TELESCOPE MAKING 27

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The magazine *for, by,* and *about* telescope makers!

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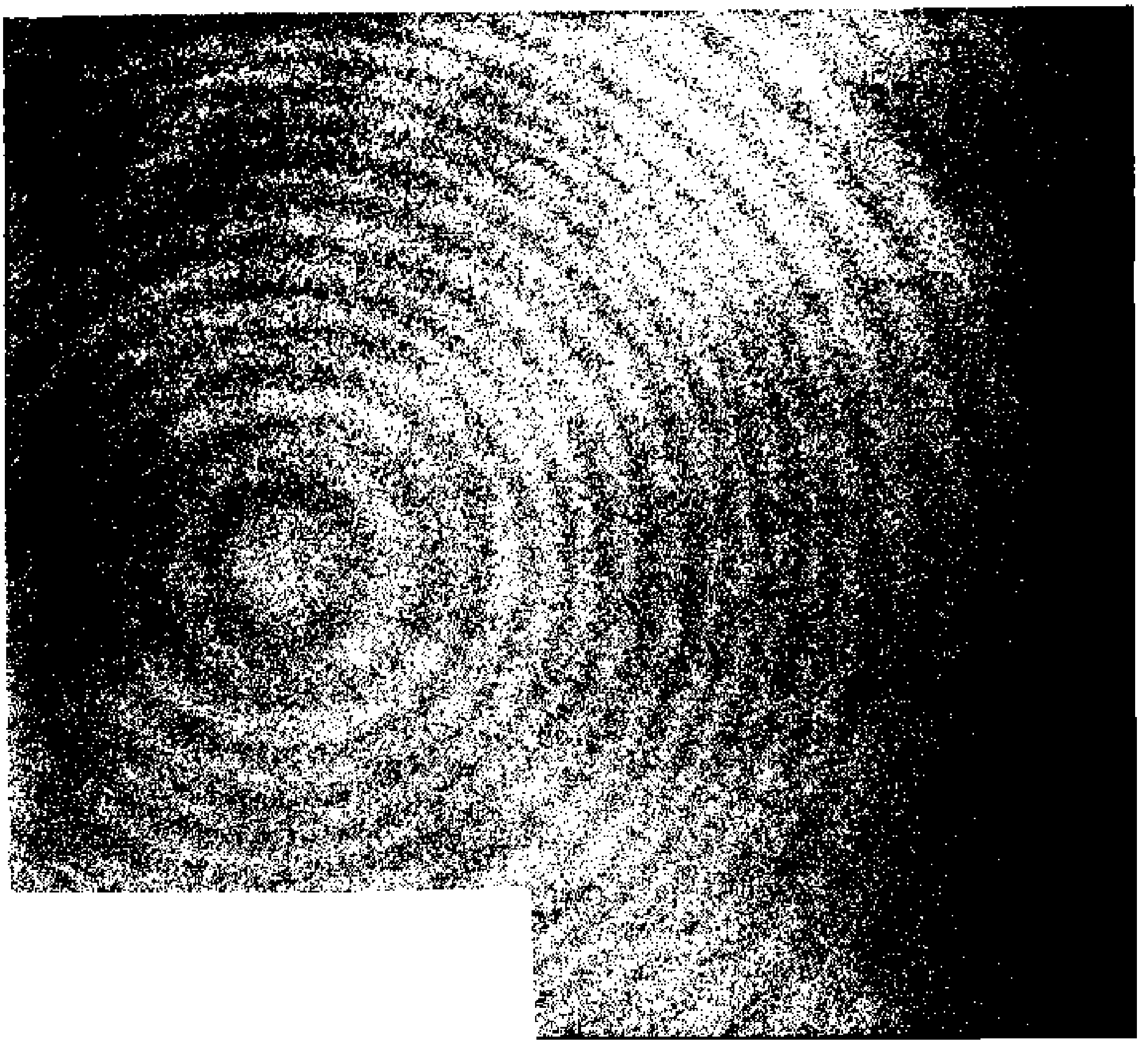

TELESCOPE MAKING

The magazine *for, by,* and *about* telescope makers!

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In this issue . . .

Cover: Interference pattern for a Schmidt Corrector plate. Photo by Michael J. Harlow.

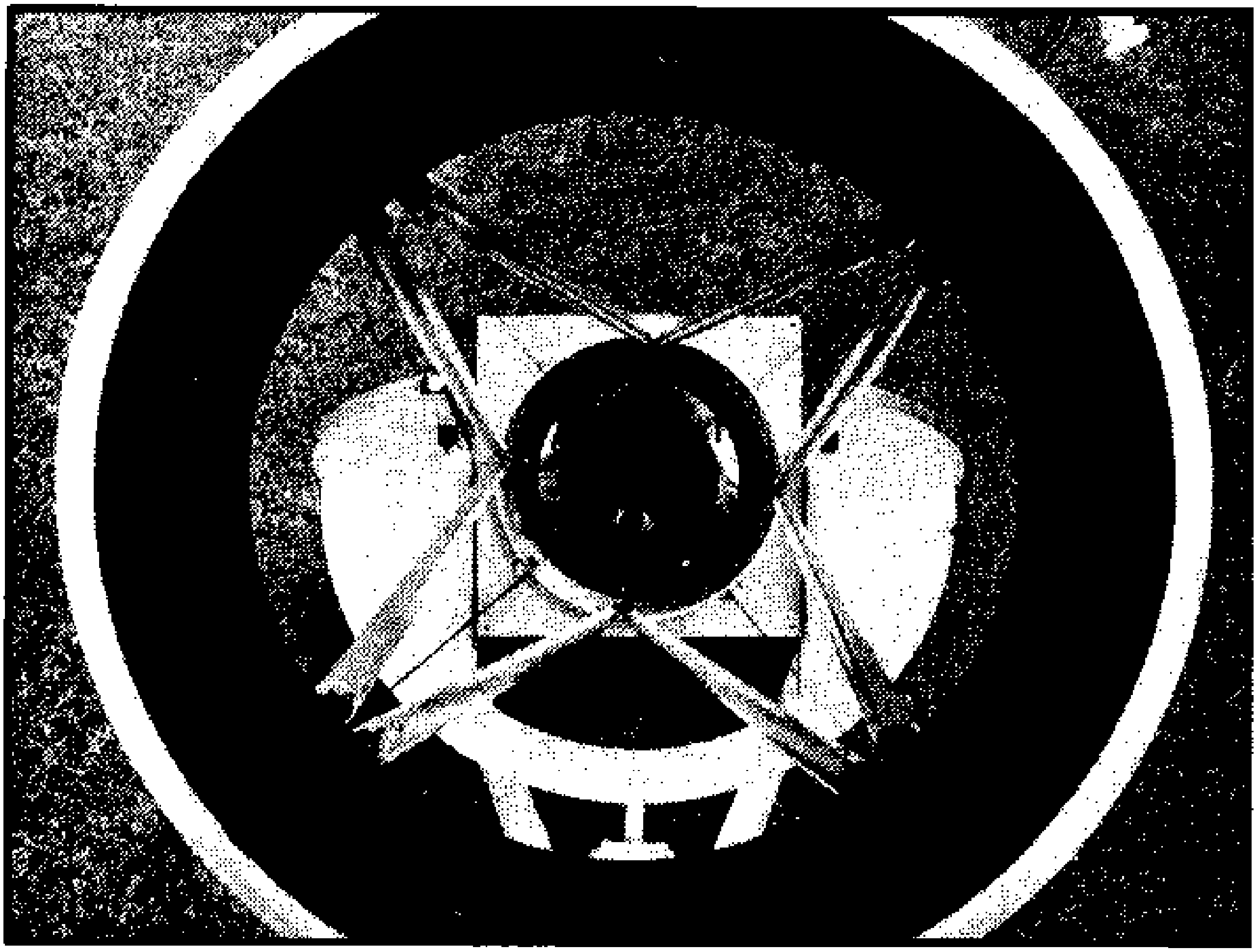
Editorial

> Telescope Kit: Two glass disks (1:6 ratio) tempered pitch, 8 assorted abrasives, rouge, instructions, free aluminized diagonal. Cost $5.50. Aluminizing 6" diameter for $2.50.

Sounds like an April Fool's joke, but those were real prices 38 years ago. Similar prices were advertised 50 years ago, when I finished my first telescope. This, I believe, is the most outstanding change I have witnessed in the passing years: the "Poor Man's Telescope" of Russell W. Porter and "Unk" Ingalls is no more! I never thought I would see the time when the cost of a beginners 6" telescope kit plus aluminizing would cost more than a finished commercial mirror. Recently a former telescope making instructor told me he had discontinued the class because he could no longer justify asking his students to pay to make a mirror when they could buy a finished one for less money. It is truly a sad state of affairs.

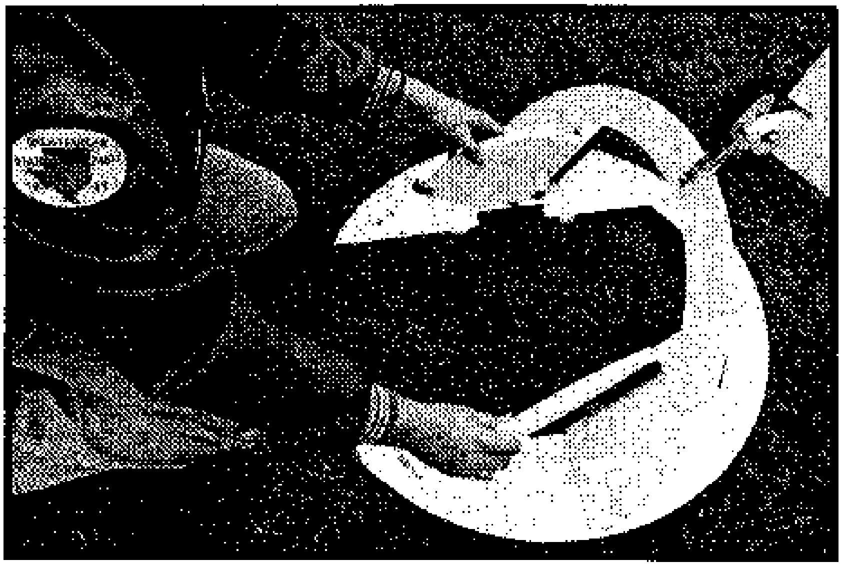
Since this last was the fiftieth year since I completed my first telescope, I decided to attend as many large telescope making meetings as possible to feel the pulse of telescope making in the United States. In one summer, between Memorial Day and mid-September, I was able to attend Riverside, the League meeting in Tucson, Stellafane, and Astrofest.

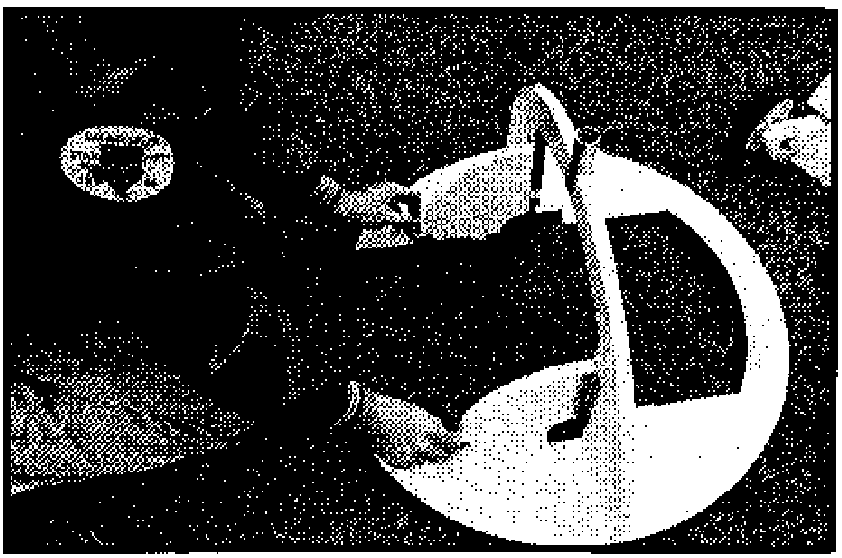
My observation is that on the West Coast there seem to be a lot of large-aperture trailer-mounted instruments. Such telescopes emphasize today's interest in Deep-Sky wonders and need to be taken out of the light and smog

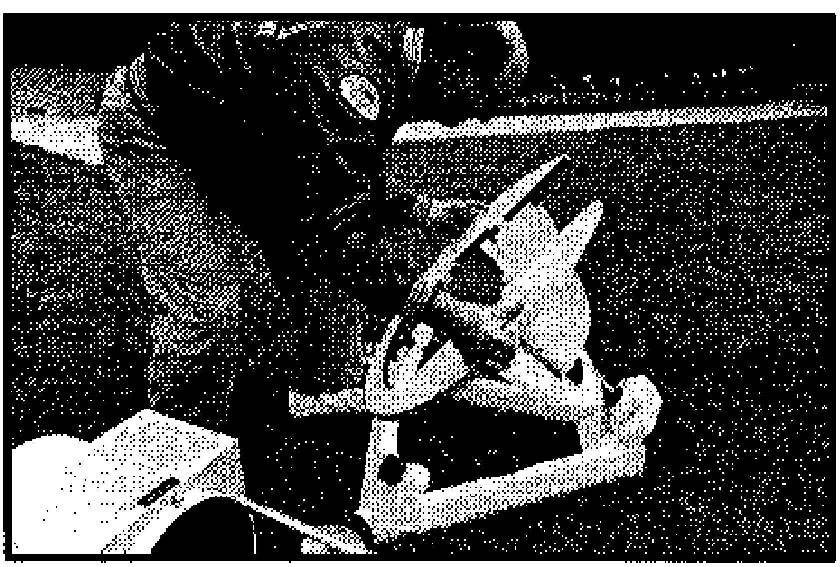


An Equatorial Split-Ring Telescope

I enjoyed my homebuilt Dobsonian. It was so much fun to use, and its 10" mirror gathered enough light to satisfy my curiosity about deep-sky objects. But, being an ATM, I ran out of projects! You know how it is: You rebuild the eyepiece case and make a few finders for friends, but you can't help tinkering with that telescope. I had just about decided to redo my Dobsonian from scratch when a friend, Eric Allen, suggested that I build an equatorial mount rather than another Dobsonian. That started the ball rolling! I had used Eric's 17.5" [see TM#24, page 18] and was impressed with its stability, but it was sadly beyond the reach of my woodworking abilities. Other equatorials were far too complicated for my tastes and usually too shaky to impress me after my Dobsonian. But I was intrigued enough to do a little research and experiment with a few ideas. Russell Porter's articles in *Amateur Telescope Making* provided me with design and performance considerations, and I began to formulate criteria for my new telescope:



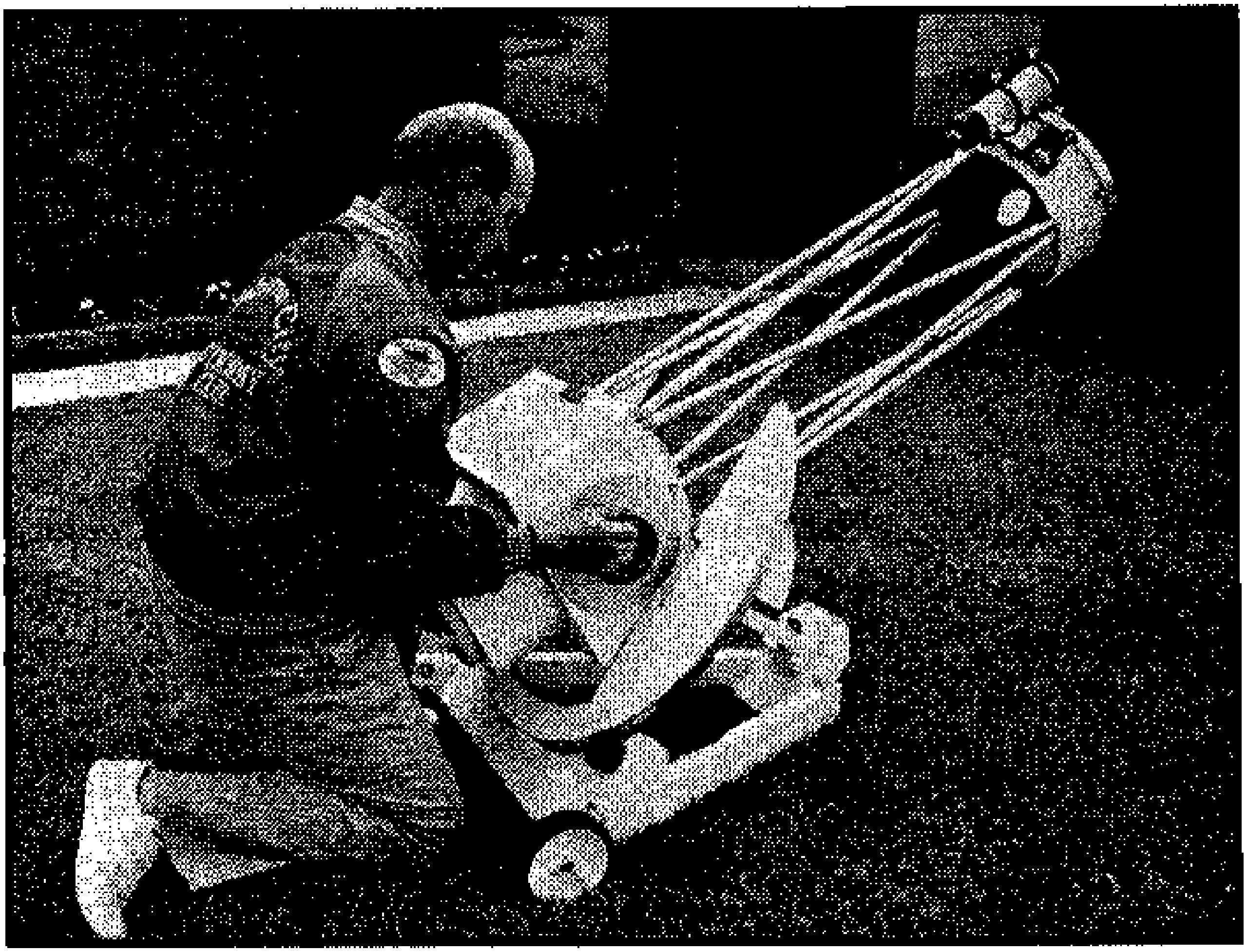




(1) It had to be at least as stable as my Dobsonian, if not more stable. Most German equatorials and English fork designs seem to have sacrificed stability for portability.

(2) It had to be driven, but the drive could not interfere with the manual operation of the scope. I personally can't see the use of an equatorial mount without a motor drive — it's like a tipped-over Dobsonian!

(3) It couldn't have any locking screws or engaging levers that would interfere with the use of the scope.



(4) After kneeling prostrate on the ground just to see through the eyepiece of a couple of German equatorials, I decided the tube had to rotate for comfortable eyepiece positioning.

(5) It had to be portable. My backyard is not the place for serious observing, so I take my "observatory" with me to a dark-sky site. And being portable, I did not want any loose parts or screws to lose in the dark.

(6) It had to be unique! I guess I wanted to have the "only one on the block" and something that I could call mine.

Well, my requirements were met in the finished telescope pictured here. Based on Porter's split-ring design, and derived from Eric Allen's 17.5"-er, this telescope is just as easy to use as any Dobsonian, but it's an equatorial, too. Let me begin by detailing construction from the top of the optical axis, which is one of the most critical areas of any telescope.

I had decided upon the open tube with a Surrurier truss because it was lightweight and strong. I also kept the PVC warm-air-duct tube from my previous telescope because it is so much lighter than Sonotube. To keep the PVC from flexing or warping and destroying collimation, I bent a ¼"-thick strip of aluminum into a circle around the upper end of the tube. The spider was then installed and bolted through the tube at the same points as the bolts, holding the aluminum ring for maximum effectiveness.

The spider is constructed from some spare brass and aluminum and the spider vanes were made from the same steel tape that is used on shipping crates. It is a permanently collimated diagonal so there are very few adjustments, although I drilled the tube holes slightly larger than the vane bolt so that small adjustments could be made if necessary. The diagonal mirror is cemented to the aluminum base with silicon glue, which seems to be excellent for this type of application. The focuser is aligned with the secondary.

From here I moved down the tube to the truss-work. I couldn't bolt the aluminum rods to the side of the tube because the rods actually cross inside the effective tube diameter. Since I had to make the tube rotate, fastening it to the tube collar was out of the question. I tried to crush the ends of the rods but the aluminum split, so I worked out a new method to attach the truss. I selected a dowel which fit snugly inside the rods and cut sixteen 2" sections to be fitted into the ends of the rods. I cut a piece of U-channel and screwed it to the dowel. After this, I simply bolted through the U-channel and the edge of the PVC for a firm attachment. Since the connections are so near the edge of the tube, the bolts also pass through a piece of steel tape on the inside of the PVC to keep it from tearing. Another screw was added for additional support.

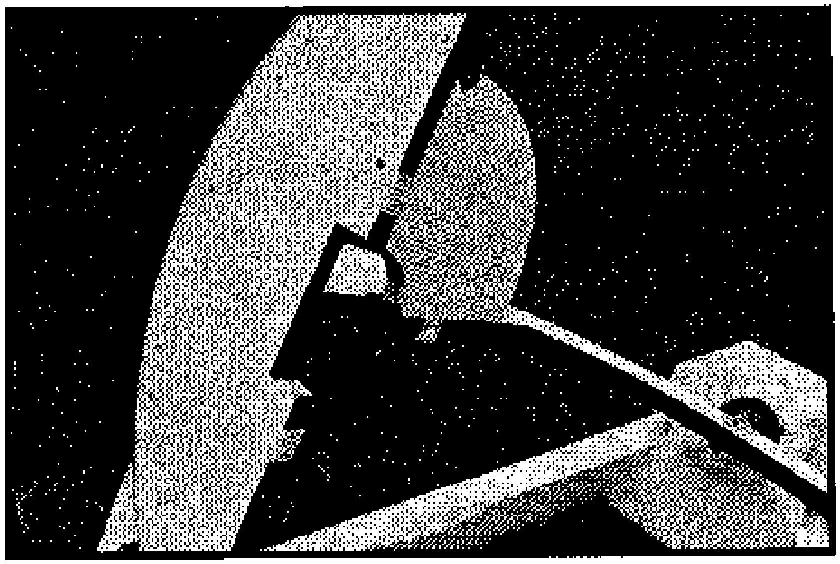
After connecting the dowels to the tube, I drilled a small hole into the side of the rods and sank a wood screw into the dowel inside. I drilled all of the top ends of the rods first, then cut a yardstick to the exact length that each of the rods should be. As I held the stick against each rod, I sank a set screw into the bottom end of each one. In this way, I made each rod exactly the same length, which is necessary for the optical train alignment.

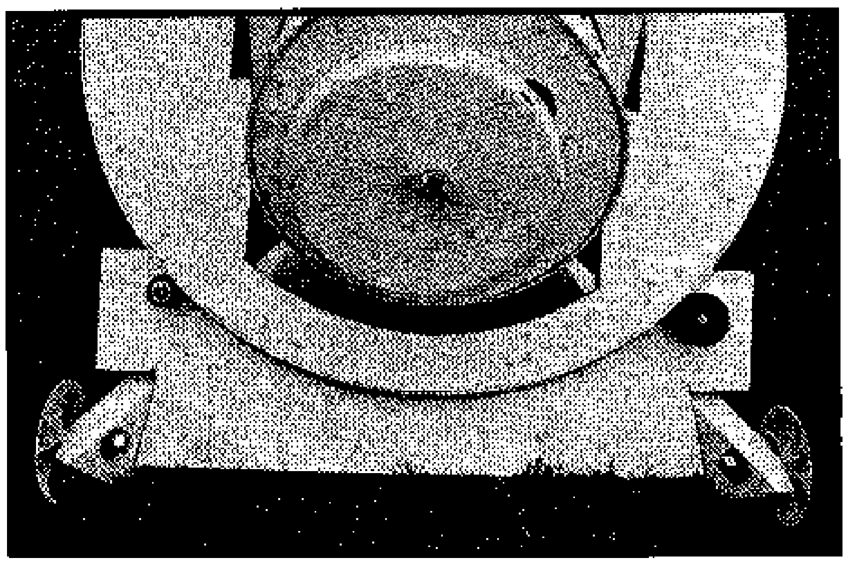
The tube collar is right out of the

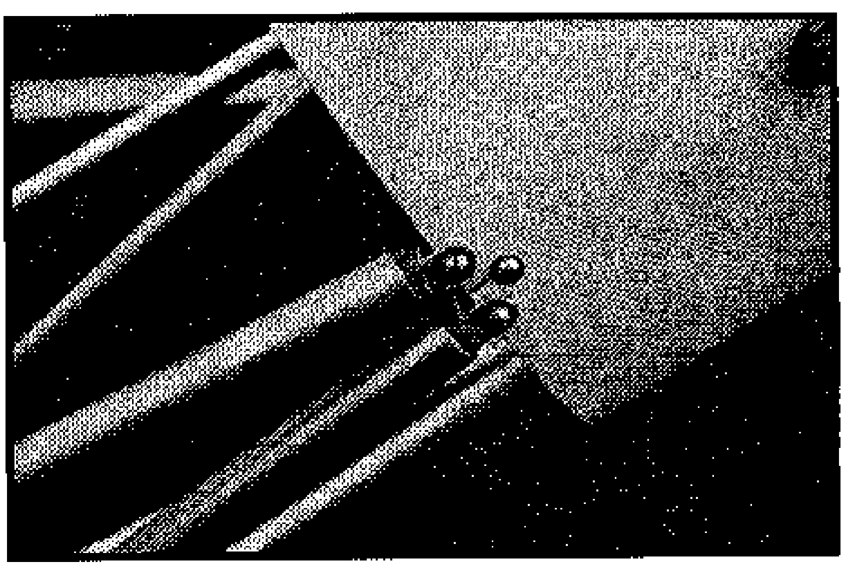
Dobsonian book, so to speak. I used video-tape reels as my declination bearings. It is important that the telescope have a smooth surface on the side of the collar because when the scope is pointed east or west, gravity pulls the bearing to the side as well as down, not just down as with an alt-azimuth bearing. Video-tape reels are perfect for a number of reasons: they are precise, smooth, and, most important, cheap. I work at a TV station and we have lots of these reels laying around, and I know that other stations have them, too. If you want a pair, just call a local TV station, ask for the chief engineer, and tell him you want a pair of old video-tape reels for your project. He will probably be glad to get rid of them even if he gives you a strange look (which I'm sure we've all had before!).

The tube collar not only supports the declination bearings but also keeps the tube cylindrical, which is important for proper collimation. The tube rests within the collar on four roller skate bearings. Since the tube is not fastened to the collar, it rotates inside it. There are no bearings on the underside of the collar because they're not necessary. The tube is always pointed up when in use and gravity pulls it down onto the bearings at all times. I put some keepers on the lower end to make sure that the collar can't slide off, but they don't normally touch the collar. I recommend you laminate the top face of the collar with Formica for durability.

My primary mirror cell is homemade and an adaptation of several different ideas. It works for me, but any style of permanent cell will work. Behind the primary mirror is the support for the counterweight. It is drilled with three large holes for access to the collimation screws. The counterweight is made of lead and usually stays in place, but can be easily removed with a wing nut to make it lighter to carry. This brings me to consideration of the balance point. Unlike the Dobsonian, this telescope makes use of a large but unobjectionable counterweight. The arc of swing at the bottom end of the tube must be as small as possible. The polar disk and the arc created by the declination swing are directly related: the larger the arc, the larger the disk must be. Since this is not a permanent installation and my car is not an 18-wheeler, I created an arc 12" from the balance point, which allows me to make the disk only 30" in diameter. A relatively simple method of determining the weight of the counterweight is to multiply each front of the tube weight by the ratio of the distance from the balance point. My finder, for example, is four times the distance from the balance point as my counterweight. If I were to add another







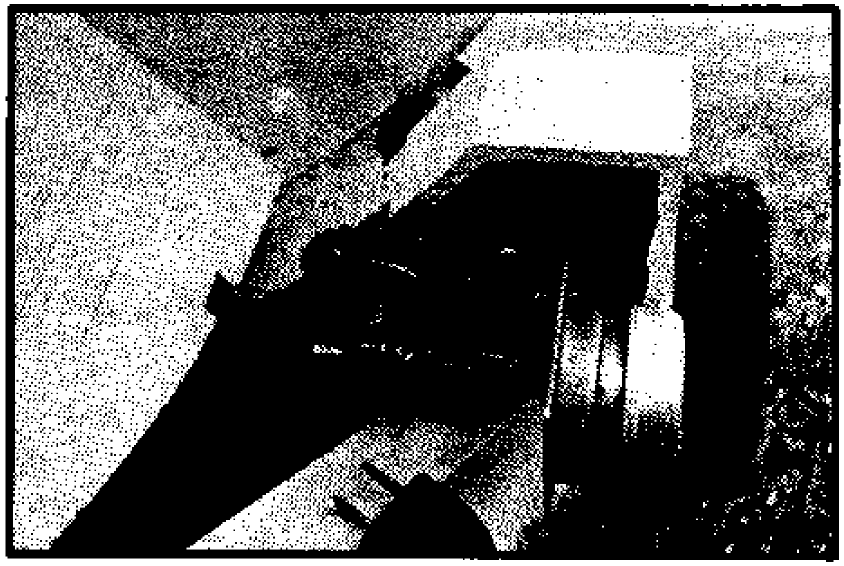
finder that weighed 10 ounces, I would have to add 40 ounces to my counterweight!

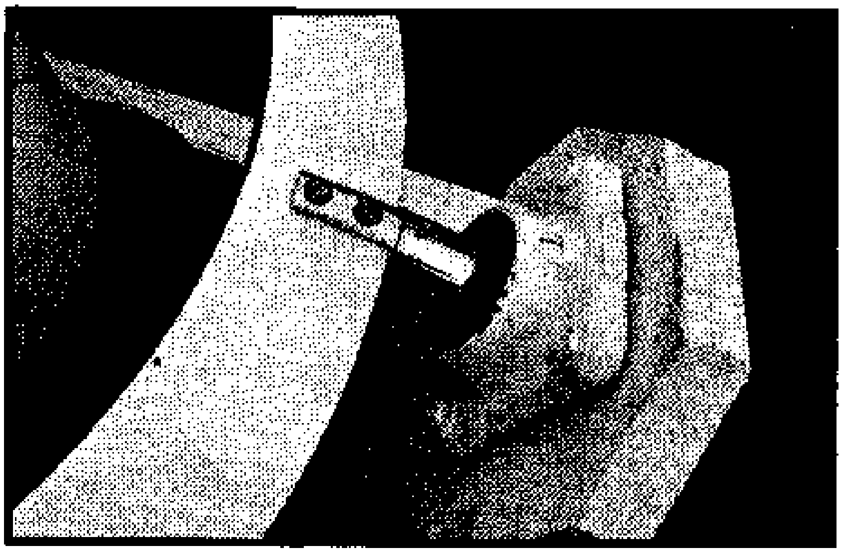
This sounds like a lot of weight, but when working with lead we found a little goes a long way. Eric Allen and I melted some lead in a skillet after we had weighed it. When it cooled, we had a large, flat weight which was easy to handle and mount. You may notice that it is not centered on the back of the telescope. The reason for this is that we balanced the tube radially as well as axially. When the tube rotates, this becomes an important consideration. Friction on the declination bearings keeps the tube from diving for the grass when I add a Nagler at the focuser. We averaged the weight of my heaviest and my lightest eyepiece and then moved the balance point just a little to compensate after the final weight was added.

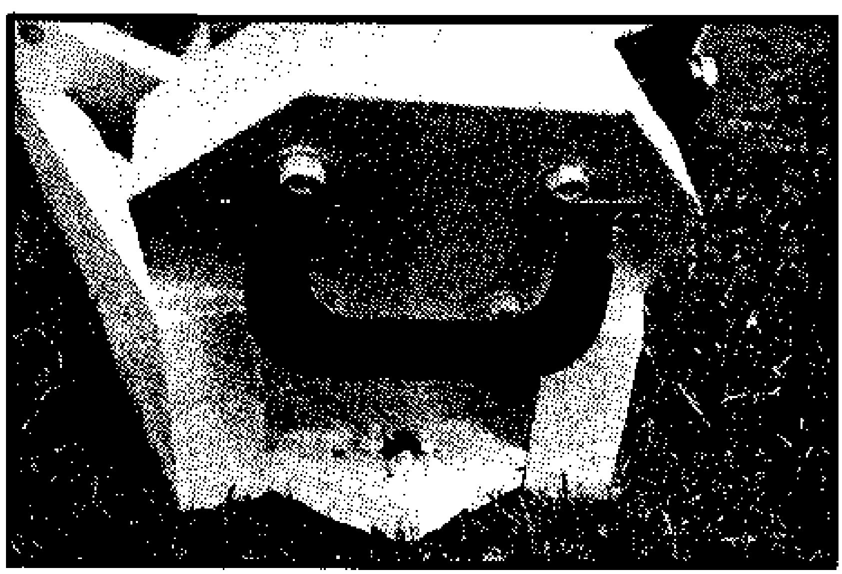
I cut the tube assembly from a piece of ¾" plywood that I found at a construction site scrap heap. I measured and re-measured exactly where the declination bearings would be, since they have to be correctly placed or the telescope won't track properly. As the circle is marked, the center point is actually your reference point for three axes: the declination axis, the optical axis, and the polar axis. In addition, it is the point from which the balance of the tube is struck. My disk is 30" in diameter with a 14" cutout for the tube to sit in.

The polar yoke is simply the bottom half of the disk re-created. Leave as much wood on the top of the disk as possible because around Polaris you'll find you need as much drive surface as you can get. I had toyed with the idea of taking the disk apart for travel but I settled on a hinged system in which two thumbscrews are the only things to tighten for set-up. It works wonderfully! The polar yoke is hinged to the polar disk with two 6" sections of piano hinge, and a 90° support is hinged perpendicular to this, locking the assembly into place.

To set up for observing, I simply tighten the two thumbscrews into place and the whole assembly is firmly locked together. The yoke is placed into a flange bearing with an attached piece of pipe along the polar axis, and the edge of the disk rides on two rollerskate wheels. On the edge of the disk, I attached a ⅛"-thick strip of aluminum for durability and to average out my sloppy carpentry. This makes a very smooth surface for driving the telescope. A lot of people are skeptical of a disk that thin, but let me explain why it works so well. If you imagine the disk assembly as a sphere with the balance point at the center, it is easy to visualize the three supports underneath. Weight







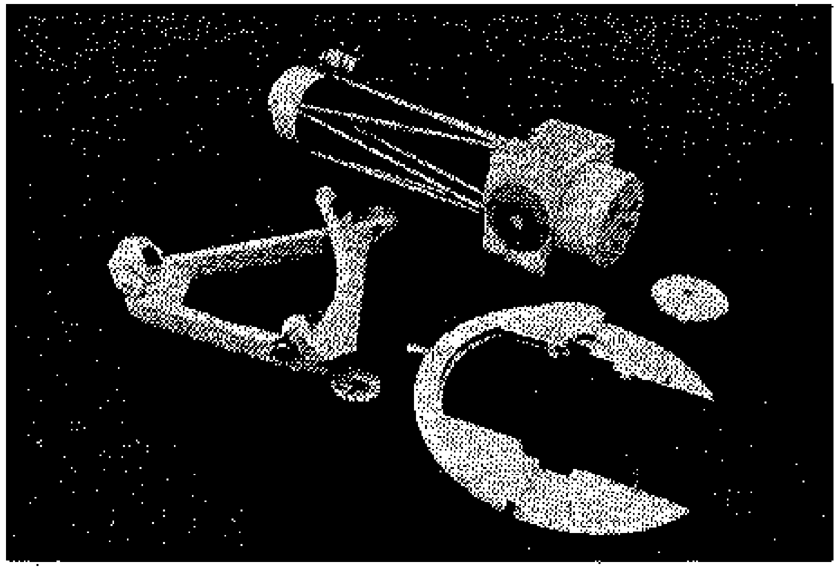
is distributed radially from the balance point to each of the supports. Since the balance point falls inside the support points, it will be stable. The key to a successful disk system is that all of the weight of the telescope is borne in the plane of the plywood and not through the face, which would bend it. There is very little flexure of the disk in actual use. What little flexure exists is compensated for because the drive and support wheels are spread far enough apart that they force the disk to "squeeze" onto the declination bearings. Remember, the edge must bear the weight, not the face!

The base is the final piece. It is the heaviest because I made it from 2x4s and sections from a 2x8. This could be lightened without sacrificing integrity. The two rollerskate wheels and the flange bearing are points of an equilateral triangle which ensures equal weight distribution and stability.

The left wheel is the drive wheel. It is 1/24th the diameter of the disk, and is turned at one revolution per hour. This drives the disk at one revolution per day. When calculating the size of the drive wheel, it is much simpler — and even necessary — to use the same standard of measure for all parts concerned. For instance, I have used diameter in calculating the size of my drive wheel (30" disk divided by 24 hours requires a 1.25" drive wheel). If your drive wheel is to be turned at a slower rate, then you will have to size the drive wheel up to compensate. Turning faster, you would decrease the diameter of the drive wheel.

I picked one revolution per hour because of the parts I had on hand. I hitched a ½ rpm motor from a surplus store with a 30-tooth window crank for a one rev-per-hour drive wheel rate. (I've got a grand total of about $10 tied up in the drive system.) Mounted on the backside of the base, the 30-tooth wheel is brazed to a 5/16" bolt which passes through the base and rides on two bearings (rollerskate bearings, what else!). The drive wheel (a turned-down rollerskate wheel) rides on this shaft. I simply tighten a nut down on a Teflon washer pressed between two metal washers to adjust friction on the polar axis and to keep the drive shaft turning the drive wheel.

My drive, uncorrected, will track an object for about 30 minutes with a rough alignment on Polaris! I have built the angle of the wheels and flange bearing to 35.5°, which is my observing latitude. I don't have to double check my polar angle because it is built into the base. I do have a refrigerator foot on the south end for fine adjustment and because I have yet to see a level observing site. The lawnmower wheels



allow me to wheel it out of the garage for casual evening observing.

This telescope serves me very well — so well that I have had several requests to build it for others. I am having mechanical drawings made up of the entire system and any TM interested in having a set can get one for a marginal printing cost. Let me emphasize a couple of things before I end: I used only hand tools in the construction of the telescope, with no machining. All of the parts are available at hardware stores, or perhaps one or two good garage sales! I love to talk about telescopes, so if there are any questions, just write me! I would like to thank Eric Allen for his inspiration and guidance. He is a man of extraordinary talent and insight, and a top-notch telescope maker.

Joe Pearson

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