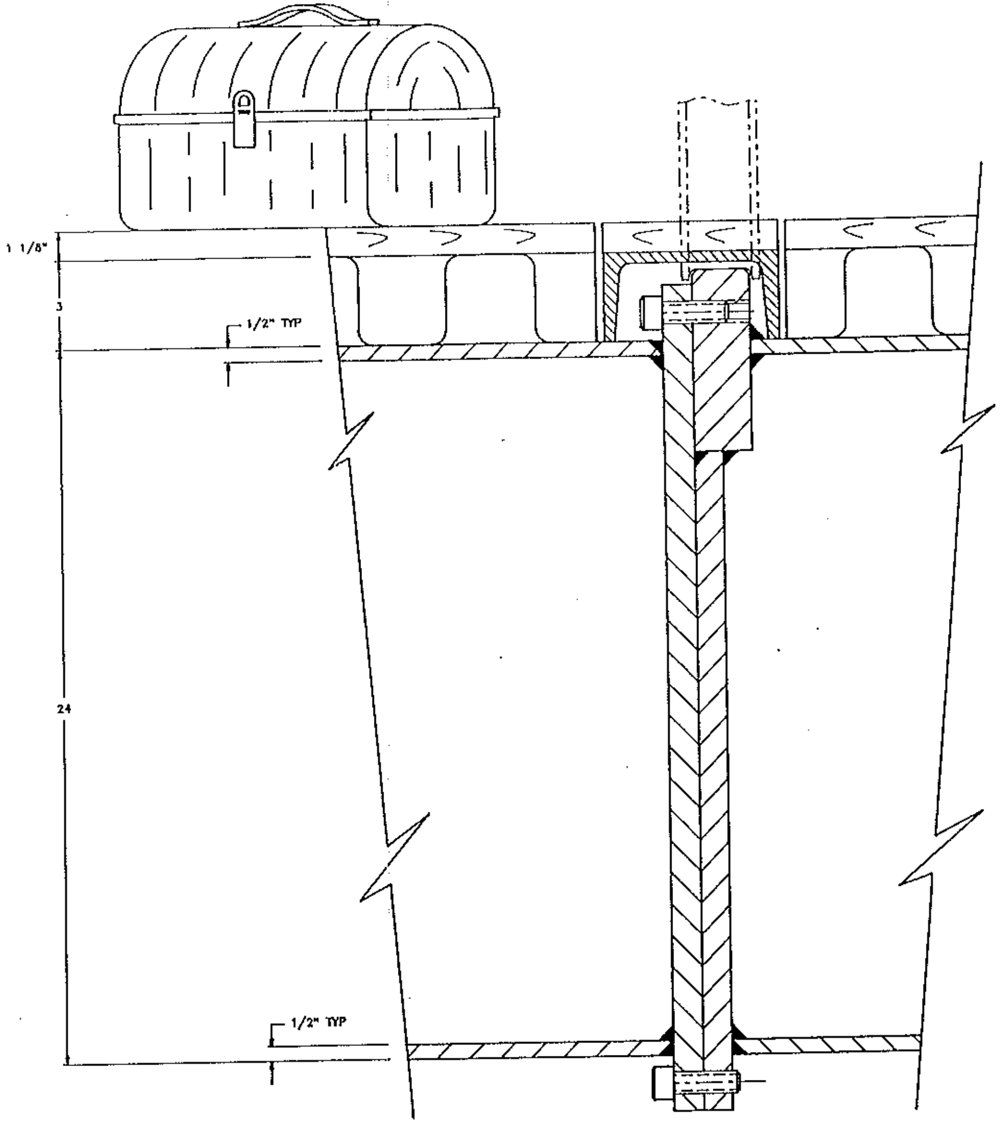
REV





SECTION E–E SHT 1

SCALE: 1/4



SECTION H–H SHT 1

SCALE: 1/2

L&F INDUSTRIES

(PRELIMINARY DESIGN)

ESTIMATED ROTATING WT.
200,000 LBS

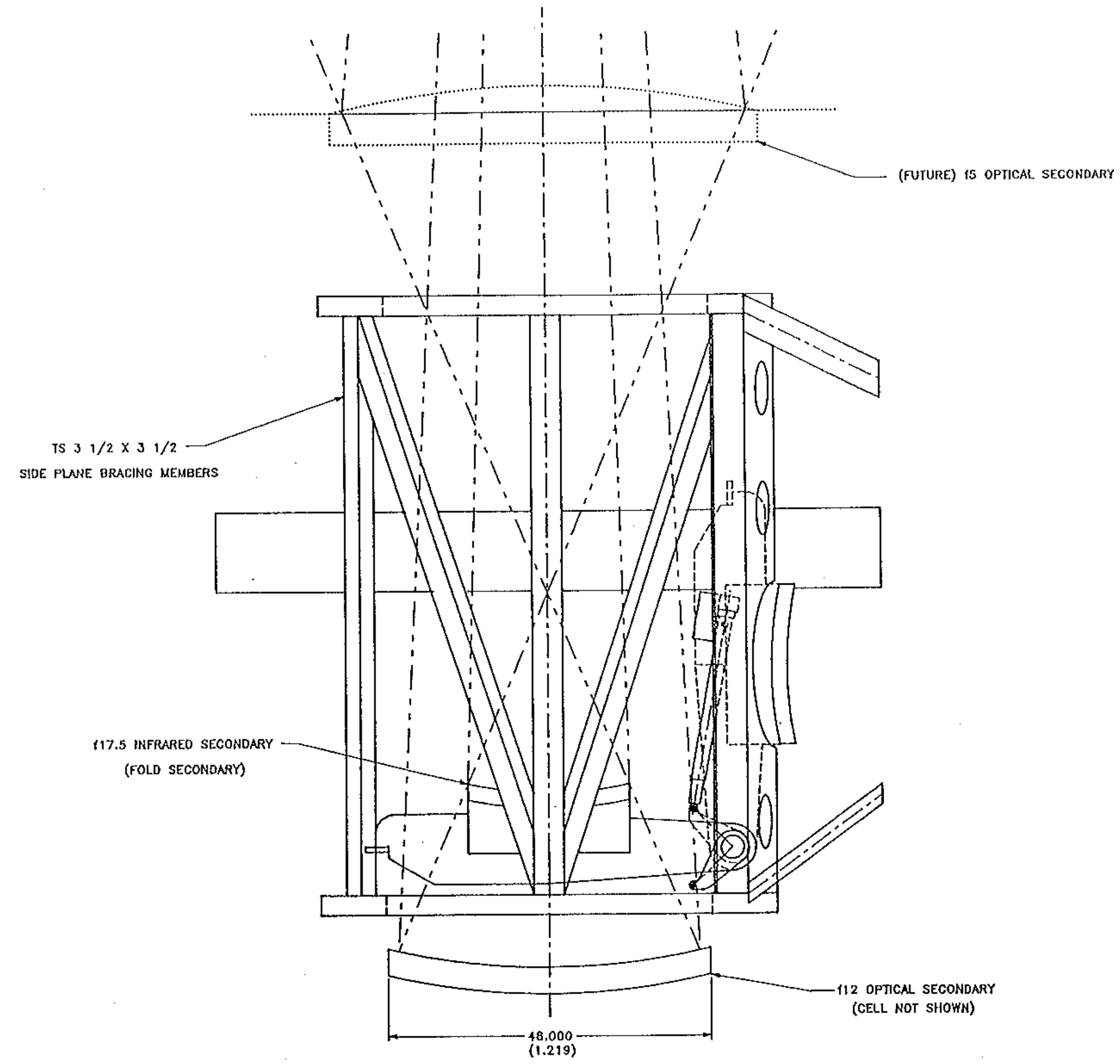
MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD–DISK TELESCOPE

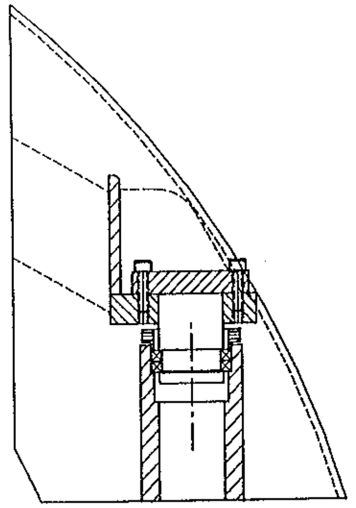
SYSTEM LAYOUT
MISC. SECTIONS

SCALE NOTED

E271066

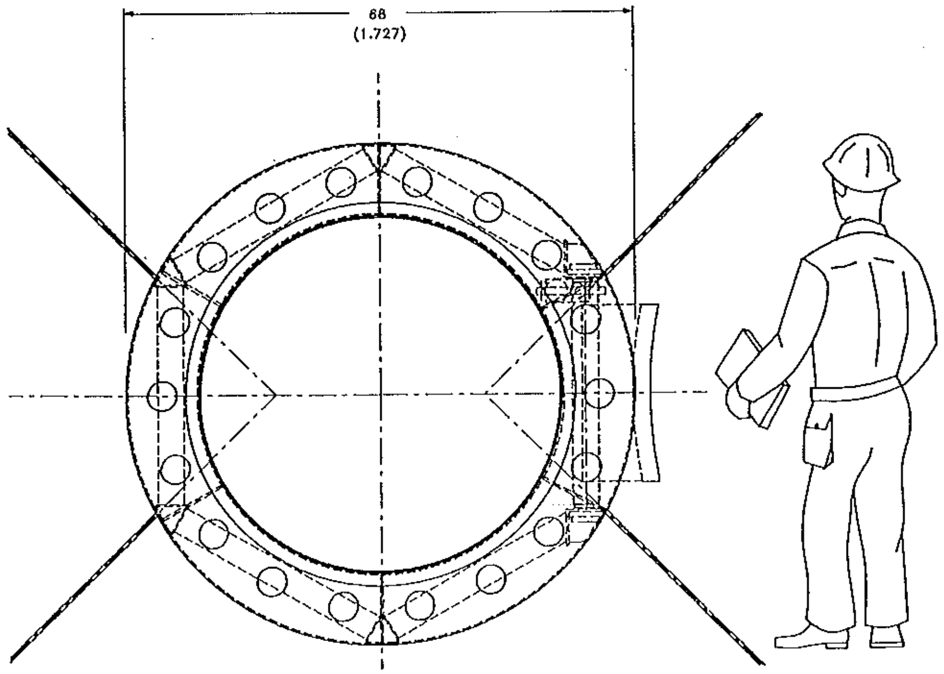
SHT 5 OF 9

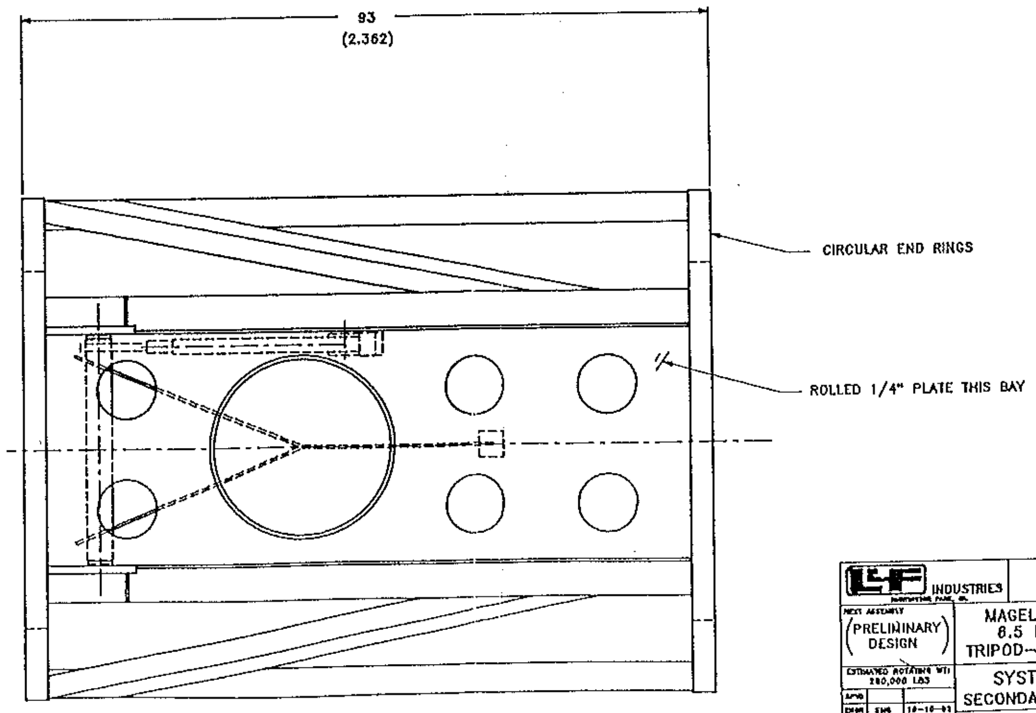




FOLD SECONDARY PIVOT

SCALE: 1/2





INDUSTRIES

NEXT ASSEMBLY
(PRELIMINARY DESIGN)

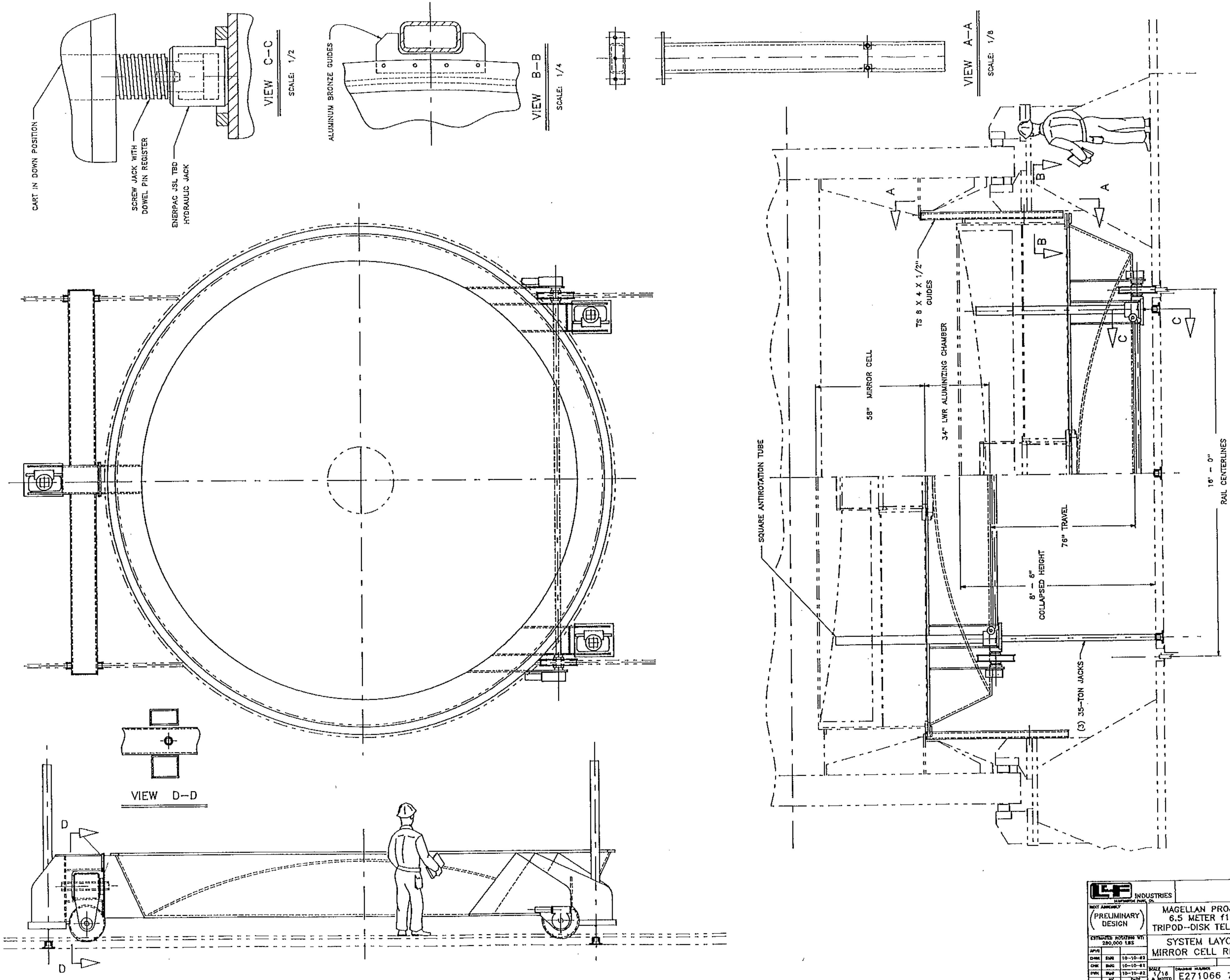
ESTIMATED ROTATING WT: 280,000 LBS

	BY	DATE
APVD		
ENGR	[illegible]	10-10-91
CHK	[illegible]	10-10-91
DWN	[illegible]	10-10-91

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD~DISK TELESCOPE

SYSTEM LAYOUT
SECONDARY~CENTER ASSY

SCALE 1/8
DRAWING NUMBER E271066
SHT 6 OF 9
REV



L&F INDUSTRIES
HUNTINGTON PARK, CA

NEXT ASSEMBLY
(PRELIMINARY DESIGN)

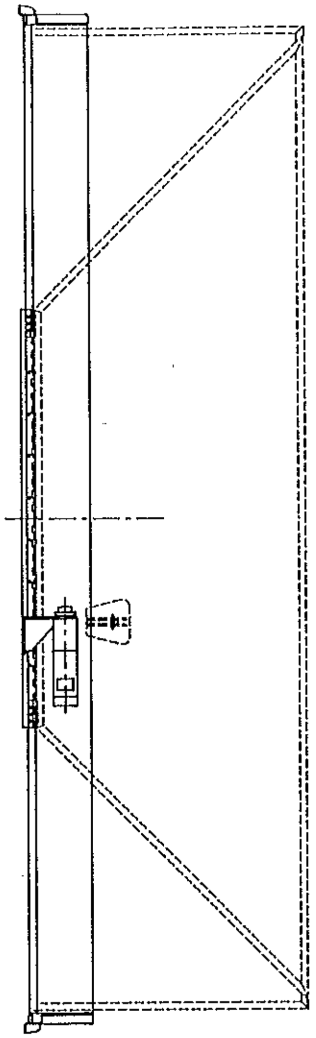
ESTIMATED ROTATING WT: 280,000 LBS

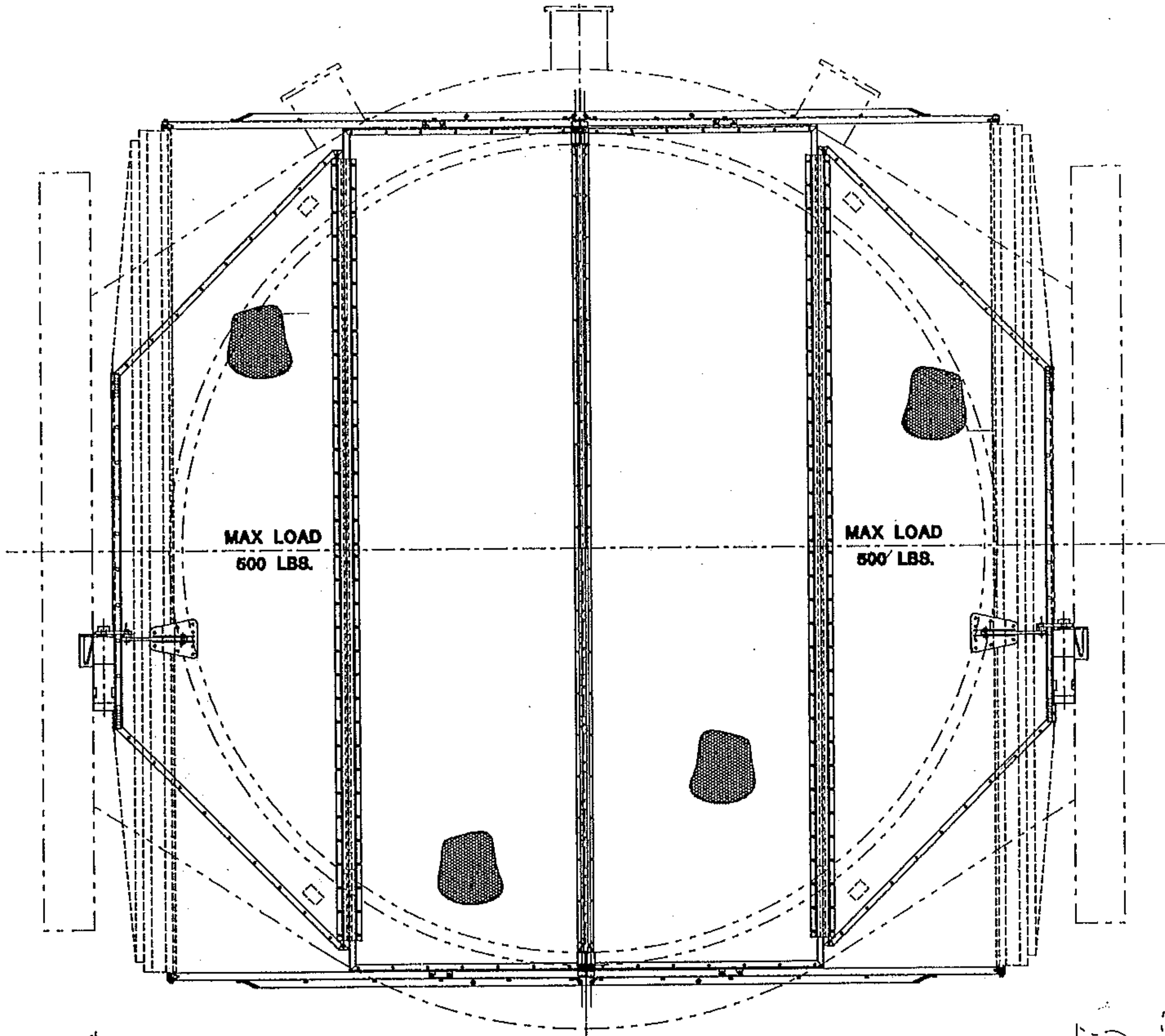
APV'D		
DSN	[illegible]	10-10-92
CHK	[illegible]	10-10-92
DWN	[illegible]	10-10-92
	BY	DATE

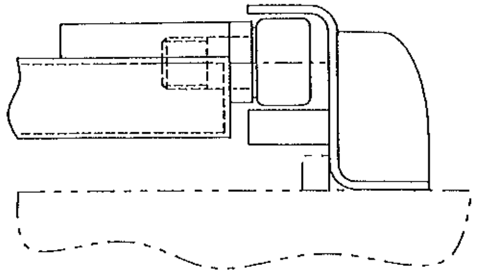
MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD–DISK TELESCOPE

SYSTEM LAYOUT
MIRROR CELL REMOVAL

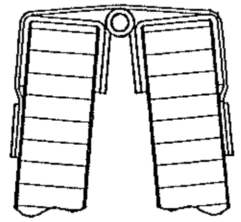
SCALE 1/16 & NOTED
DRAWING NUMBER E271066
SHT 7 OF 9
REV



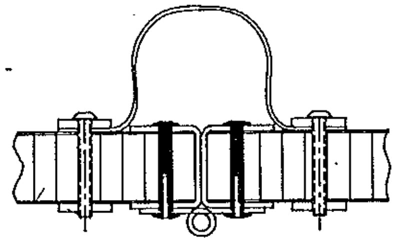




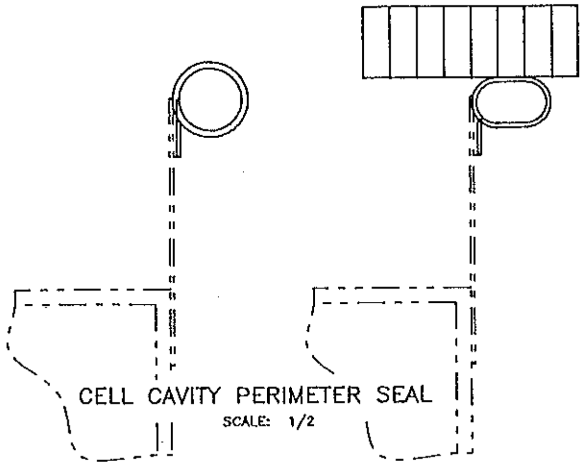
TRACK ROLLER/TRACK
SCALE: 1/2



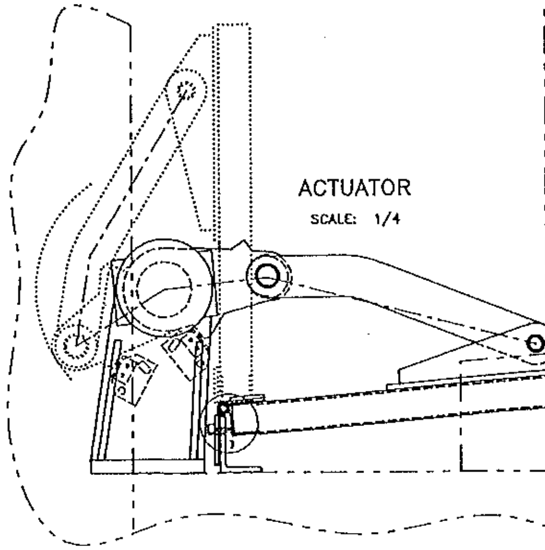
HINGE/SEAL
OPEN
SCALE: 1/2



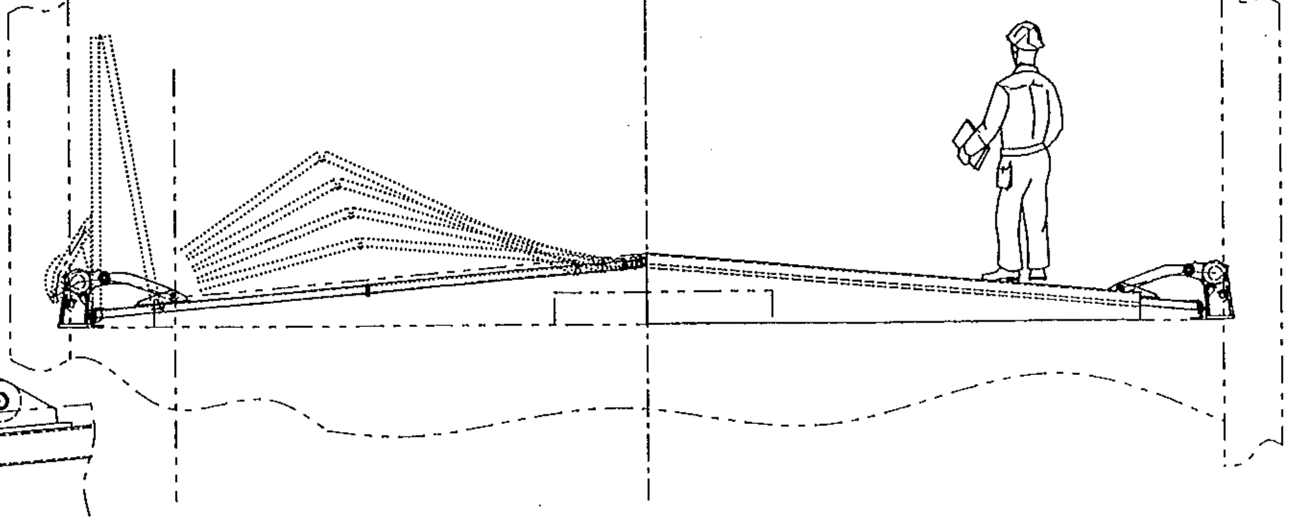
HINGE/SEAL
CLOSED
SCALE: 1/2

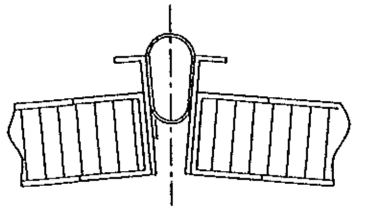


CELL CAVITY PERIMETER SEAL
SCALE: 1/2



ACTUATOR
SCALE: 1/4





PARTING LINE SEAL
SCALE: 1/2

L&F INDUSTRIES
HUNTINGTON PARK, CA.

NEXT ASSEMBLY
PRELIMINARY DESIGN

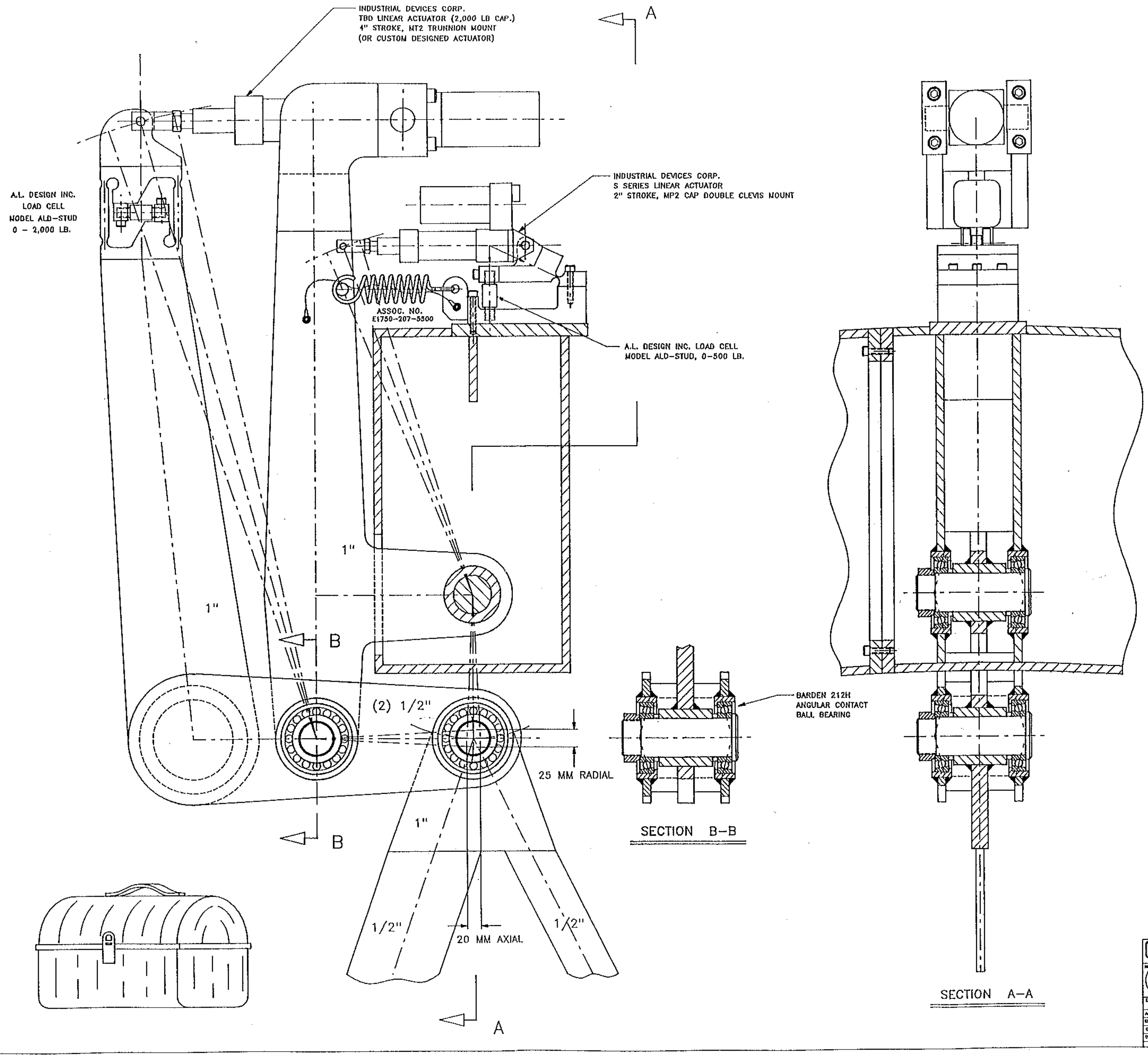
ESTIMATED ROTATING WT
280,000 LBS

APPD		
DSGN	[illegible]	10-10-92
CHK	[illegible]	10-10-92
DWN	[illegible]	10-10-92
	BY	DATE

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD-DISK TELESCOPE

SYSTEM LAYOUT
MIRROR COVER

SCALE 1/16 & NOTED
DRAWING NUMBER E271066
SHT 8 OF 9
REV



L&F INDUSTRIES
HUNTINGTON PARK, CA

NEXT ASSEMBLY
(PRELIMINARY DESIGN)

ESTIMATED ROTATING WT
260,000 LBS

APVD		
ENGR	GMG	10-10-92
CHK	GMG	10-10-92
DWN	GMG	10-10-92
	BY	DATE

MAGELLAN PROJECT
6.5 METER f1.25
TRIPOD-DISK TELESCOPE

SYSTEM LAYOUT
VANE END ACTUATORS

SCALE 1/2
DRAWING NUMBER E271066
SHT 9 OF 9
REV