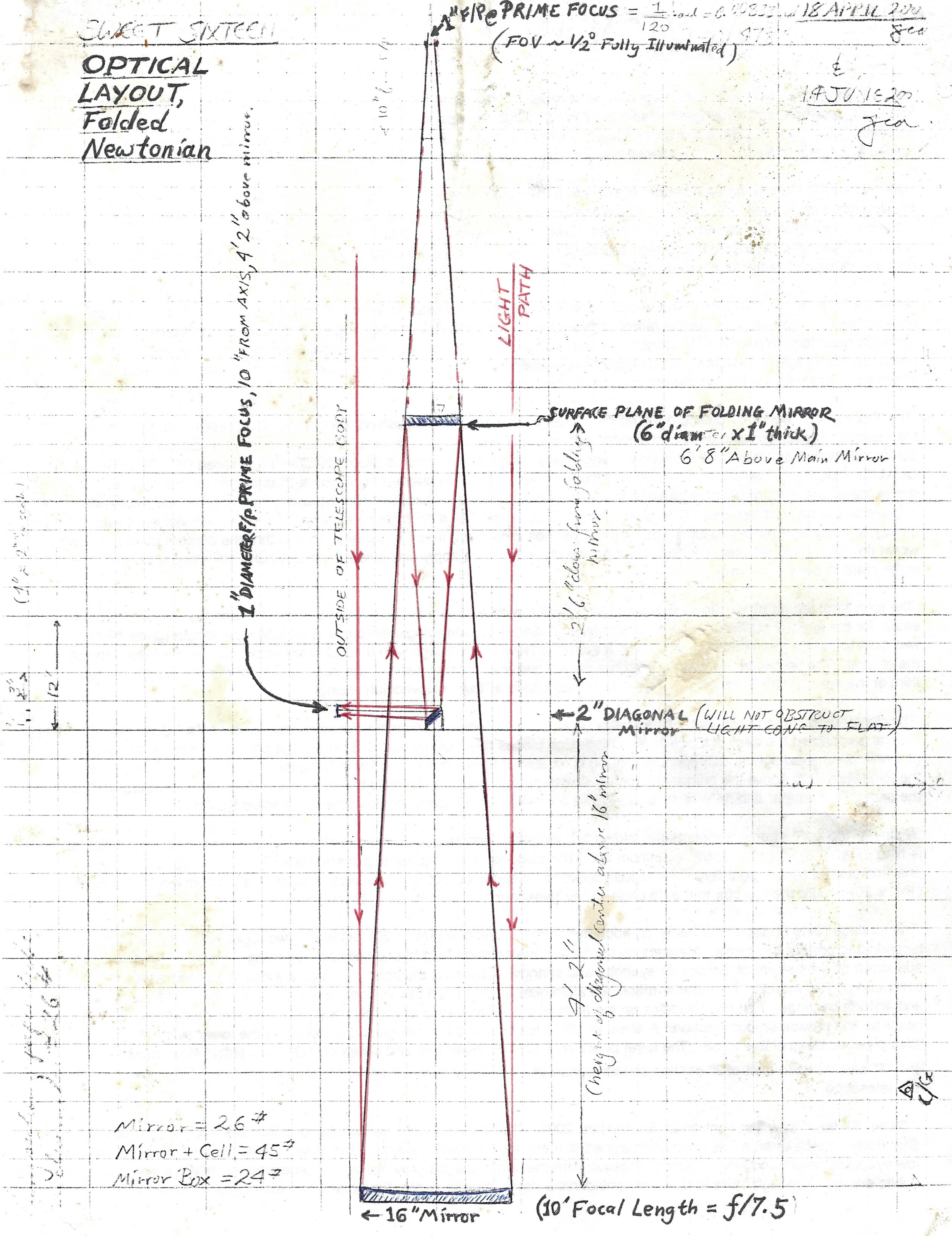
SWEET SIXTEEN

OPTICAL LAYOUT, Folded Newtonian



18 APRIL 200
Jca

&

14 JUNE 200
Jca

Mirror = 26#
Mirror + Cell = 45#
Mirror Box = 24#

16" f/7.5 NEWTONIAN, FOLDED & FLEXED

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NOVAC
03/02

"Sweet Sixteen" is NOVAC's new large club telescope. Club member Bill Powers generously donated a large (16" f/7.5) mirror, other optics, and structural material to NOVAC. Club President, Ed Karch, designated a "Gang of Sixteen", all notorious ATM nuts, to build a telescope from this treasure hoard. Six months of work have resulted in an unusual large Folded Newtonian reflector, with a special "flexing" mirror design, on a modified Dobsonian mount. Here is the story:

The primary f/7.5 mirror has a diameter of 16" and a thickness of 1.5" . Testing by Guy Brandenburg, at his AMU mirror grinding lab, established that the mirror had a fine smooth spherical figure and a focal length of ten feet. The aluminum coating was dull, but the expert optical engineer, Dwight Cumberland, of CUMBERLAND OPTICAL, in Marlow Heights, Maryland, was able to restore it to a high degree of reflectivity. These are good people! Rather than charge me for the good hour's work using "secret arts", they urged me to consider it as their contributuion to NOVAC.

At some future time, when the mirror needs recoating, the club may want to refigure it into a parabola. For now, we are using it "as is". Sort of. A spherical mirror of this size will produce star images degraded by aberration. However, using methods described in recent ATM literature, a special mounting was built to mechanically distort the mirror into a more nearly parabolic figure. It works! When leverage is applied to "flex" the mirror, the quality of star images noticeably improves. Ours may be the largest mirror to be so "flexed".

The "flexing cell" works by pulling down on the center of the mirror while pushing the rim up. This deepens the curvature of the surface from spherical to parabolic (a difference of about one wave). The outer shell of the cell is made from a 15" automobile wheel rim (borrowed precision!). The outside edge of the mirror is glued ("GOOP") and taped ("PROFESSIONAL QUALITY DUCT") to the lip of the rim. A 1/8" thick rubber pad, 13" in diameter and with a 2" diameter central hole, cut from dense foam "wet suit" material is glued to the back of the mirror. An aluminum "puller plate", 1/2" thick by 13" in diameter, is glued to the back of this pad. (The glue is "3 M" SCOTCH-GRIP #1357 High Performance Contact Adhesive. It was messy to apply and tended to lump up). A long 3/8" bolt runs down from the puller plate and thru the center hub of the wheel rim. A spring, washer, and wing - nut on the end of the bolt apply compression on the outer shell and tension on the puller plate to bend the mirror.

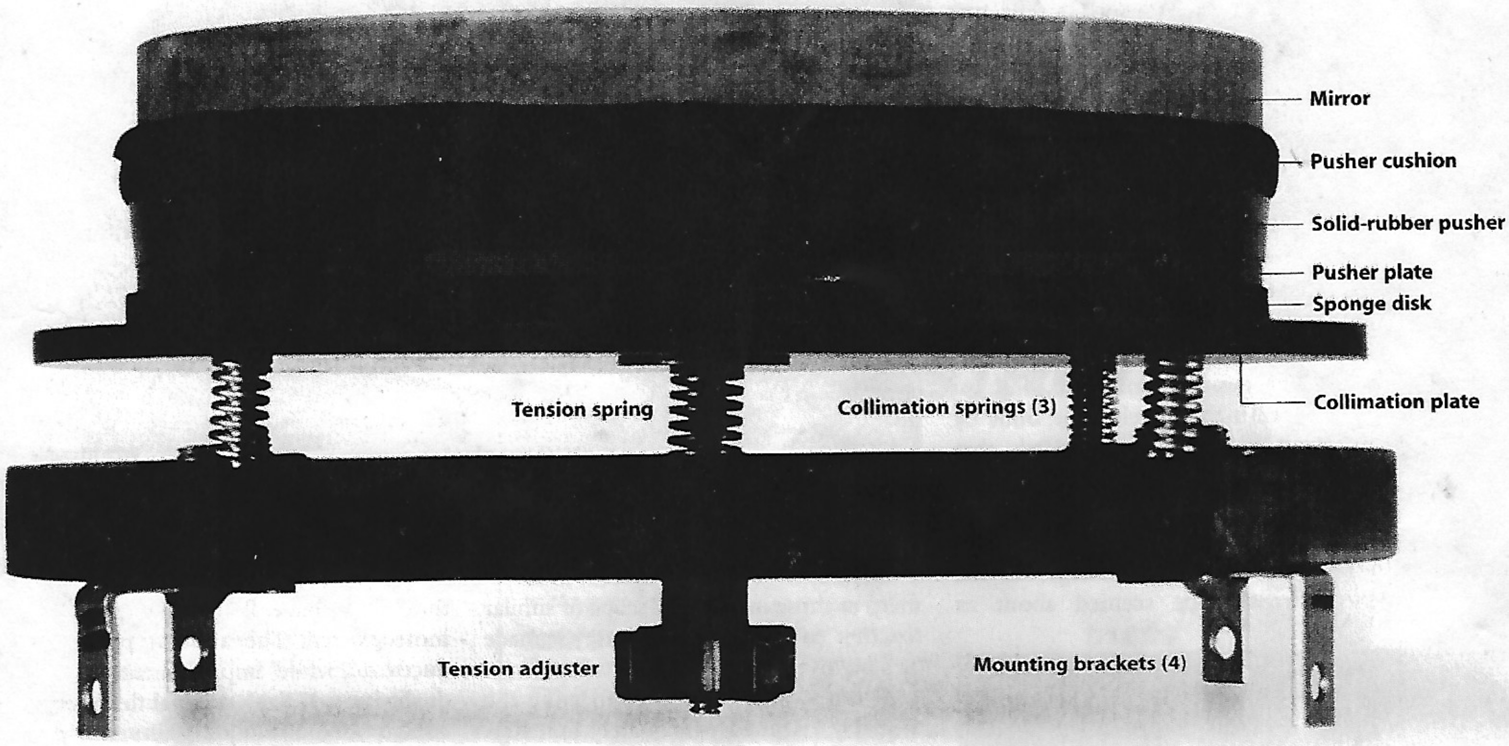
The long focal length of 10' allows the use of long focal length eyepieces. This is good. John Dobson holds that these are easier for the general public to use. Accordingly, a 2" diameter wide - angle eyepiece of 44 MM focal length (gives 70 X) was built to match the telescope. However, a standard Newtonian design with a 10' primary would put the eyepiece high off the ground. The tall ladder required might have proven awkward for the public in the dark. Thus, for our telescope, the top third of the optical path is folded back upon itself to produce a "folded Newtonian" design.

The donated optics included some high quality (one twentieth wave!) 6" diameter fused quartz optical flats. Cumberland Optical aluminized the best of these flats. Our design places this "folding flat" 6' 8" above the primary mirror. A 2" diagonal (the only purchased optical component//ORION) is located 2' 6" down from the flat to bring the prime focus out the side of the telescope 4' 2" above the primary mirror. A simple push-pull 2" focuser holds the eyepiece. The 6" flat obstructs 37% of the primary's diameter and 14% of its area. These are reasonable figures, comparable to standard SCT designs.

A single "top box" structure mounts the folding flat, diagonal, and focuser in fixed relation to each other. The adjustable flat is held by a "T" spider of 1" x 1/8" aluminum bar. The diagonal is fixed (after alignment) on a single 1" x 1/8" cross bar. The "top box" is built of lightweight 5 MM luan plywood. It slides up out of a "rib cage" built of 1" aluminum angle. Eyebolts (1/4" x 20) secure the top box to the rib cage. They telescope together for ease of transport.

The rib cage rests on top of the heavy plywood mirror box. Eyebolts (1/4" x 20) fasten the two together. The box has a hinged lid to protect the mirror. Magnets on the lid and the rib cage hold the lid open for observing. The mirror cell is supported off the bottom of the box by eyebolts and springs. Opposing thumbscrews lock the cell in position after collimation. Two massive 7" diameter machined aluminum rings bolted to the sides of the mirror box act as lifting handles and altitude bearings. Felt lined saddles on the ends of the vertical arms of the plywood azimuth turret carry these altitude bearings and provide smooth motion. A sheet of 1/8" thick acrylic plastic is glued (pliobond) on the lower side of the 1" thick plywood base of this turret. The turret pivots on a 3/8" diameter bolt and slides on 1/2" thick teflon slabs mounted on the "T" shaped base built of 2" section square aluminum. The base is mounted on 5" diameter casters to facilitate moving the telescope.

"Sweet Sixteen" saw first light on 21 September, 2001. The following night, we used it for public outreach at the NOVAC Star Party. Since then, it has been campaigned at many local outreach events. The basic design features of simplicity, low eyepiece height and long eye relief, together with the bright images provided by the large primary, make it well suited to public events. Although there is room for considerable detail improvements, the project has turned out successfully.



Above: **Flex cell for the author's 8-inch f/6 telescope. Compared to the diagram on page 134, this version has several minor differences. For example, it is now recommended that the multilayer collimation plate, shown here supporting the solid-rubber pusher, be replaced by a single layer of 1/2-inch polycarbonate as shown in the diagram.**

Flexing Spheres into High-Quality Telescope Mirrors

If you can grind and polish a sphere, you can make a telescope mirror that will leave nothing to be desired. | **By Alan Adler**

SINCE THE FIRST NEWTONIAN telescope was made in 1668, opticians have labored (often with difficulty) to produce the required paraboloidal mirror. Generations of amateur telescope makers have been taught to proceed by first grinding and polishing a smooth sphere, and then to modify the sphere into a paraboloid. And therein lies the difficulty. While a spherical surface will arise somewhat naturally from normal grinding and polishing action, a parabolic one will not.

For several years I've worked with Bill Kelley and Howard Moore of Arizona, researching methods for flexing spherical mirrors into high-quality paraboloids. We've found that flexed mirrors not only are easier to make but also have smoother surfaces than conventional hand-figured paraboloids. This is partly because the standard Foucault test is a null test for spheres — even the smallest errors or surface roughness can be detected and, therefore, corrected. Also, as most opticians know, the more aspherizing one does, generally the rougher the surface becomes. Richard Berry summed it up nicely when he said, "Hand parabolizing produces lumpy results. Flexed mirrors avoid that problem."

I've personally made two flexed mirrors. Both tested very well. The first, a 12.5-inch f/4.8, employs a sphere made by Tinsley Laboratories. It has consistently tested at 1/10-wave peak-to-valley (P-V) wavefront error. The second, an 8-inch f/6.1, was the first mirror I ever ground — a good smooth surface, spherical to within about 1/32 wave. It tests out as 1/40 wave when flexed into a paraboloid. This mirror is now installed in my equatorially mounted scope and shows perfect star images at 500× to 700×.

Other flexed-mirror telescopes have