STARMASTER
PORTABLE TELESCOPES
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Truss Telescope

Users Manual

by Ron Wodaski

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TAXES AND OTHER CHARGES: All taxes (including any manufacturer's tax, retailers occupation tax, use tax, sales tax, excise tax, duty, custom, inspection or test fee, or any other tax, fee or charge of any nature whatsoever) imposed by any governmental authority or measured by the transaction between Starmaster and Buyer shall be paid by Buyer in addition to the price quoted or invoiced.

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MODIFICATIONS TO BE IN WRITING: This Contract may be modified, amended, altered and changed only by writing or written change undersigned by both parties hereto.

EXCLUSION OF COURSE OF DEALING: It is agreed that no prior course of dealing or usage of trade not expressly set forth in this contract shall be admissible to explain, modify, or contradict this contract in any way.

SEVERABILITY: Except for provisions hereof covering Starmaster's obligation to perform and Buyer's payment obligation, all other provisions are severable. In the even that any such severable provision(s) is found to be illegal, void and/or unenforceable, all other provisions of this Contract shall remain fully enforceable and valid, as if such severable provisions had never been part of this Contract.

INTEGRATED AGREEMENT: Unless subsequently modified by the written agreement of the parties, this Contract and its attachments contains the entire agreement of the parties with respect to the terms, conditions, and provisions set forth herein; and no prior or contemporaneous agreement, representation, warranty, contract, promise or statement shall be effective to add to, to alter, to vary, or delete any of said terms, conditions, and provisions. The parties mutually agree that this is a fully integrated agreement.

REASONABLE CONSTRUCTION: Both parties agree that in the event of a dispute regarding the meaning of this Contract, the courts and or arbitrators shall give this Agreement a reasonable construction and shall not construe said Contract more strongly against one party than the other.

FORCE MAJEURE: Starmaster shall not be liable for any loss, delay, injury, or damage that may be caused by circumstances beyond its control including, but not restricted to acts of God, fire, theft, explosions, vandalism, work stoppage, floods, or delays in transportation.

Solar Viewing Warning

A SOHO image of the sun shows a dramatic prominence.

Solar observing can be hazardous to your eyes and to your telescope. **Do not** use your telescope for solar eyepiece projection! The intense energy from the sun can cause serious damage to your eyepieces, Telrad finder, and the telescope tube.

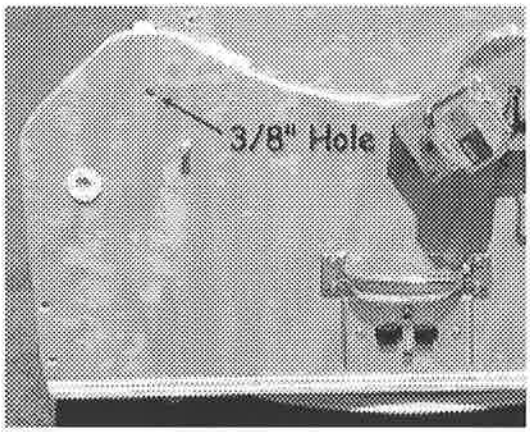
Never use your telescope for solar observing without the proper aperture filters. Should you choose to do solar observing, select only good quality filters made by a reputable manufacturer.

Important Safety Note about Transporting the Assembled Scope

Tube Assembly Latch Knob Required!

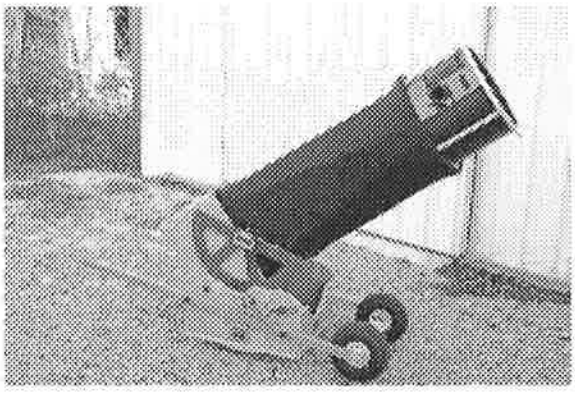
If you use the transport handles to move the fully assembled telescope, you must secure the telescope tube **before** you move the scope.

The tube assembly latch knob must be in place whenever you use the transport handles to avoid damage to the scope. The knob passes through the rocker box and into the mirror box, firmly securing them together. There is a 3/8" hole near the top and back of the rocker box (see figure below) through which the transport latch passes.



The tube assembly latch knob passes through this 3/8" hole into the mirror box, locking the tube assembly for transport with the transport handles.

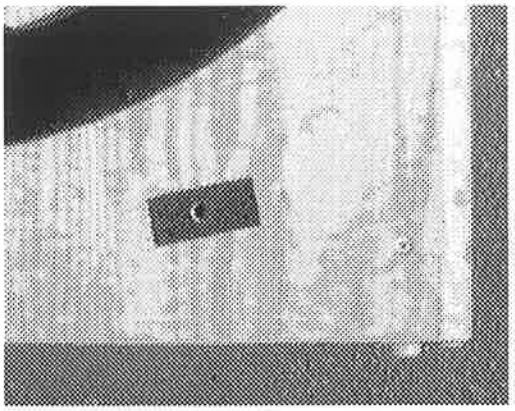
Position the tube assembly at approximately a 45-degree angle so that the rocker box 3/8" hole lines up with the matching threaded hole in the mirror box. In this position, the scope should pass through any conventional-height door.



The scope angled for inserting the transport latch.

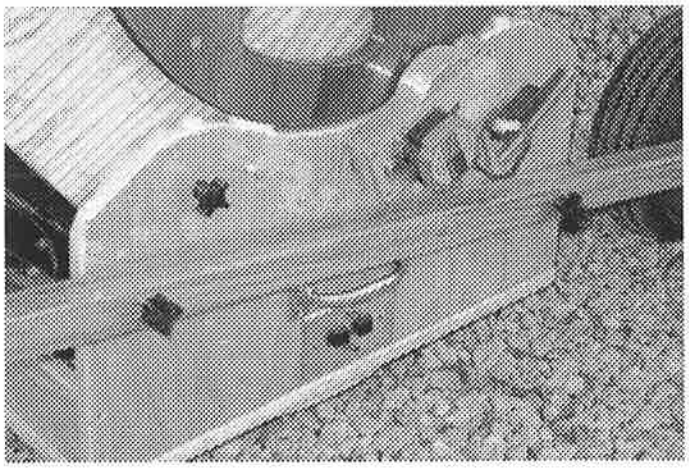
The hole in the mirror box is threaded. Pass the latch knob through the rocker box, and screw it into the mirror box. Tighten firmly, but only with your hand. Don't use a wrench or otherwise over-tighten this knob.

There is a black scuff-proof material around the hole in the mirror box. This prevents scratching of the mirror box in case you miss the hole by a small amount.



The scuff-proof patch is located on the side of the mirror box.

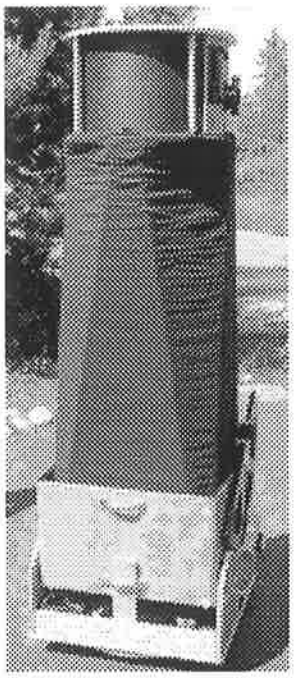
The figure below shows the transport latch installed and the scope ready to move.



A close-up view of the transport latch knob installed.

IMPORTANT: Always use the transport latch whenever you move the scope!

For details on assembling and using the transport handles, please see the section "Transport Handles - Assembly" following the instructions on assembling the Telescope (see page 51).



Introduction

Congratulations

Congratulation! You have just purchased one of the finest optical telescopes made in the US. With proper care and attention to a few minor details, this instrument should provide you with hours of wonderful observing for many years to come.

This manual will provide you with instructions for assembly and basic maintenance. If you have questions that are not covered in the manual, please feel free to call us here at Starmaster (620 638-4743 or starmaster@ctk.net). It is our goal to make your observing sessions with this telescope as enjoyable and hassle-free as possible.

Do's and Don'ts

If you observe the following list of do's and don'ts, you'll get the most out of your Starmaster:

- Never point your Starmaster directly at the sun unless you first attach a high-quality solar filter with at least a 5.0 neutral density rating.
- Never leave your telescope unattended during the daytime. Children may point the telescope at the sun. Even without an eyepiece, eye damage can occur. Extreme heat build-up can also occur, leading to damage or even fire.
- Do not leave your telescope outside in severe weather. Your Starmaster is not weatherproof. Exposure to heavy rain or snow can cause damage to the wood structure.
- When unattended, always rest your Starmaster in the horizontal position. High winds will topple any Dobsonian telescope left in the upright (vertical) position.
- Do not touch the primary and secondary mirror surfaces. Body oils will damage the coatings on the mirrors, resulting in a decrease in light transmission. Please read the section of the manual on mirror cleaning before you attempt any type of cleaning.
- Use the cloth secondary mirror cover to keep dust off of the secondary when the scope is not being used. We have also supplied you with a dust cover for the primary mirror that fits into the top of the mirror box. This will help keep dust and dew off of the primary mirror when the scope is set up but not being used. The primary remains open to the air, however, and dust could still settle on it if it is left installed for a long time, even with the dust cover in place.
- If you leave your Starmaster set up outside overnight, always cover the complete telescope for protection against wind, dew, and dust. Although a tarpaulin will suit this purpose, we strongly suggest that you purchase a telescope cover. Examples include the Desert Storm Shield and the Scope Coat. These covers are made of highly reflective Mylar. They provide dust and dew protection while keeping the optics cool. We are dealers for both of these fine products and can provide them to you at a very competitive price.

Notes on Eyepiece Selection

The optics in your Starmaster are extremely high quality. To get the most out of your Starmaster, use eyepieces that are also of high quality. Every optic that the light passes through affects the final quality of what you see. Don't settle for inexpensive eyepieces or outdated designs.

We highly recommend TeleVue eyepieces. They are very high quality, and the designs have been tweaked specifically to work well with the fast optics in our telescopes. TeleVue eyepieces come in a wide variety of focal lengths and specialty designs. They provide sharp, high-contrast views from edge to edge. We are an OEM dealer for TeleVue and can provide them to you at competitive prices.

A Guide to Eyepieces

Magnification

You can easily determine the magnification of a particular eyepiece with a specific telescope. The formula for determining magnification is:

$$mag = \left(\frac{\text{telescope focal length}}{\text{eyepiece focal length}} \right)$$

The focal length of the telescope and eyepiece must be expressed in the same units (e.g., mm, inches, etc.) The formula for determining a telescope's focal length in mm is:

$$focal\_length = (aperture * focal\_ratio * 25.4)$$

where the aperture is in inches, and 25.4 is the number of millimeters in an inch. If the aperture is already in millimeters, simply multiply the aperture by the focal ratio.

For example, the 12.5" ELT Starmaster has a focal ratio of f/5. The focal length is:

$$focal\_length = (12.5 * 5 * 25.4) = 1587.5$$

The focal length of your telescope does not change, so once you calculate this number you can use it with every eyepiece in your collection. If you used a 16mm Nagler in this telescope, the magnification would be:

$$mag = \left(\frac{1587.5}{16} \right) = 99.2$$

If you use a Paracorr, it increases the power of your eyepieces by 15%. To find the actual magnification when using a Paracorr, multiply the result by 1.15. In this example, 1.15 * 99.2 is 114.

Low-Power Observing

Eyepieces with focal lengths in the range of 27 to 35mm or longer provide the widest possible fields of view. These eyepieces are ideal for observing large open clusters and galaxies. They are also useful as a kind of "super finder." The wide field of view allows you to locate hard-to-find objects. You can then switch to an eyepiece with more magnification to see details of the object.

Wide-field eyepieces are also an excellent way to view the sun and the moon. The wide field puts the sun or moon at the center of the field of view, and it is easier for the eye to

take in the entire object this way. **If you observe the sun, please read the warning on page 4 before you attempt observing. The sun requires special filters to avoid damage to you and/or your telescope!**

Moderate-Power Observing

Eyepieces in the range of 15mm to 22mm provide an average field of view and a moderate amount of magnification. They are excellent for enlarging small clusters, globular clusters, and many galaxies. The seeing conditions on many nights will limit your magnification to the range between 100x and 150x. Moderate-power eyepieces will put you in this range with many Starmaster telescopes.

Note: The actual magnification you get from any eyepiece depends on the focal length of your telescope, as described in the previous section "Magnification."

Moderate-power eyepieces are also excellent for wide-field views of planets, and they are an excellent tool for scanning the lunar surface.

High-Power Observing

High-power eyepieces, typically those in the range of 3mm to 13mm, provide high-power views of planets, planetary nebulae, and small galaxies. You will need good seeing conditions to work at the higher powers that these eyepieces provide. If you use too much magnification, the details will appear fuzzy and you will lose contrast. Switch to a lower-power eyepiece if you encounter this problem.

Barlows and Powermates

A Barlow lens is a negative lens that allows you to increase the magnification of any eyepiece you use it with. You insert the Barlow into the focuser, then insert the eyepiece into the Barlow. The most common Barlows have magnification factors of 2x and 3x. High quality Barlows improve the image quality in fast focal ratio telescopes.

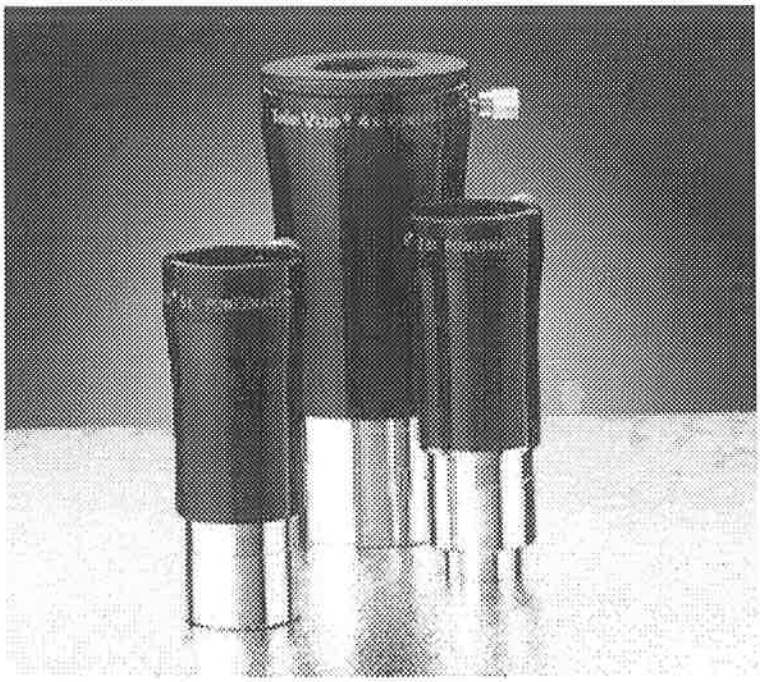
Note: The Paracorr increase the focal ratio (by 15%), but it is not a Barlow. It is a more complex system of lenses that is designed to provide a flat field in a fast focal ratio telescope with a minimal increase in focal ratio.

A Barlow has another advantage, too. With many eyepiece designs, the shorter the focal length of the eyepiece, the closer you must place your eye to the eyepiece in order to see the full field of view. The distance between the back of the eyepiece and your eye is called "eye relief." With many eyepieces, high powers mean short eye relief. Certain eyepiece designs, such as the TeleVue Radians and Naglers, use Barlows internally in order to increase eye relief.

A Barlow increases eye relief because it increases the power of an eyepiece. For example, consider a hypothetical 20mm eyepiece. Let's say it has an eye relief of 25mm. We'll also create a hypothetical 10mm eyepiece with an eye relief of 8mm. If you use the 20mm eyepiece with a 2x Barlow, it will provide the same power as the 10mm eyepiece, but with the full 25mm of eye relief. Thus, a Barlow allows you to view at higher powers more comfortable. If you have astigmatism, and must wear glasses when observing, long eye relief is essential, and Barlows can give you more flexibility.

A Powermate is a special lens design from TeleVue that addresses some minor shortcomings in the Barlow design. According to Al Nagler:

"If Barlows are made too short or with too much magnification, the diverging rays can cause severe vignetting and image degradation in eyepieces due to mismatched pupils. I had to go beyond the simple Barlow concept to achieve the goal of a compact, high power, fully corrected image amplifier.



There are three sizes of TeleVue Powermates: 2.5x, 4x (2" barrel), and 5x.

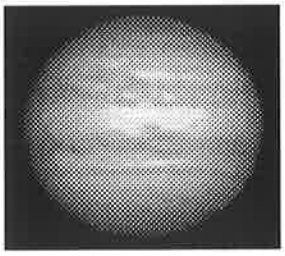
"Enter POWERMATE: My approach yielded a 4-element parfocal, compact amplifying lens system. POWERMATE consists of a negative achromatic doublet plus a positive 'pupil-correcting' doublet. While it looks and functions like a Barlow, your eyepiece will operate with pupil locations where the designer intended, avoiding mismatch problems. POEWRMATE optimally mates its power to your eyepieces. No additional 'interface lens' is needed, since POWERMATES have it built-in."

Powermates are available from 2.5x to 5x. The 4x Powermate has a 2" barrel, which allows you to do high-power observing with your 2" eyepieces.

Powermates are ideal for planetary observation. Powermates are also ideal for imaging planets with a digital camera. The fast focal ratio, large aperture, and high quality optics of a Starmaster telescope makes it ideal for this type of imaging.

For tips on using a digital camera with your Starmaster, see Gary Honis' web site at:

http://members.tripod.com/~ghonis/c2020zdeep.htm



An image of Jupiter taken by Gary Honis with his 20" Starmaster and an Olympus C2020Z.

What's in the Cartons

1. Primary mirror
2. Secondary cage
   - Telrad base, focuser, etc. attached at factory
3. Trusses (includes cloth carrying case)
4. Mirror box
   - Altitude bearings (sometimes called trunions or side bearings)
5. Rocker box, with a separate box full of goodies inside the rocker box
   - Altitude drive unit (motor and gear box)
   - Bag of bolts (also called hand knobs)
   - Fuzzy dowel
   - Light shroud
   - Wooden paddle
   - Telrad finder
   - Bubble level
   - Allen wrench
   - Sky commander
   - Sky Tracker hand controller
   - Cables
   - Two 12-volt batteries
   - Battery charger
   - Secondary mirror in its holder with dust cover
   - Other accessories you ordered
6. Mirror transport box and its cover
   - Mirror cell on the mirror frame

Optional:

7. Transport wheels and hardware
8. Transport handles
9. If you ordered a large number of accessories that will not fit in the goodie box, they will be shipped in one or more additional cartons.

First-Time Assembly

Your Starmaster telescope will arrive in seven to nine or more cartons, depending on what your ordered. Unpack each carton carefully and inspect the contents for damage. If any damage is found, notify the us at Starmaster immediately for proper claim processing. A delay in filing a claim may interfere in prompt resolution of the problem.

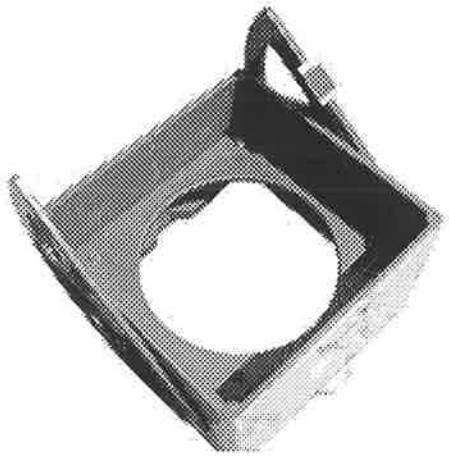
Note: Leave the protective covering on the mirror until you are ready to install it in the mirror cell.

There are several items that ship disassembled and that must be assembled before you can use the telescope:

- The altitude bearings must be attached to the mirror box. These are the large, curved half-wheels that the telescope rides on as you tilt it up and down.
- The drive unit (motor + gearbox) that controls altitude must be attached to the rocker box. This unit is only present if you ordered the Sky Tracker GOTO system.
- The secondary mirror must be attached to the spider assembly.

Attach Altitude Bearings

This step adds the two altitude bearings (sometimes called trunions or side bearings) to the mirror box. The mirror box is the part that holds the mirror. It has a large circular cutout that acts as a baffle. The image below shows the mirror box with the altitude bearings already attached.



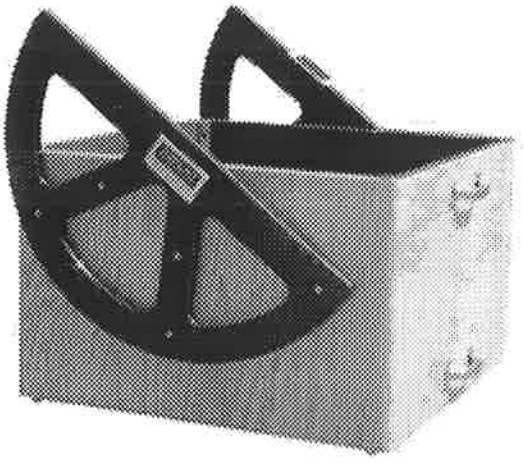
The mirror box is the large square box that holds the mirror when the telescope is fully assembled.

There are two altitude bearings, and they are not identical. Each one has to be placed on the proper side of the mirror box. Instructions below will help you identify which altitude bearing goes on which side. You can also refer to the above figure, which shows that one of the altitude bearings has a Velcro-covered plate that supports the Sky Commander. Note the position of the two brass handles in relation to the altitude bearings. One end of the mirror box has a single handle, and the other end has two handles.

The figure below shows the altitude bearing that doesn't have the Sky Commander plate. Both altitude bearings have five pre-drilled holes. These holes match up to holes in the sides of the mirror box. The holes will match up properly only when the altitude bearing is located on the correct side of the mirror box.

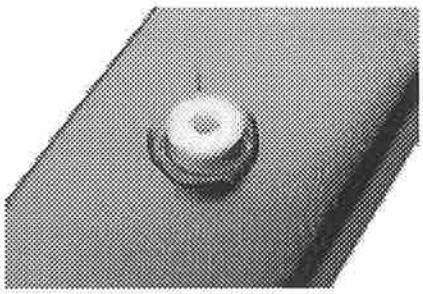
There are two different altitude bearings, one for each side of the mirror box. Use the screw holes shown above to attach each altitude bearing to the mirror box. Be sure to attach the correct altitude bearing to each side of the mirror box.

When the holes are properly matched up, the altitude bearings attach to the mirror box as shown below. Note that the altitude bearings sit at an angle, with the high side of the bearing located near the end of the mirror box that has the single brass handle.



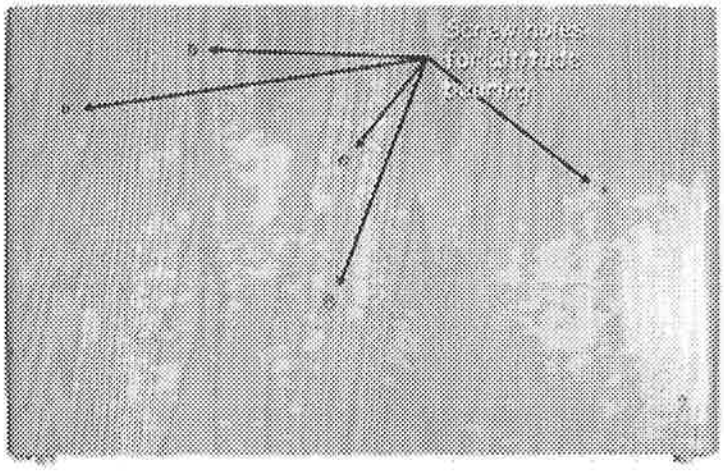
When the altitude bearings are properly attached to the mirror box, they sit at an angle.

To attach a bearing, lay the mirror box on its side on a soft surface, such as a scrap of carpet. Place the altitude bearing on the side of the mirror box so that the plastic spacers on the bearing (see next figure) are between the mirror box and the bearing.



When installing an altitude bearing, make sure that the plastic spacer faces the mirror box This creates the proper relief between these two parts.

Use the supplied #6 x 1-5/8" wood screws to attach the side bearings. *Make sure that the screws pass through the holes in the side bearing and into the pre-drilled holes in the correct side of the mirror box before you screw them down!* The pre-drilled holes are marked with a small, black circle to make them easier to find. The next figure shows the location of the holes. The black circles are not just in the figure; we put them on every mirror box to make your life a little easier!



The screws holes for the altitude bearing are pre-drilled into the mirror box sides. They are marked for easy identification.

Note: Do not install the mirror at this time. The mirror is installed later, using a special procedure that keeps the scope secure during the mirror installation. The large mirrors are too heavy to install into the mirror box at this stage.

Attach Altitude Drive Unit (Sky Tracker Only)

The altitude drive unit is shipped separate from the rocker box for safety during shipping. The azimuth drive unit is inside the rocker box, and is attached at the factory.

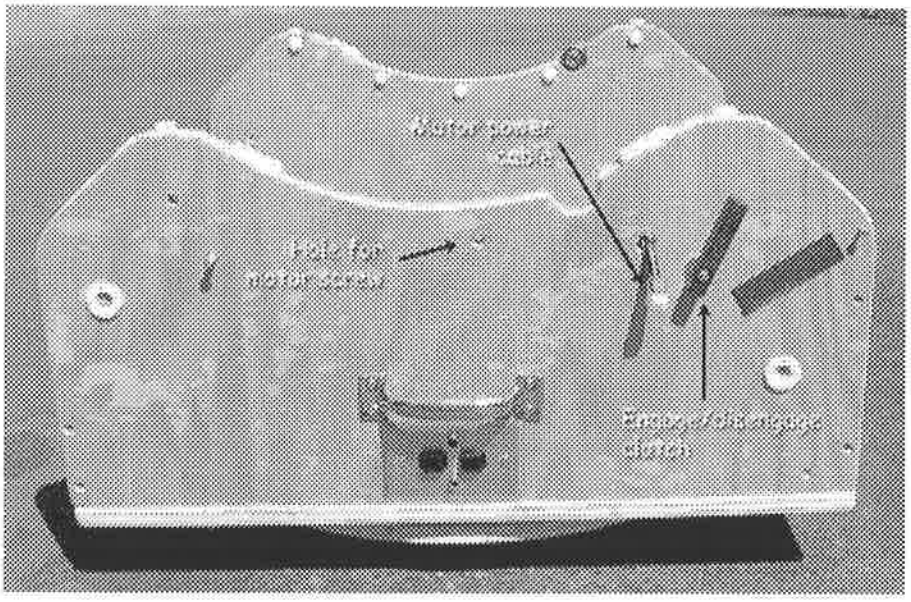
The altitude drive unit attaches to the outside of the rocker box with a single screw, and there is a single power cable to connect to the drive unit. However, the unit has to be

lined up properly before you attach it. The following section will show you how to properly attach the altitude drive unit.

You need only one tool to attach the unit: a ¼" Allen wrench (shown at right). This wrench is included with your Starmaster telescope.

The figure below shows the side of the rocker box that the altitude drive unit attaches to.

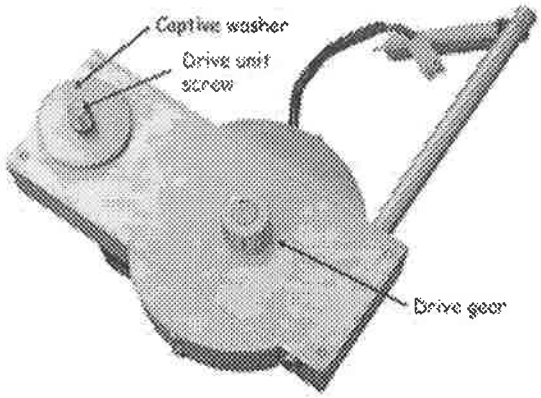
There is a hole almost in the middle of the rocker box, near the top. The screw on the drive unit threads into this hole. A power connection for the motor hangs through the rocker box. There is also a black clutch lever attached to the rocker box that you will use to engage and disengage the altitude clutch. The black scuff-proof pad next to the clutch lever protects the rocker box from scratches.



The altitude drive unit is attached to this side of the rocker box.

The drive unit attaches to the rocker box with a single screw. The screw is captive to the drive unit, and takes a ¼" Allen-head wrench (supplied). There is a washer on the back side of the drive unit; make sure this is in place as shown on the next page.

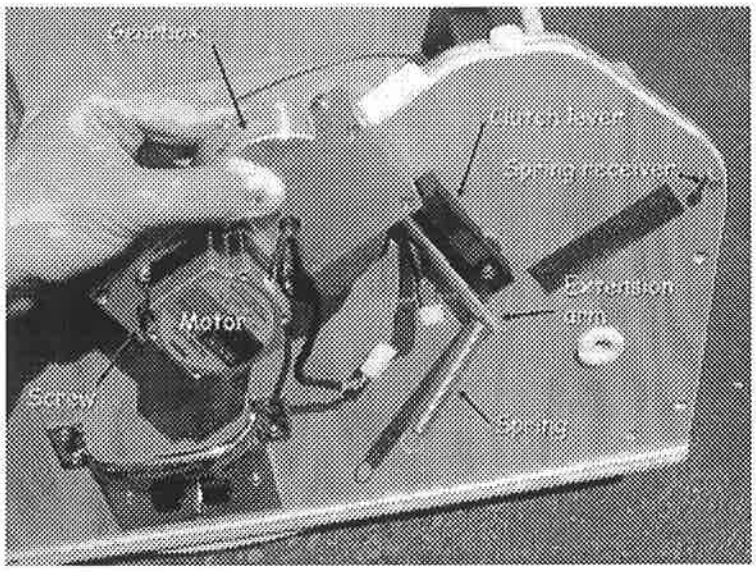
The drive gear on the unit engages the altitude bearing of the mirror box, and drives the scope in altitude during goto and tracking.



The back of the drive unit shows the screw, the captive washer, and the drive gear. See the next figure for identification of other parts shown here.

Position the drive unit as shown below prior to attaching it. Make sure of the following:

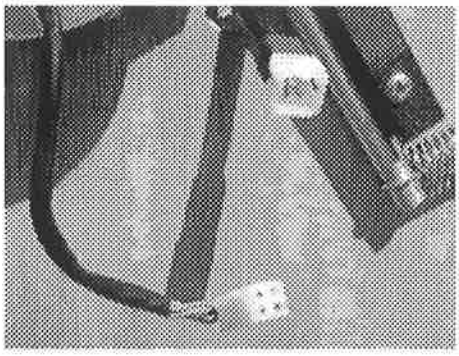
- The drive gear fits into a cutaway in the rocker box (see top of page 18).
- The drive unit screw lines up with the hole for it in the side of the rocker box.
- The arm sits parallel to the clutch lever. Position the lever as shown below *before* you align the drive unit.
- The spring and power cables should be free of any obstructions.



To attach the altitude drive unit, arrange the clutch lever, arm, and spring as shown here.

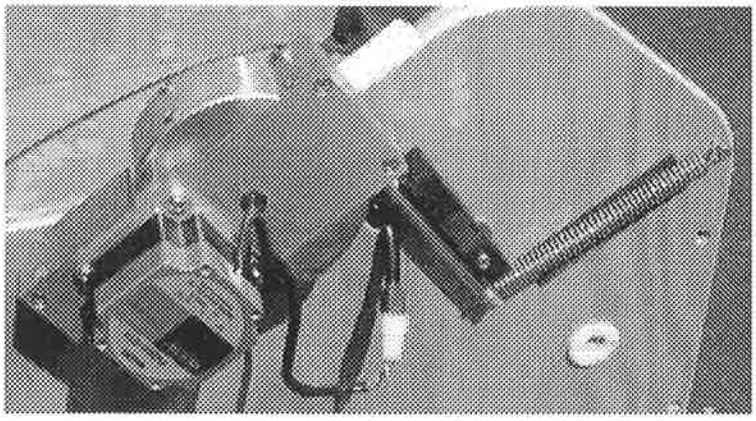
Once the drive unit is lined up correctly, use the ¼" Allen wrench to secure it. Tighten firmly, but please be careful not to over-tighten.

Connect the rocker box power cable and the motor cable (shown below) by snapping them together. Note that two of the connector's four corners have rounded edges that will help you orient it correctly.



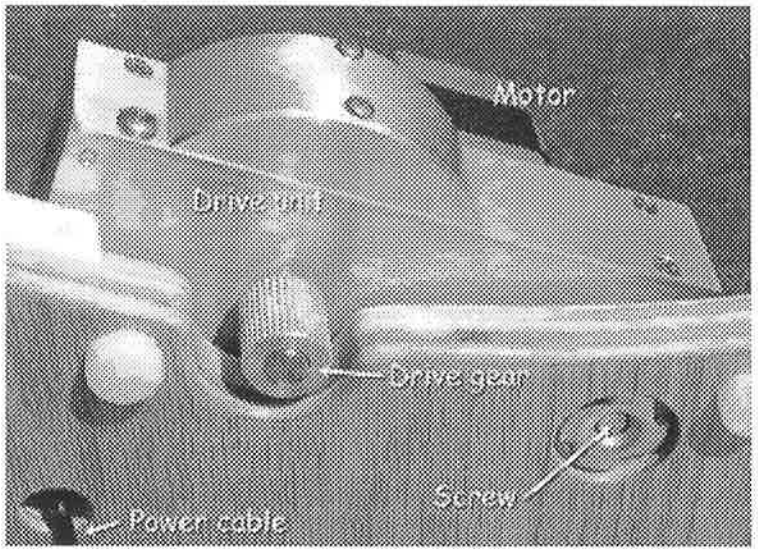
Connect the motor cable (bottom) to the power cable (top).

To complete the installation of the altitude drive unit, stretch the free end of the spring over the receiver post (a screw, actually) near the edge of the rocker box (see below). The spring should line up with the scuff-proof pad on the rocker box. Make sure that the clutch lever is in the position shown below before you attempt to attach the spring. Otherwise, if there is tension on the spring, it will be difficult or impossible to attach to the receiver post.



The altitude drive unit has been installed and connected.

The figure below shows the drive unit from the inside of the rocker box. This reveals the cut-out in the rocker box for the drive gear.



The installed drive unit viewed from inside the rocker box. Note that the drive gear fits within a cut-out in the rocker box. Note also the embedded nut that the drive unit screw threads into.

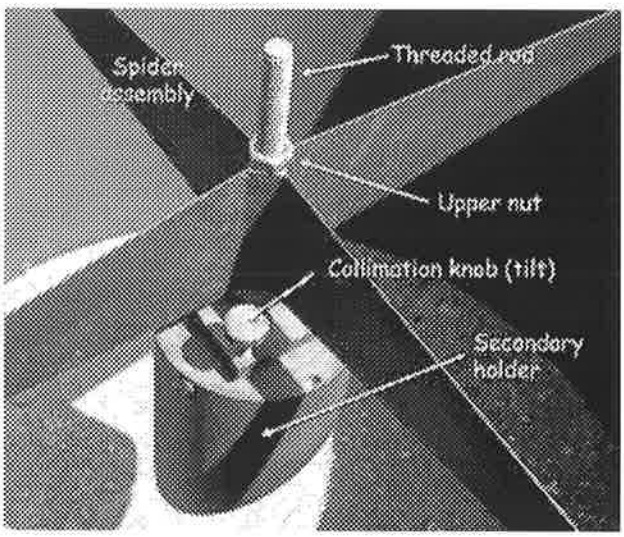
Installing the Secondary Mirror

The secondary mirror for many of our scopes is shipped separately to prevent damage. The secondary mirror is installed into the upper cage assembly, shown below. In this figure, the upper cage is oriented as it installed on the telescope, with the spider assembly at the top.

The upper cage assembly.

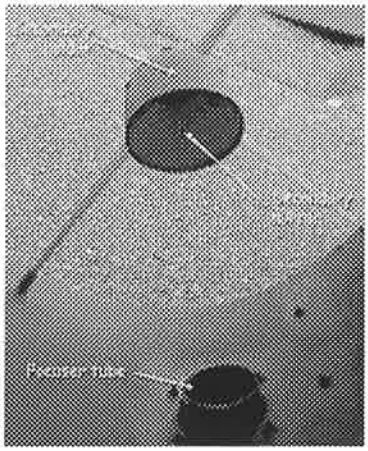
The secondary mirror has a black cloth bag over it to keep dust away. Leave the cloth on during the installation of the secondary to help prevent finger prints on the secondary. You should avoid touching the cloth where it covers the actual secondary mirror, however. The secondary mirror has a reflective coating that is exposed and it is easily damaged by contact. The cloth is soft, and will not damage the secondary. However, hard physical contact can still damage the coating through the cloth.

The secondary holder (see figure below) has a threaded rod attached at the top. Remove the upper nut and washer *only*. Be careful not to move the lower nut; it is set to the correct position during final testing at the factory. Insert the threaded rod up through the hole at the center of the spider assembly. Lift the upper cage if necessary to obtain enough clearance for this maneuver. Place the washer and nut back on the threaded rod and finger-tighten it. Don't fully tighten the upper nut yet; you'll need to adjust the rotation of the secondary as part of the initial collimation.



The secondary is installed into a hole at the center of the spider assembly.

Align the secondary holder so that the secondary mirror lines up with the focuser tube as shown below. You need only do a rough alignment at this time. Final alignment takes place during the initial collimation of the telescope. Tighten the upper nut just enough to prevent the secondary mirror from rotating.



The secondary holder, installed and viewed from below.

Field Assembly

Please see the previous section on first-time assembly before you attempt your first field assembly. Several items are packaged separately for shipping, and need to be attached prior to the first field assembly. This includes the altitude drive unit, secondary mirror, and the altitude bearings.

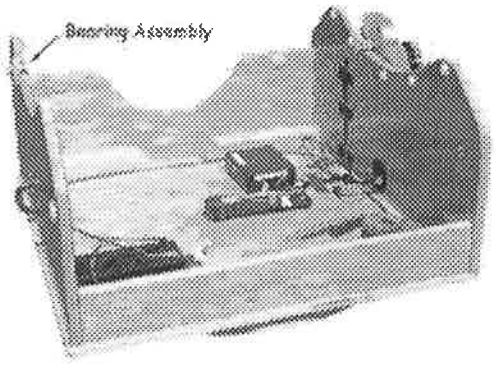
Also, please see the earlier section on the contents of the boxes you received, to make sure you have all of the parts you need. Sometimes, boxes are delivered on separate days even though they were shipped on the same day from our facility. If you have any questions, please don't hesitate to contact us.

We suggest that you set up for the first time in indoors, so you can get familiar with the various parts of the telescope.

Set up Rocker Box/Ground Board

Start by placing the rocker box (see below) and its attached ground board on a reasonably level surface. It is not critical that the rocker box be *exactly* level. We have supplied a small bubble level with the telescope. Lay the bubble level in the rocker box, and shim one or two legs as necessary to make the rocker box level. A pair of door shims, available from most hardware stores, makes a handy and very precise leveling tool. Push them together to raise a leg, and move them apart to lower a leg.

The tallest edges are the sides. The latitude bearings attached to the mirror box will fit into the curves in the sides.

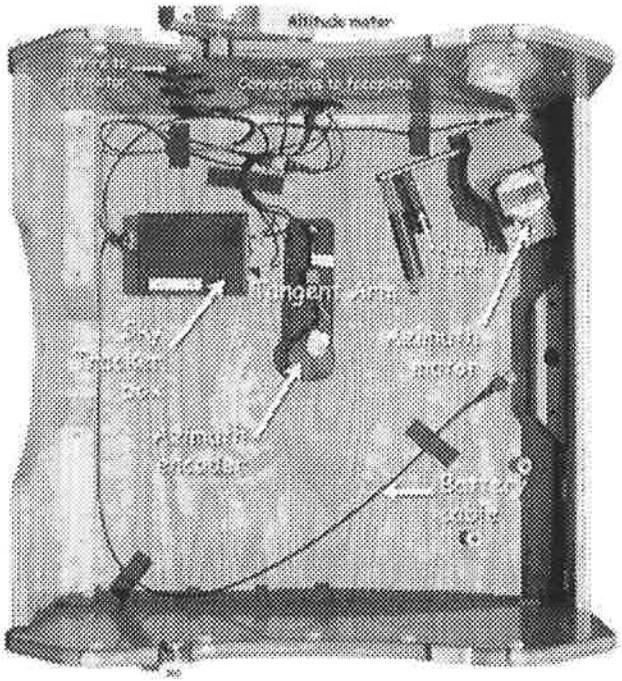


The rocker box for the 16" Starmaster. Note that there is a high edge (back) and low edge (front).

Leveling the Rocker Box

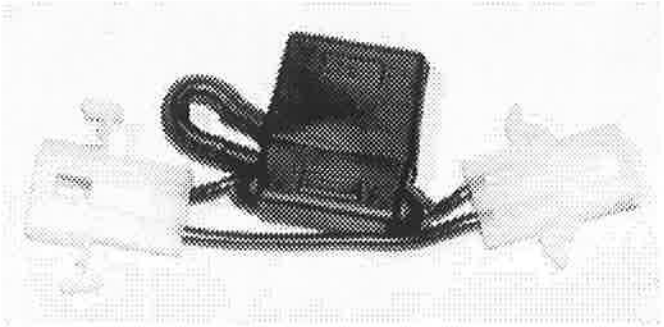
If the rocker box is not close to level, the azimuth motors will strain to push the scope "uphill" in certain directions, and this is not good for the scope. The Sky Commander does not require a perfectly level scope, however. As long as the rocker box is close to level, you are OK.

The figure below shows an overhead view of the rocker box. Note that the Sky Tracker box (goto controller), azimuth encoder, and azimuth drive unit are all assembled into the rocker box at our factory. You should not need to connect or adjust any of these parts at delivery or in the field. Take note of the location of the azimuth clutch, which you use to engage and disengage the azimuth drive. Also take note of the battery cable, which you connect to the battery after field assembly is completed.



An inside view of the rocker box shows the goto controller, azimuth drive unit and clutch, etc.

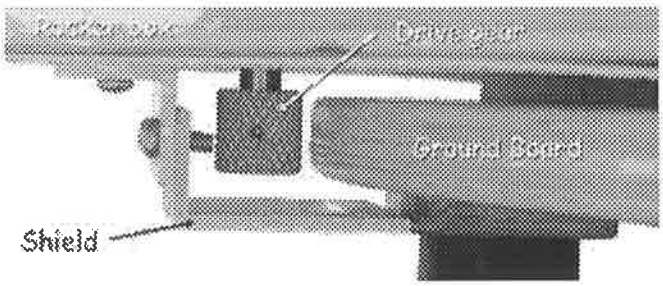
Note: Recent Starmasters have a fused connection to the battery. The figure below shows the appearance of the fuse link. The fuse link attaches at the end of the battery cable shown above.



The fuse link supplied with the most recent Starmaster models.

Verify Clearance for Azimuth Drive Gear

If your Starmaster is equipped with the Sky Tracker goto system, check the clearance all around the ground board. Rocks, uneven ground, tufts of grass and other obstacles could jam up against the shield that protects at azimuth drive gear. See the following figure for a close-up look.



The azimuth drive gear moves around the outside of the ground board.

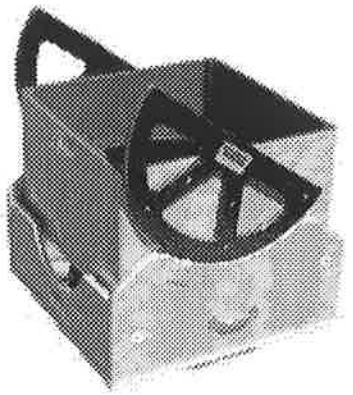
If there is a slope where you are setting up the telescope, make sure that the corners of the rocker box can turn through 360 degrees. The corners stick out well beyond the legs of the ground board, and may hit the high side of the slope as the telescope moves.

Set up the Mirror Box

The mirror box fits inside the rocker box. There are felt pads on the side of the mirror box to protect it from scraping against the rocker box.

Place Mirror Box in Rocker Box

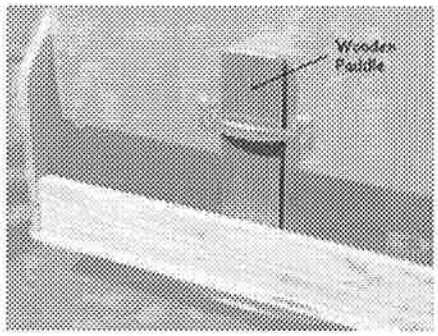
Note that the rocker box has two side pieces with large curves. The mirror box's altitude bearings sit in these curves. Hold the mirror box with the bearings on either side, and with the high point of the bearings away from you. Slide the mirror box into the low end of the rocker box, and set the altitude bearings into the curves on either side of the rocker box. The figure below shows how the mirror box sits in the rocker box when installed correctly.



The mirror box's altitude bearings nestle into the curves of the rocker box.

Secure the Mirror Box with Wood Paddle

There is a small, flat wooden paddle that comes with your telescope. This paddle is a fancy high-tech tool that will stabilize your telescope while you assemble it. Insert the paddle through the lower handle on the low end of the mirror box, so that it fits inside the low end of the rocker box.

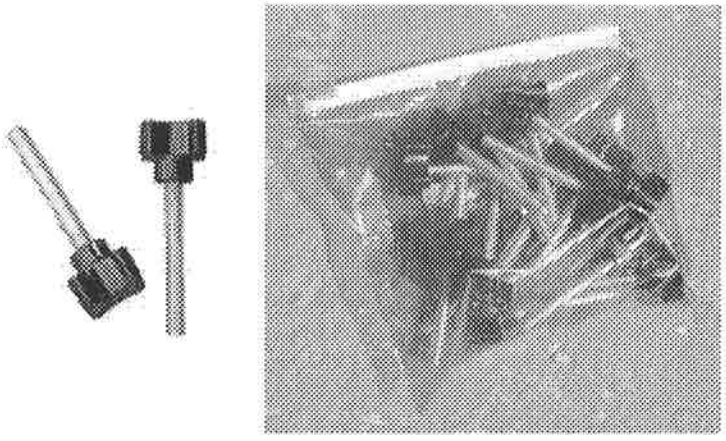


As you assemble the telescope, it gets more and more top heavy. Insert the wooden paddle as shown above to prevent the telescope from tipping while you are assembling it.

Orientation tip: Note that the low end of the mirror box's altitude bearings matches up with the low end of the rocker box.

Attach Trusses

Your telescope comes with a bag of bolts, also called hand knobs. There are 16 of them, and we have adopted a "one size fits all" strategy. You will use exactly the same size bolt to attach the trusses, the mirror, and the upper cage assembly. The figure below show the bag and a few sample bolts.



Locate the bag of bolts (hand knobs). You use the same size bolts for all major assembly steps.

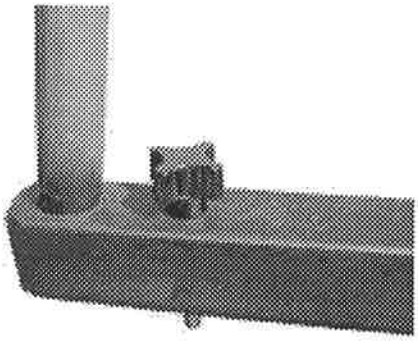
The figure below shows a typical Starmaster truss. We make the trusses carefully using guides, so they are as identical as we can make them. It is not necessary to put the same truss in the same location on the scope. No matter how you mix and match trusses between observing sessions, the scope should need only minor collimation tweaks after re-assembly.

There are four trusses. The narrow end is the top, and the wide end is the base.

The large end of the truss is the base, and the small end is the top. The base attaches to a shelf inside the mirror box using two bolts. The top attaches to the upper cage assembly using a single bolt.

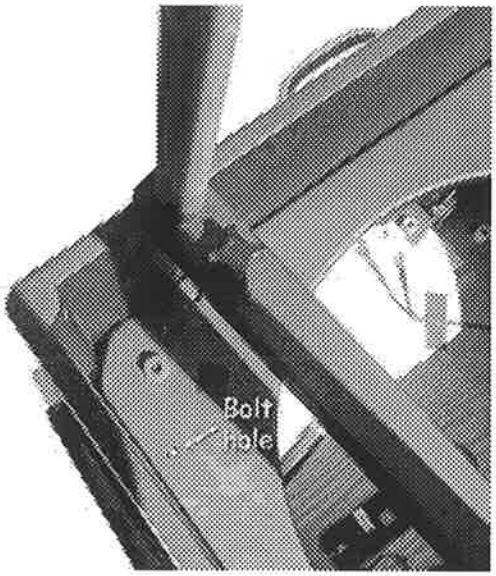
Installing a Truss

The figure below shows a portion of a truss base, with one of the bolts already inserted into it. Some of our users put the bolt in first and use the tip of the bolt to find the matching hole in the mirror box. Other users get just as good results by putting the truss into the mirror box and then inserting a bolt. We leave it up to you to decide which method works best for you.



TIP: You can insert a hand knob into the base of a truss before you put the truss into the mirror box.

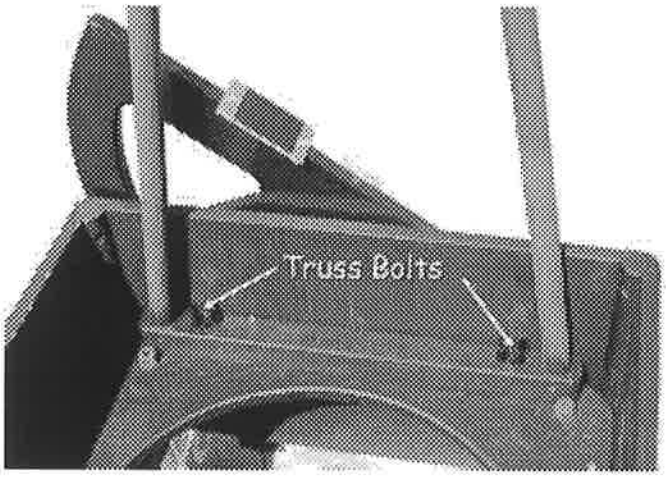
The base of each truss sits on a shelf inside the mirror box that does double duty as a light baffle (see figure below). Line up the base of the truss and the bolt holes. Hand tighten the knobs. Do not over-tighten, but make the bolt snug so that the truss won't move as you point the scope at different parts of the sky.



There is a pair of bolt holes on all four sides of the mirror box. Line up the base of a truss with the bolt holes and hand-tighten the bolts.

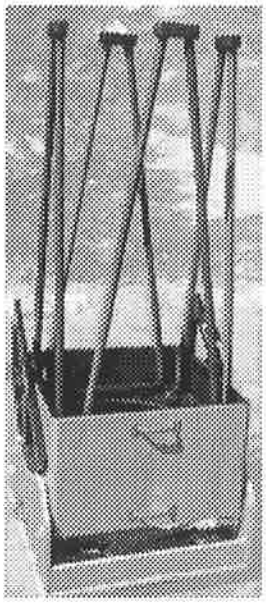
Position of Trusses

The figure below shows the first truss installed in the mirror box. Note the rubber bumpers near the ends of the truss base. These aid in correctly positioning the trusses.



Each truss has two bolts that hold it in place.

The figure at right shows what the telescope should look like after you have installed all four trusses.



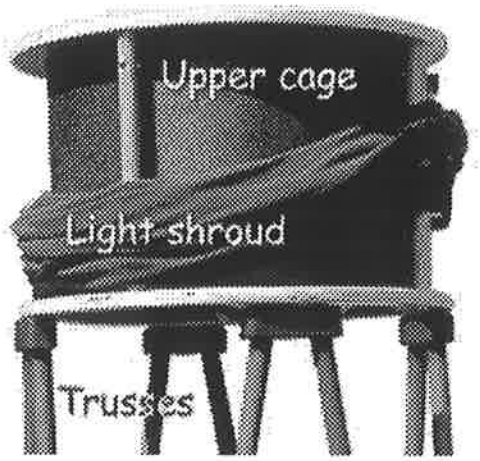
It's very important that the trusses be solidly attached to the mirror box. The combination of the mirror box, the trusses, and the upper cage assembly provide a light but very strong system. We suggest that you make sure the truss bolts hold the trusses to the mirror box very securely before you move on to the next step.

Please be careful not to over-tighten any of the bolts. The bolts have a large gripping surface, and as long as they are hand-tight they will do their job well. If you over-tighten them, they can strip or compress the wood in the base of the truss.

TIP: If you forgot to insert the wooden paddle, this is a good time to put in place. The next step adds a lot of weight at the top of the scope, and if the wooden paddle is not in place, the scope could tip unexpectedly.

Attach the Upper Cage Assembly

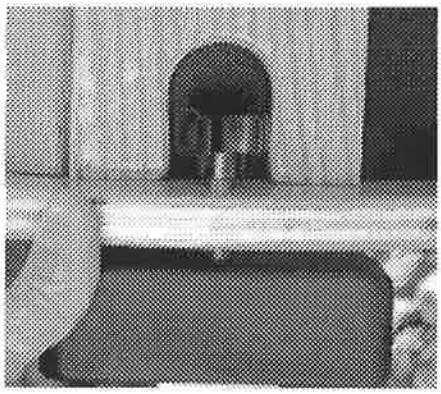
Carefully set the upper cage assembly on top of the trusses, as shown below. The focuser should face the side of the mirror box, above an altitude bearing. Put a few bolts in a pocket or other handy location so you can secure the upper cage assembly without having to leave it unsupervised.



Set the upper cage assembly on the trusses.

The focuser is close to the bottom edge of the upper cage, leaving just enough room for inserting a bolt at that location. You can lift the shroud (see above) past the focuser to make it easier to get access to the bolt holes.

The figure below shows a close-up of the point where the truss and the upper cage meet. We've have cut out certain portions of the focuser board where necessary to give you some finger room for tightening the bolts.

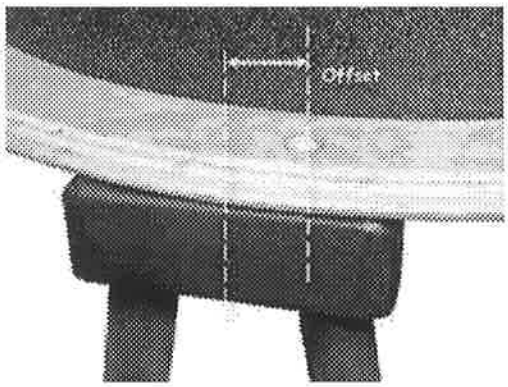


Insert a bolt through a hole in the base of the upper cage assembly and into the top portion of a truss. Use your fingers to align the truss with the bolt.

Lightly screw in three of the bolts. Do not tighten them all the way yet. Just make them snug enough to keep everything together while you do the next step.

Automatic Tension on Trusses

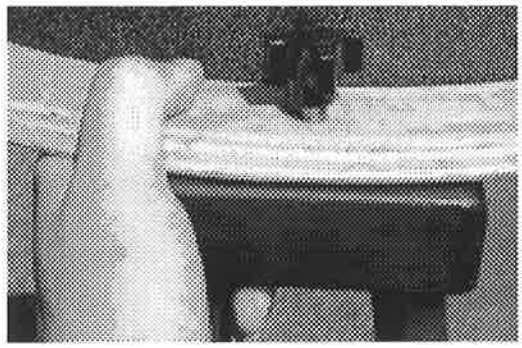
The fourth bolt looks like trouble, but with a purpose. The figure below shows what you will find when you try to insert the fourth bolt: the holes in the truss and the upper cage don't line up. This is normal! We designed it this way for a reason. The offset between the two hole locations is going to put helpful tension on the trusses, and increase the stability and rigidity of the scope.



The last truss will be offset from the hole in the upper cage assembly. This is normal.

When you bring the holes in the truss and the upper cage into alignment, you are stiffening the entire assembly. The larger the scope, the more you will have to move the last truss to make everything line up.

The figure below shows one way to get everything lined up. Use the palm of your hand to apply sideways pressure to the truss until the holes line up. Drop the bolt through the aligned holes with the other hand. Maintain sideways pressure until you have made several turns of the bolt. Otherwise, the bolt will tilt and the threads will not catch properly. This is called cross-threading, and you want to be careful to avoid it. Once a bolt cross-threads, it will have a tendency to do it again the next time. Once you have made several turns of the bolt, you can release pressure and continue tightening.



Apply pressure to the truss with the palm of your hand to align it with the last bolt hole.

Before continuing with field assembly, verify that all four bolts that secure the upper cage and the trusses are properly tightened. This puts the entire telescope under tension. This tension allows us to make a light-weight scope that is still stiff enough to hold collimation reliably. Lower the light shroud by sliding it down along the trusses (see below).

Install the Primary Mirror

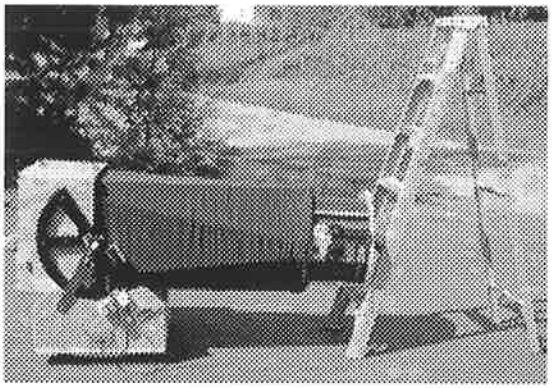
The primary mirror is heavy. Before you install it in the scope, you must secure the scope horizontally so that it cannot tip out of control while you are adding the weight of the primary mirror to the back end of the scope.

We have designed the primary mirror so that it is as easy as possible to install. Our smaller scopes have mirror assemblies that can be installed by one person. However, for your first assembly, we suggest that you have another person available to assist you. As you gain experience, you will find it easier to install the mirror. The mirror assembly is balanced in such a way that if you insert it correctly, gravity will assist you. If it seems that you are fighting the mirror during installation, it's possible that something isn't quite right. Stop, make sure everything is oriented and secured correctly, and then try again.

Securing the Scope Horizontally

The first step in securing the telescope is to support the front end (upper cage). The figure below shows a stepladder being used for this purpose. Anything that is stable and can take the weight will work well. Lawn chairs, observing chairs, benches -- all will work. The exact height you need depends on the size of the telescope. You want to support the telescope so that it is slightly below the horizontal, as shown in the figure below. This position is a very stable one for mirror installation. Because the body of the scope is tilted slightly below horizontal, the back of the scope is tilted slightly forward. This small tilt will help to keep the primary mirror stable while you attach it with four bolts.

Remove the wooden paddle and lower the telescope as shown below, with the upper cage resting on support you have chosen.

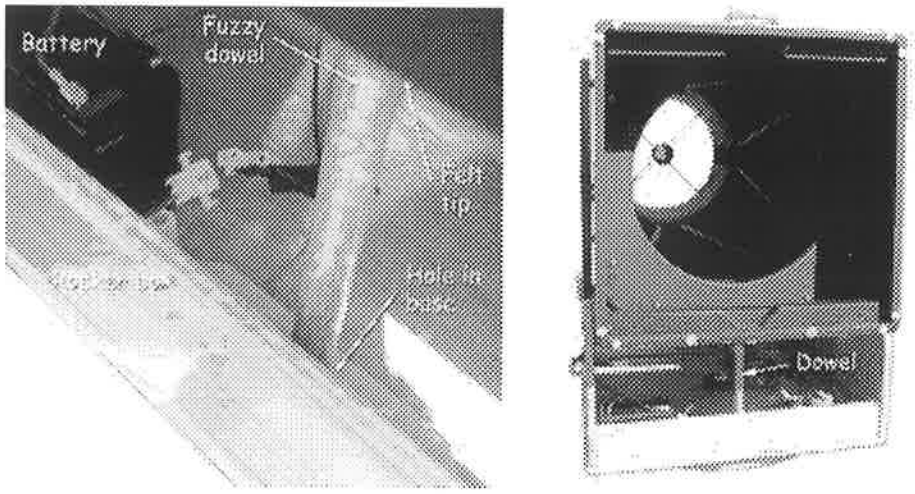


Use a chair or other handy support for the front end of the telescope.

We have supplied a dowel with a fuzzy tip with the telescope. You probably wondered what it was for. This is our mirror-installation dowel. This simple device secures the scope from tilting while you install the primary mirror.

The dowel fits into a hole in the rocker box at the low end of the box. There is a hole cut into one of the internal braces, and the non-fuzzy end of the dowel fits into this hole. To

insert the dowel, tip the front end of the telescope down slightly past the horizontal (right side of figure below). Tilt the dowel and insert the non-fuzzy end into the hole. Straighten out the dowel and allow the telescope to rise slightly so that the mirror box contacts the fuzzy tip. The scope cannot rise any higher because of the dowel.

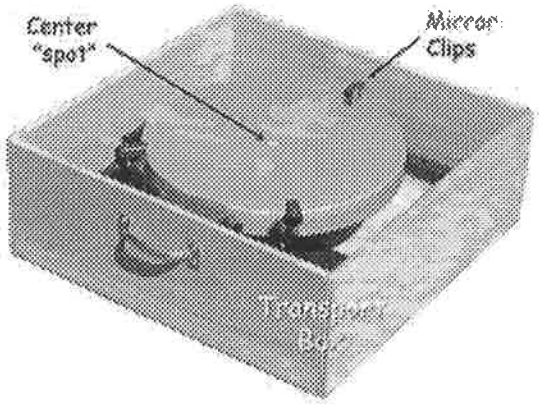


Insert the fuzzy-tipped dowel to secure the scope for primary mirror installation.

With the dowel preventing the scope from tilting upward, and the chair or other support preventing it from tilting downward, you are ready to install the primary mirror.

Handling the Mirror

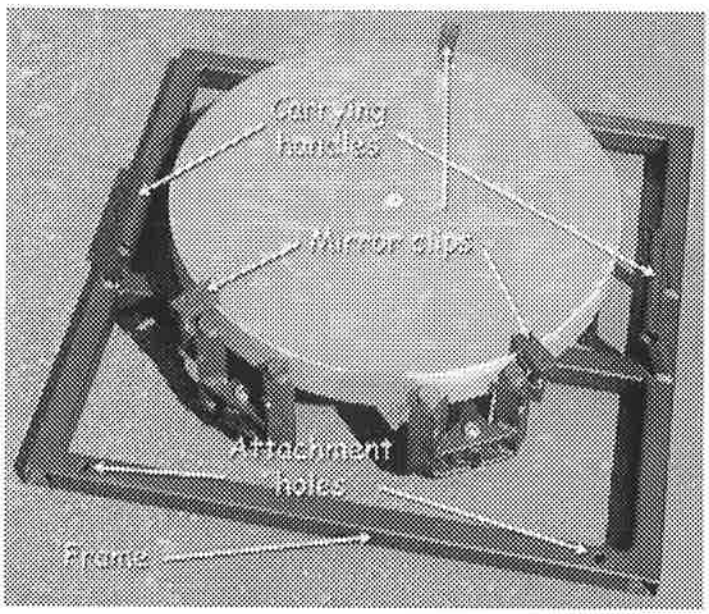
The mirror has it's own transport box, a large wooden box shown below with cover removed. The mirror always stays in the mirror assembly, which consists of a square frame and the cell that the mirror sits on. The figure below shows the mirror in its transport box, with the cover removed. When the mirror is not installed in the scope, store it in the transport box to help keep dust off of it.



The mirror in the mirror transport box, with the cover removed.

There are two handles on the mirror frame (see below). To remove the mirror from its transport box, lift using the handles. ***Never touch the mirror with your hands or anything else.*** It should be keep as protected as possible at all times.

The figure below shows several important things about the mirror, cell, and frame. It shows the two handles used for lifting the mirror assembly. There are also three mirror clips, which prevent the mirror from falling out if the scope is tilted too far forward. These clips should be located slightly above the surface of the mirror, *not* in contact with the surface. See page 32 for instructions on adjusting the spacing of the mirror clips.



The mirror, cell, and frame.

Also note the attachment holes in the mirror frame. There are two on the bottom of the frame, and two on the top. These holes are used to attach the frame into the base of the telescope. The two widely spaced holes (visible above) are the bottom of the frame. The two holes at the top of the frame are spaced much closer together. This allows you to tell at a glance where the top and bottom of the frame are. It you try to install the primary upside down, the bolt holes won't match up.

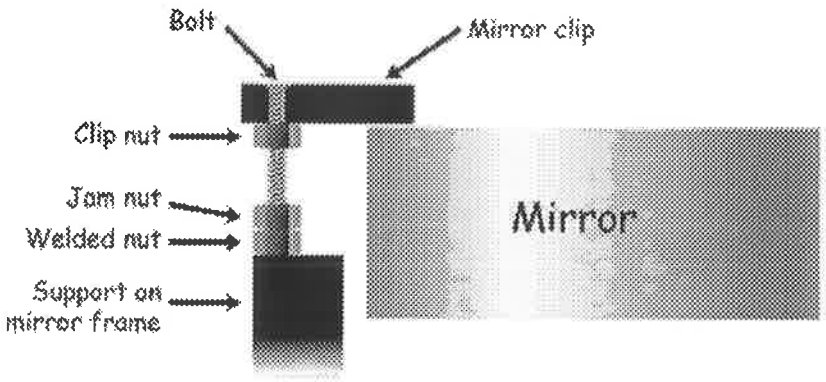
Remember:

- Widely spaced bolt holes are at the bottom
- Narrowly spaced bolt holes are at the top.

Mirror Clip Spacing

There are three mirror clips that restrain the mirror. They don't really hold the mirror in place; they prevent it from falling out. The mirror clips are designed to be a small distance above the surface of the mirror in normal use. If the scope is tilted far forward (below horizontal), the mirror clips come into play and prevent excessive mirror movement. The mirror clip is made of a material that is soft enough that it will not damage the mirror coating if it makes reasonably gentle contact with the mirror surface.

The figure below shows the parts of the mirror clip. The clip has a hole at one end, and a bolt basses through the hole. There is a nut up against the mirror clip that holds it at the top of the bolt. This clip nut should always be tight against the mirror clip. The bolt threads into a nut welded onto a support on the mirror frame. A jam nut is also threaded onto the bolt, between the clip nut and the welded but. When the jam nut is tightened down against the welded nut, it locks the mirror clip in place.



To lock down mirror clip spacing, tighten the jam nut against the welded nut.

If you need to adjust the height of the mirror clip, follow these steps:

1. Verify that the clip nut holds the mirror clip securely against the head of the bolt. The bolt head is angled, and sits down under the surface of the mirror clip as shown above.
2. Rotate the bolt downward by turning the mirror clip by hand. As long as the clip nut is tight, you can rotate the bolt using the mirror clip.
3. At some point the mirror clip will just touch the edge of the mirror. Reverse direction, and go one rotation backwards so that the mirror clip moves back up. It now clears the mirror surface by a small amount.
4. Square the mirror clip to the edge of the mirror. For our more geometrically inclined users, you want to make the mirror clip perpendicular to a tangent line.
5. Carefully tighten the jam nut to lock the mirror clip into position.

The mirror clip will now be riding a very small distance above the mirror. If the mirror clip is too far from the mirror, the mirror will move too far to make contact with the clip when the scope is tilted downward. This increases the pressure between clip and mirror, and can be avoided with correct spacing. When the spacing is small, there is very little acceleration toward the mirror clip, and all is well.

Inserting the Mirror Frame into the Mirror Box

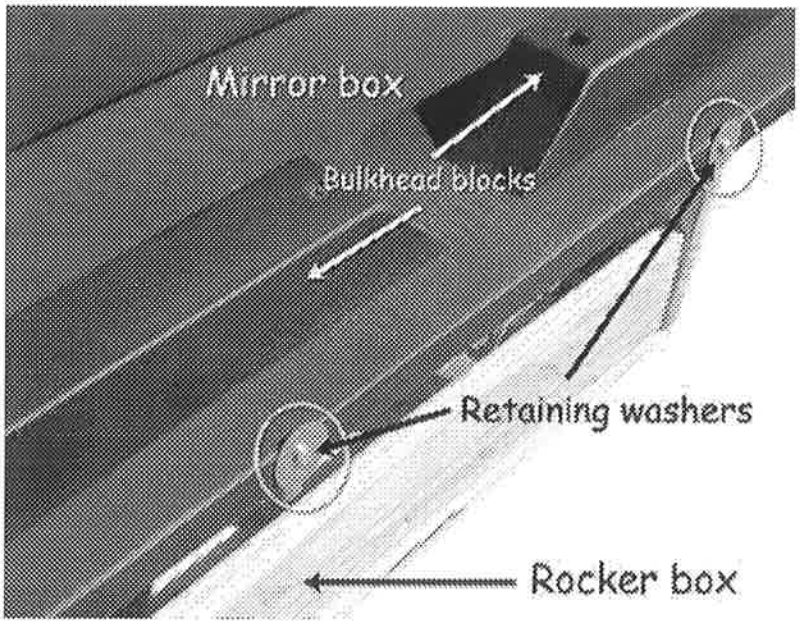
This is the trickiest part of assembling the telescope. It's tricky not because it's hard, but because it is so *easy.* You'll understand what we mean after you have done this a few times. We have designed the mirror frame so that gravity works in your favor. The mirror sits well in front of the frame. As you are inserting the frame into the mirror box, the weight of the mirror works in your favor. You gently guide the mirror frame into place, and then secure it with four bolts.

TIP: Put the four bolts you will need to secure the mirror in a handy place: e.g., pants pocket, shirt pocket, on top of the mirror box, etc. You want the bolts within easy reach, especially if you are assembling the scope without assistance.

Although you can carry the mirror frame from place to place using the handles, you cannot insert it into the mirror box using the handles. The reason is simple: the handles are on the inside! The handles are well above the back of the mirror frame, and so is the mirror. The main use for the handles is in lifting and transporting the mirror.

For your first assembly, place the mirror frame behind the telescope, and oriented so the top of the frame is toward you and the bottom of the frame is toward the mirror box. The base of the mirror frame is the end with the far-apart bolt holes.

Look at the bottom edge of the mirror box. You will note that there are two retaining clips (washers secured by screws), as shown in the figure below. To insert the mirror frame into the mirror box, you need to fit the base of the frame into the gap between the retaining clips and the wooden bulkhead blocks.

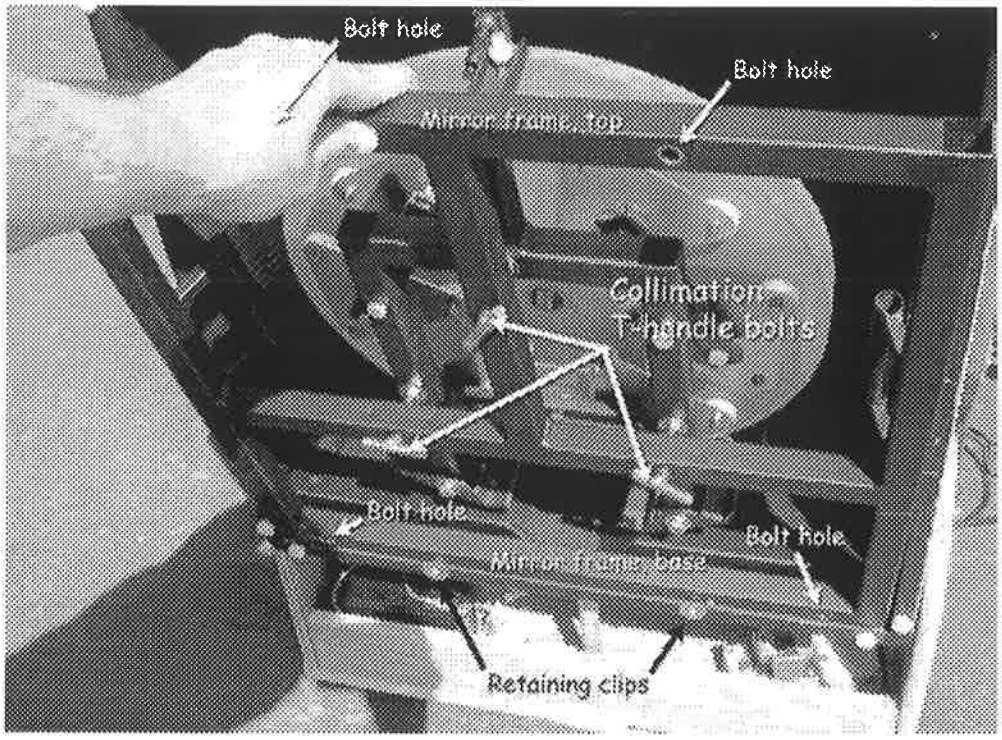


The mirror box has two clips to help hold the bottom of the mirror frame while you tilt it up and then secure it with bolts.

Stand with the mirror frame between you and the mirror box. Lift the mirror frame by the sides using both hands. **If the mirror frame is too heavy for you to handle on your own, get a second person to assist in lifting and placing the frame.** Hold the mirror frame slightly titled, with the base slightly forward away from you. This keeps the weight of the mirror back toward the mirror support, and prevents it from bouncing forward against the mirror clips. Depending on the height of the support holding the upper cage assembly, the telescope may rise a small amount when you insert the mirror and frame. Don't panic! This is normal. Let the telescope rise and seat itself against the fuzzy dowel.

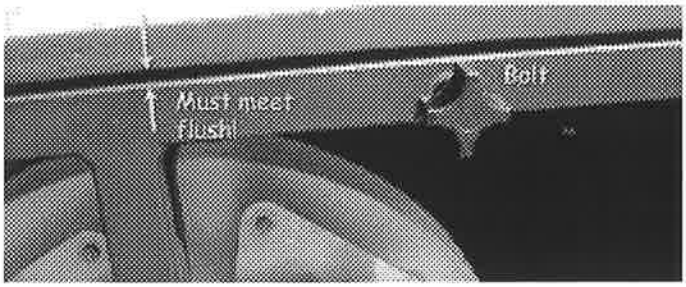
Carefully slip the base of the mirror frame into the space between the retaining clips and the bulkhead blocks (see below). The dowel will prevent the weight of the mirror from tilting the scope upward. Let the scope take the weight of the mirror frame while you continue to hold it at an angle, with the top tipped slightly back toward you.

Note how easy it is to control the mirror frame when it is in this position because of the way it balances.



Setting the mirror frame into the mirror box.

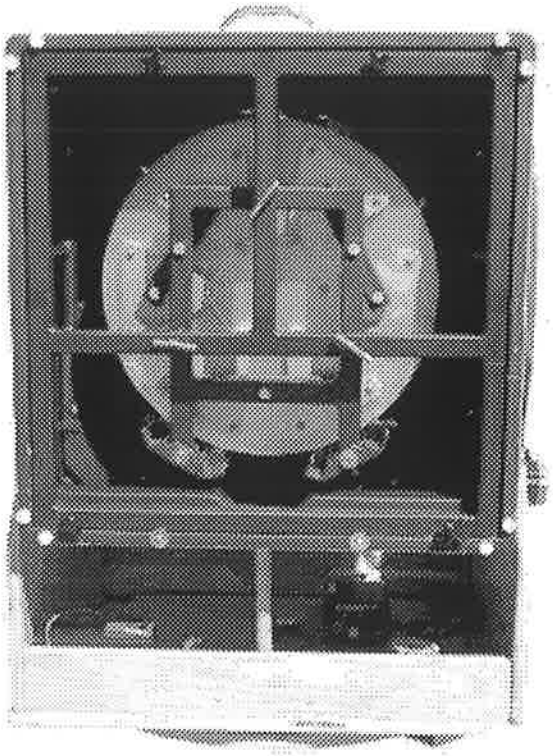
Let the weight of the mirror gently tip the mirror frame forward until the top of the frame sits against the top of the mirror box. The mirror frame should slip inside the lip of the mirror box so that it is approximately flush with the lip, as shown below.



The mirror frame should sit completely within the edges of the mirror box.

Insert a bolt in one of the holes in the top of the mirror frame, and lightly tighten it. You may find that you need to make small adjustments to the mirror frame to get it to line up with the holds in the wooden blocks. The safest way to do this is to grip the sides of the mirror box with your fingers, hook your thumbs around the sides of the mirror frame, and squeeze on the side you want to move. This gives you good control over the amount of movement, and does not shock the frame like a mallet would! You can scoot the mirror back and forth as needed to line up the holes.

Leave each bolt slightly loose in case you need to adjust the frame position. When all of the bolts are in place, firmly tighten them so that the frame presses against the wooden blocks. Do not over tighten, use hand pressure only. The figure below shows the appearance of the back of the scope after the mirror frame has been installed.



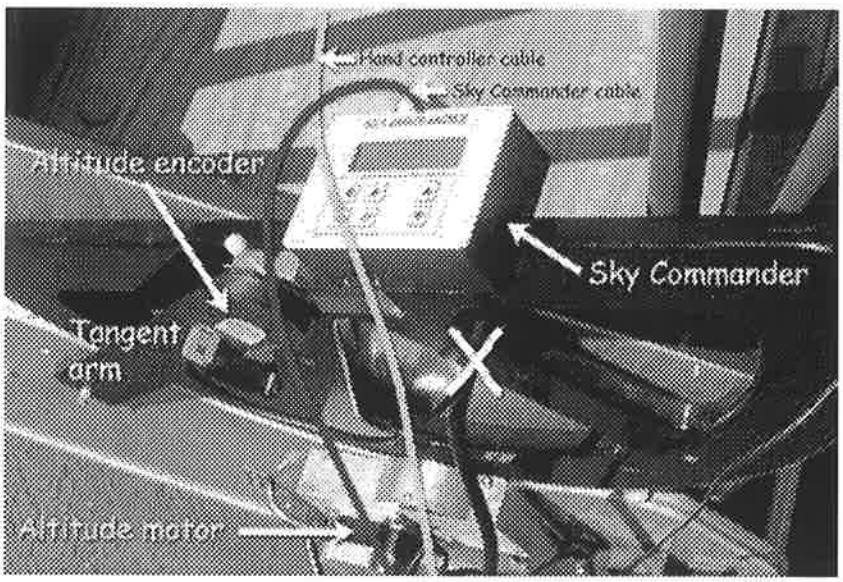
A rear view of the telescope with the mirror frame installed and ready to go.

With the mirror frame installed, the telescope will be close to balance. Keep in mind that the balance point has been set for a Paracorr and eyepiece sitting in the focuser. This means that the back of the scope will be slightly heavy until you put something in the focuser. If you remove the fuzzy dowel before you put anything in the focuser, the scope may rise a bit. This is normal. If want to balance the scope before removing the dowel, just put your Paracorr or a heavy eyepiece into the focuser, and install the Telrad finder as well.

Attach the Encoders and the Sky Commander

If you purchased a Sky Commander to use with your scope, you need to install the control box, the altitude encoder, and connect the cables. The figure below shows the fully installed Sky Commander, and installation details follow below.

TIP: The "X" shows where ***not*** to route the sky Commander cables! Route the Sky Command cable outside of the side bearings, and over the hand controller cable. This helps to control the hand controller cable and prevent it from hanging loose and getting in your way.

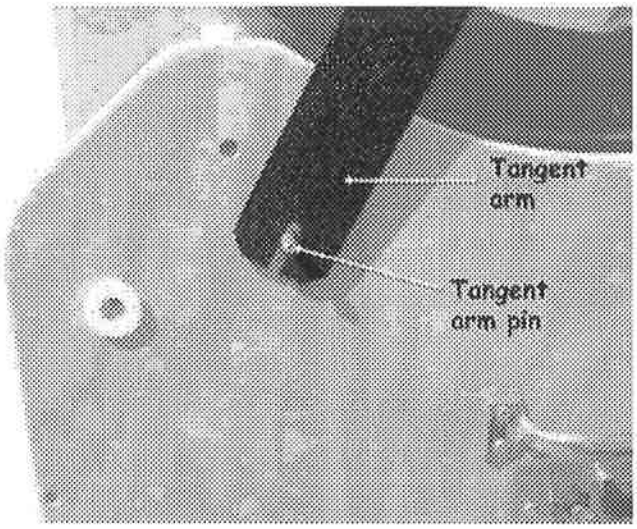


The Sky Commander, altitude encoder, and cables after installation.

Complete instructions for the Sky Commander can be found in the separate Sky Commander manual.

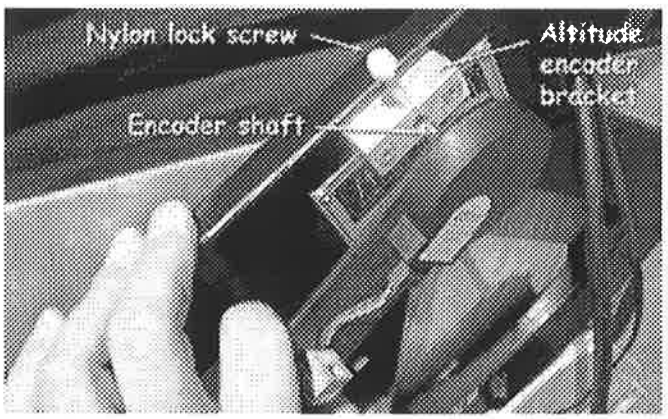
Altitude Encoder

The altitude encoder is attached to a black plastic strip called a tangent arm. One end of the tangent arm attaches to a pin on the side of the mirror box (see figure on next page), and the other end (with the shaft of the encoder) attached to the altitude encoder bracket. There is a small washer on the pin that prevents the tangent arm from slipping off of the end of the pin. You do not need to loosen or remove the screw that holds the post in place. The notch in the tangent arm slides in edgewise.



Attaching the altitude tangent arm to the tangent arm pin.

Swing the end of the tangent arm with the encoder attached into alignment with the aluminum altitude encoder bracket on the altitude bearing, as shown below. The other end of the tangent arm has a notch that allows you to move the arm so you can line up the encoder shaft with the hole in the bracket. Make sure the lock screw is loose enough to allow you to insert the encoder shaft. Do not force the shaft; it will slide easily into the hole. Set the tangent arm flush against the housing, and then tighten the nylon lock screw finger tight. Do not over tighten or you could damage the nylon screw.



Inserting the altitude encoder shaft into the altitude encoder bracket.

TIP: Between observing sessions, turn the nylon screw all the way in. This helps prevent it from falling out when disassembling or moving the scope.

Sky Commander Control Box

There is an aluminum mounting plate on the one of the altitude bearings. This is the plate for the Sky Command control box. The control box and the plate have hook-and-loop material on them that keeps the control box secured to the plate.

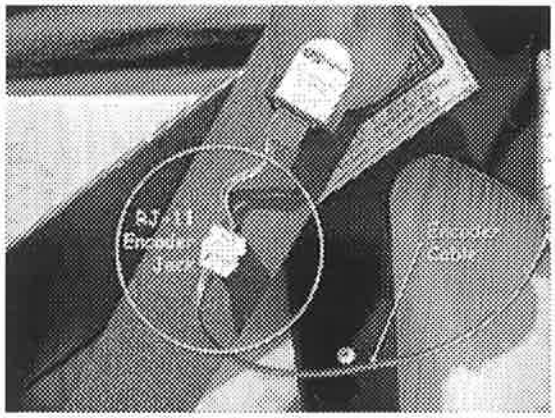
Attaching the Sky Commander control box.

Set the control box on the plate so that the cables are away from you, and the on/off switch is toward you.

Cables

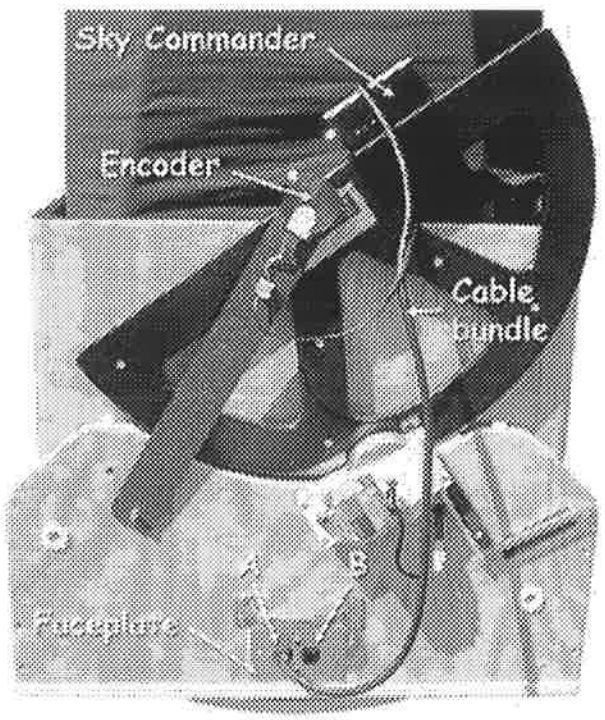
Route the cables around the Sky Commander. Run the cable for the hand controller under the Sky Commander cables to help keep it from flopping around. There are two Sky Commander cables: a single, thin cable that attaches to the altitude encoder, and a thicker wrapped cable that attaches to the faceplate on the side of the mirror box.

Attach the thin cable to the female RJ-11 jack on the encoder support, as shown below. The cable must be oriented properly to connect. You will hear a slight click when the cable is properly inserted.



Attaching the encoder cable to the encoder jack.

The thick, wrapped cable extends down to the faceplate on the side of the mirror box. There are two female jacks in the faceplate. Insert the connector at the end of the wrapped cable into jack A, as shown below. Jack B is for the hand controller cable.



The Sky Commander and altitude encoder installed and connected.

That's all there is to setting up the Sky Commander and encoders. The figure above shows the completed installation and cabling.

Note: The azimuth encoder is already attached to the rocker box at the factory. The wrapped cable you connect to the faceplate connects the Sky Commander to the azimuth encoder as well as to other devices in the rocker box, such as the Sky Tracker control box.

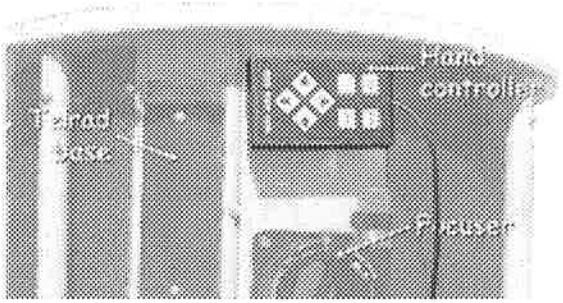
Set Up the Sky Tracker

The control box and the internal cables for the Sky Tracker are installed and set up at the factory. All you need to do is install the hand controller and connect it to the faceplate on the side of the mirror box. See the later section "Operating the Sky Tracker" for details on using the Sky Tracker with the Sky Commander for goto.

Hand Controller

The Sky Tracker hand controller has a long cable that allows you to operate the Sky. We recommend that you hold the controller in your hand when moving the telescope. This allows you to press the standby key (STBY) in case of trouble. When not in use, you can attach the hand controller to the upper cage assembly. The figure below shows the hand controller attached to the upper cage. It uses a hook-and-loop fastener that is pre-installed at the factory.

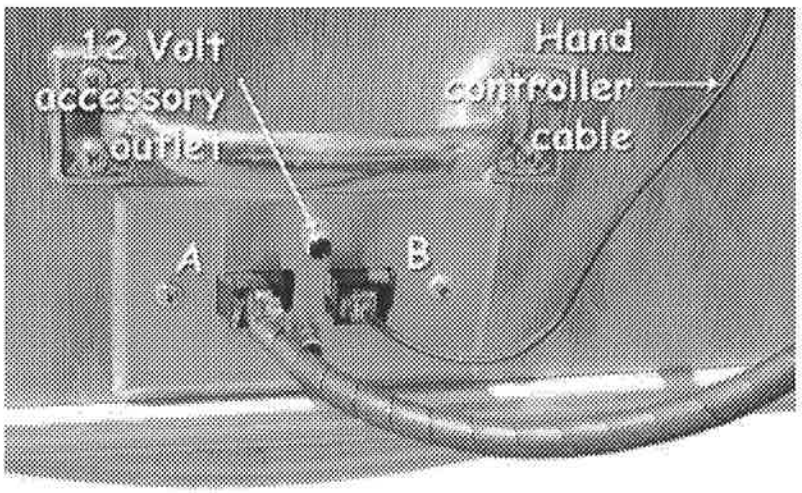
When used in this fashion, the cable runs loosely along the side of the scope. Keep an eye on the cable to make sure it doesn't snag on anything as the scope moves about.



The hand controller for the Sky Tracker attaches to a hook-and-loop strip on the upper cage assembly.

Hand Controller Cable

The hand controller cable plugs into jack B in the faceplate on the mirror box, as shown below. As with all connections, make the connection before you connect the battery.



See the section "Using the Sky Tracker" later in this manual for more information on the hand controller and how to use it.

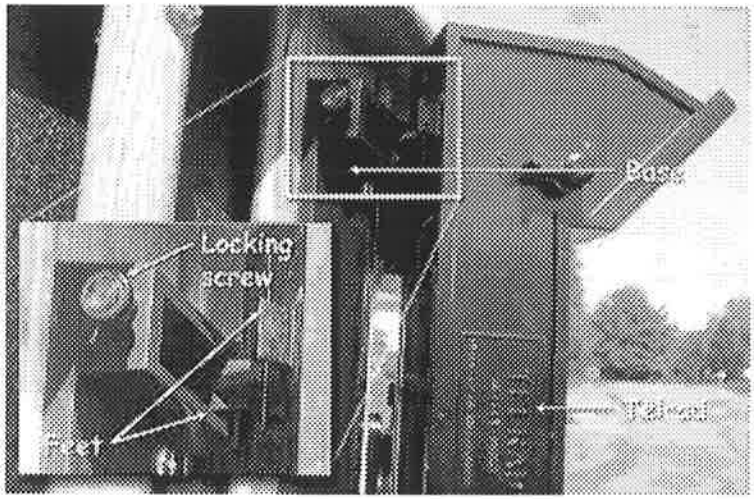
IMPORTANT: ALWAYS KEEP THE HAND CONTROLLER NEARBY. IF THERE IS A PROBLEM, SUCH AS AN OBSTACLE THAT COULD DAMAGE THE SCOPE, STOP THE SCOPE DURING A GOTO BY PRESSING THE STBY (STANDBY) BUTTON.

TIP: the two RCA-pin connectors on the faceplate are 12-volt power outlets. You can use them to supply power to your 12-volt accessories.

Attach Telrad Finder

The Telrad finder's base plate is attached to the upper cage assembly at the factory. There are two slots in the base that correspond to the two sets of feet on the Telrad finder. Note that one side of each slot has a knob in it. These are locking screws.

The figure below shows how the finder fits into the base. Slip the finder's feet into the side of the base away from the locking screws. Make sure that the locking screws are backed out far enough to allow you to tilt the Telrad's other feet down into the base. Hold the Telrad in place and tighten the lock screws. Do not over-tighten. The lock screws are plastic, and can break if tightened too aggressively.



Attaching the Telrad finder to the upper cage.

Your Telrad comes with instructions that tell you how to align it to the telescope and use it as a finder.

Insert and Connect Battery

Your telescopes comes with two batteries and a charger. This allows you to charge one battery while the other one is being used. These batteries require a special type of charger, so we have used a special connector on the batteries that will only connect to the type of charger supplied with the telescope.

The battery is fully charged after 8 hours on the charger.

The battery should be removed before you transport the scope. It sits loosely in the rocker box and could fall easily. It's also quite heavy, and would make the rocker box harder to transport.

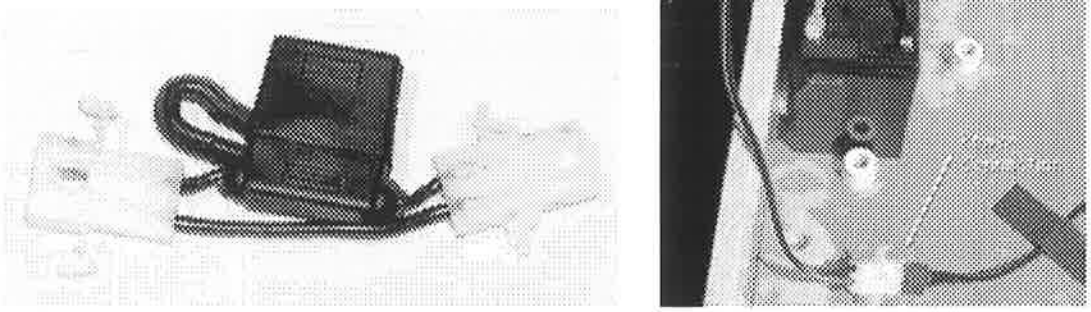
IMPORTANT: DO NOT CONNECT THE BATTERY UNTIL YOU HAVE MADE ALL OTHER CONNECTIONS DURING ASSEMBLY. MAKE SURE THE POWER SWITCH ON THE SKY TRACKER IS SET TO OFF BEFORE YOU CONNECT THE BATTERY.

A power surge can occur if you connect equipment after the battery is connected, or if equipment is ON when the connection is made. This can cause a fuse to blow, and the fuse will have to be replaced before you can continue.

When everything else is installed and connected, place the battery into the rocker box as shown in the figure below. There are two rubber bumpers that keep the battery in place.

Note that one of the battery connections has a red stripe next to it. This is the positive terminal of the battery. The red wire MUST be connected to this terminal for proper operation of the scope. Reversing connections will cause a fuse to blow.

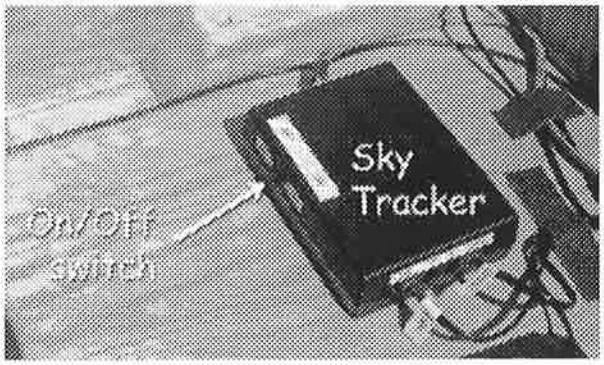
There is a connector in the rocker box that matches the connector on the battery (see below). Slip these two connectors together to supply power to the telescope.



Left: Newer Starmasters have a fuse link. Right: Connecting the battery

TIP: If your Starmaster has a fuse link, it is located at the power connection point. The fuse will cut power to the telescope if there is a short. This helps protects the electronic equipment. If you connect the battery and there is no power, open the black case of the fuse link and check the fuse. If you need to replace the fuse, the type and rating can be found on the fuse. Replacement fuses can be found at most auto supply stores.

After the battery is connected, turn on the Sky Tracker (see below) and the Sky Commander. You are now ready to start using the telescope.



The power switch for the Sky Tracker, which is located on the base of the rocker box.

Assembly Checklist

- ☐ Set up rocker box
- ☐ Level rocker box
- ☐ Verify clearance for azimuth drive gear
- ☐ Put mirror box into rocker box
- ☐ Secure mirror box with wood paddle
- ☐ Attach trusses to mirror box
- ☐ Attach upper cage assembly to trusses
- ☐ Put support under upper cage assembly
- ☐ Put fuzzy-tipped dowel into rocker box
- ☐ Verify correct placement and clearance on mirror clips
- ☐ Remove mirror from its transport box
- ☐ Install Telrad Finder
- ☐ Insert mirror frame into mirror box
- ☐ Insert heavy eyepiece to balance scope
- ☐ Remove support under upper cage
- ☐ Remove fuzzy dowel
- ☐ Attach altitude tangent arm with encoder
- ☐ Attach Sky Commander
- ☐ Plug Sky Commander cables into altitude encoder and jack A of faceplate
- ☐ Attach Sky Tracker hand controller to upper cage assembly
- ☐ Plug Sky Tracker hand controller into jack B of faceplate
- ☐ Verify that all cables are connected
- ☐ Install and connect battery
- ☐ Turn on Sky Commander
- ☐ Perform two-star alignment
- ☐ Select object with Sky Commander, verify alignment
- ☐ Turn on Sky Tracker
- ☐ Engage clutches
- ☐ Select new object with Sky Commander
- ☐ Press GOTO button on Sky Tracker hand controller
- ☐ Repeat last two steps until done

Collimation

Collimation is extremely important. It has a major impact on the performance of a Newtonian telescope. A telescope with high-quality optics, like your Starmaster, will benefit greatly from a careful, accurate collimation.

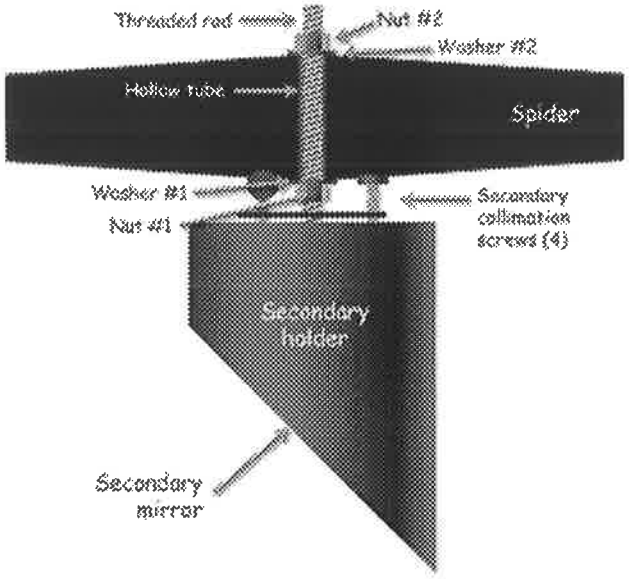
All Starmaster telescopes are accurately collimated prior to shipment. Check collimation of the primary and secondary mirrors whenever the telescope is transported.

Collimation is not especially difficult, but it is a new procedure for many owners. The way you collimate depends on the tools you use. Follow the instructions that came with your collimation tools. We recommend that you perform initial or major recollimation using a sight tube, Cheshire, and auto-collimator. We sell an excellent set of these tools made by Tectron, including a booklet that provides detailed information about collimation.

After collimation with the Tectron tools, you can also use a laser for minor recollimation in darkness. We recommend and sell the Kendrick laser collimation tool. The best tool for final, ***final*** collimation is still the auto-collimator. Use the sight tube and Cheshire for rough collimation, the laser for a quick field or night-time collimation, and the auto-collimator for extra-fine collimation.

The seeing conditions determine the value of a thorough collimation. If the seeing is average, a carefully refined collimation will show little or no benefit. On nights when the seeing is dead calm, however, the contrast and sharpness improvements from a very careful collimation will be very rewarding.

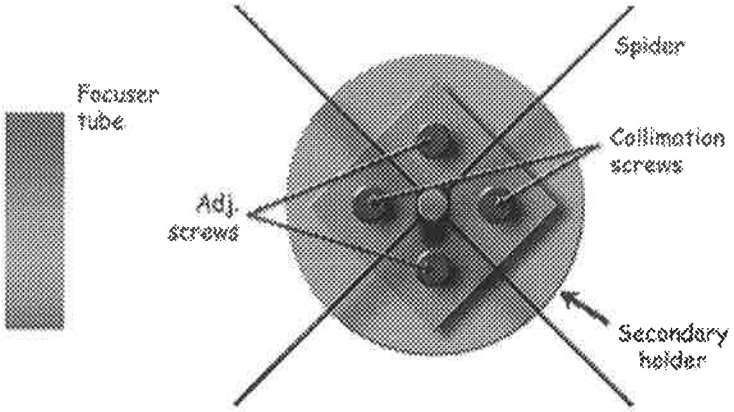
Collimating the Secondary Mirror



Parts of the secondary mirror assembly.

The figure above shows the layout of the parts around the secondary mirror. See also the section "Installing the Secondary Mirror" near the beginning of the manual which explains the installation of the secondary.

In normal use, you will only need to use minor collimation adjustments when you re-assemble the telescope. The figure below shows a view down the telescope from the front. There are four screws on the secondary, but only two of them are normally used during collimation. These are labeled "Collimation screws" in the figure. They control the tilt of the secondary. The other two adjustment screws are set at the factory. They square the secondary to the focuser, and this should not need adjusting. If you accidentally move the adjustment screws, call us for assistance in setting them right.



The secondary mirror viewed from the front end of the telescope.

TIP: Use the focuser tube (shown at left in the figure above) for determining the two collimation screws. *The collimation screws will always be the pair that line up with the focuser.* One collimation screw is on the side near the focuser, and the other collimation screw is on the side away from the focuser.

There are two adjustments that you will typically make when collimating the secondary:

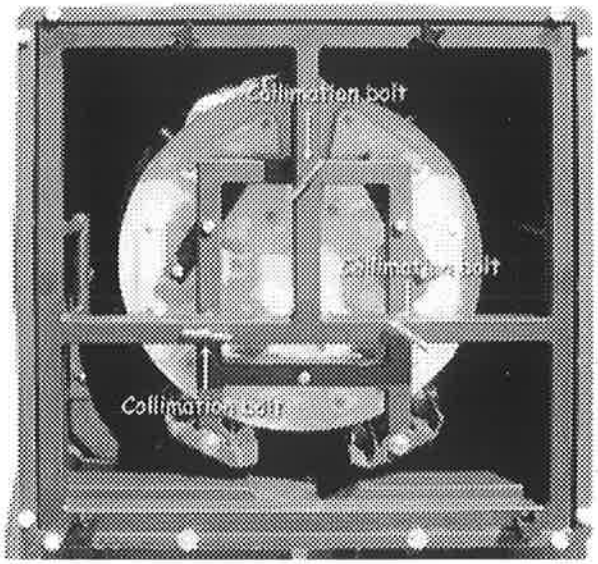
- **Rotate the secondary** - Loosen the top nut (nut #2, page 44) slightly to allow rotation. Do not loosen it completely, or the secondary will move too easily. There should be some friction so that you can make small, controlled adjustments to rotation.
- **Tilt the secondary** - This is accomplished using the collimation screws (see figure above). These screws tilt the secondary toward or away from the focuser. As noted elsewhere, there is rarely a need to adjust the other two screws.

During factory setup, two other adjustments of the secondary are done. In normal use, you will rarely need to perform these adjustments yourself:

- **Change position along length of tube** - The lower nut (#1) controls the position of the secondary mirror along the length of the tube. We set the position of this nut when we perform collimation at the factory. If this nut moves, or if you change the configuration of the telescope (e.g., using shorter or longer truss tubes), you can adjust the position of the secondary by altering the position of the lower nut. Follow the instructions that came with your collimation tools for positioning the secondary along the length of the tube.
- **Square the secondary with the focuser** - Use the ***other*** two adjustment screws to align the secondary mirror with the focuser.

Collimating the Primary Mirror

Collimation of the primary is extremely straightforward. There are three collimation T-handle bolts on the back of the primary, as shown below. Collimation is achieved by turning these three bolts in or out to adjust the tilt of the mirror. The method you use to evaluate collimation depends on the tool(s) you are using (Tectron and/or laser).



Collimate the primary mirror using the three collimation bolts shown above.

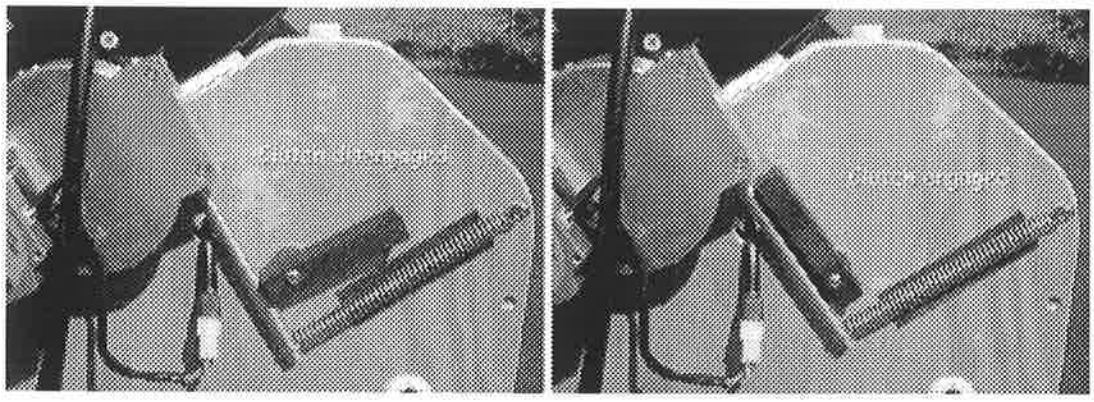
On the larger scopes the back of the primary is too far away from the focuser to allow you to adjust the collimation bolts while you observe through the focuser. It's handy to have another person available during collimation so that you can have one person at the focuser, and another person making adjustments to the primary.

Using Sky Tracker

Engaging and Disengaging Clutches

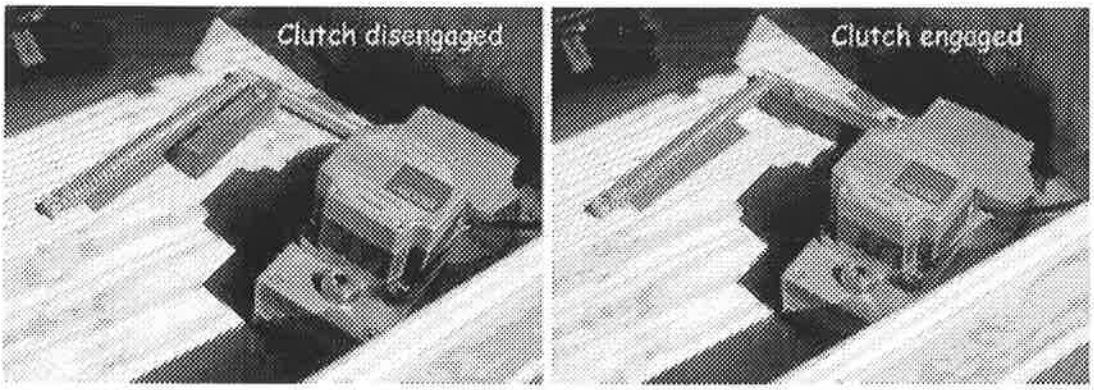
The altitude and azimuth drives have clutches. When the clutches are engaged, the drive gears on the drive units are pushed against the surfaces they drive, and the scope will move. When the clutches are disengaged, you can position the scope manually.

The clutches for both drivers work in a similar way. The figure below shows the two positions of the altitude clutch. When the clutch lever is parallel to the spring (below left), the clutch is disengaged and you can move the scope in altitude freely by hand. When the clutch lever is parallel to the arm (below right), the clutch is engaged and the drive unit will move the scope in altitude.



Flip the lever to engage and disengage the altitude clutch.

The figure below shows the two positions of the azimuth clutch, located in the rocker box. When the clutch lever is parallel to the spring (below left), the clutch is disengaged. When the clutch lever is parallel to the arm (below right), the clutch is engaged.



Flip the lever to engage and disengage the azimuth clutch.

Using the Hand Controller

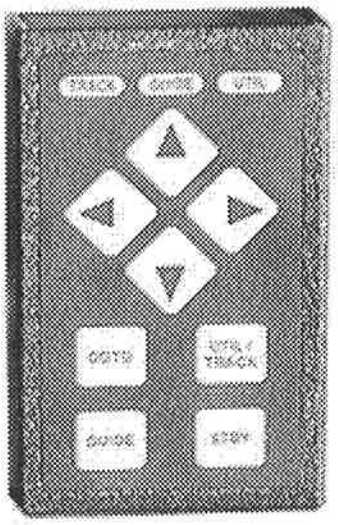
There are a row of lights and two groups of buttons on the hand controller. The top row of lights indicate the current operating mode of the Sky Tracker. The diamond of four arrow buttons are used to move the scope. The four buttons at the bottom of the hand controller provide access to special features.

Status Lights

TRACK Indicates that the scope is tracking at the sidereal rate. When lit, the arrow buttons move the scope at a very slow rate suitable for centering objects in the field of view.

GUIDE Same as TRACK, but the centering speed is four times slower. This is useful for centering objects at high powers.

UTIL Indicates that the scope is not tracking. When lit, the arrow buttons move the scope at high speed. Use this mode for making large manual movements across the sky.



The hand controller for the Sky Tracker

Arrow Buttons

The left and right buttons move the scope in azimuth. The up and down buttons move the scope in altitude. Pushing two buttons (one from each group, of course!) moves the scope in both directions at once. When using UTIL mode, the scope moves very fast and does not stop instantly. It glides to a stop. When you are moving the scope a long distance, allow enough time for the scope to slow down. This is most important when you are viewing near the horizon. If the scope is moving to fast, it will reach the vertical stop. The motors are very strong in order the move the scope quickly. Driving the scope into the stop hard can cause damage and should be avoided.

Special-Purpose Buttons

GOTO	When pressed, the scope moves to the object that the Sky Commander currently shows on its display.
UTIL/TRACK	Toggles between the UTIL and TRACK modes.
GUIDE	Sets the GUIDE mode. Tracking is on, and the centering speed is four times slower than for TRACK.
STBY	Toggles power to the motors on and off. Good for conserving battery power. Use this button to interrupt a GOTO operation.

For information about using the various modes and buttons, please see the section "Operating the Sky Tracker" in the "Miscellaneous Notes" portion of the manual.

How Sky Tracker Works

The Sky Tracker has multiple components that work together. The Sky Commander is the brains of the outfit. It reads the encoders and knows the current position of the telescope. It has a database with many objects in it, and it knows about RA and Dec. You use the Sky Commander just as you would with any Starmaster. You perform an initial alignment to the sky (normally a two-star alignment), and when you want to view an object, you select the object from the Sky Commander's databases.

Note: There is a separate manual with complete information about the operation of the Sky Commander.

Without Sky Tracker, you would then move the scope by hand and observe the readout of the Sky Commander to determine when your object was in the field of view. With Sky Tracker, simply push the GOTO button and the motors will point the scope at the desired object.

Setup

In order for the Sky Tracker and the Sky Commander to work together, the Sky Commander must be set up correctly. If you purchased a new telescope with Sky Tracker, we have already set up the Sky Commander for you. If these settings are changed, you must set the baud rate for the Sky Commander to 9600 baud.

Operation

When you first turn on the Sky Tracker, the UTIL light will be lit. In this mode, the scope slews very fast when you hold down the arrow buttons.

Before you can use GOTO, you need to align the Sky Commander. Perform a standard two-star alignment (full details in the Sky Commander manual). The first object that displays is M31. Press the UP arrow on the Sky Commander to switch to Alt-Az mode. Select the object you want to view with the Sky Commander. Test alignment by hand before turning on the Sky Tracker. If alignment is not correct, the Sky Tracker could try to move the telescope past safe limits.

NOTE: The GOTO function will only work if the Sky Commander is in Alt-Az mode! GOTO does not function in RA/DEC mode.

NOTE: Select objects that are at least 10 degrees above the horizon.

By keeping the telescope above the horizon, you avoid unweighting the mirror, which could disturb collimation. If you do point the scope too low, check collimation and fix it if necessary.

Taking Down the Scope

The scope tears down in the reverse order of assembly. We have provided a handy checklist that you can use for taking down the scope.

Disassembly Checklist

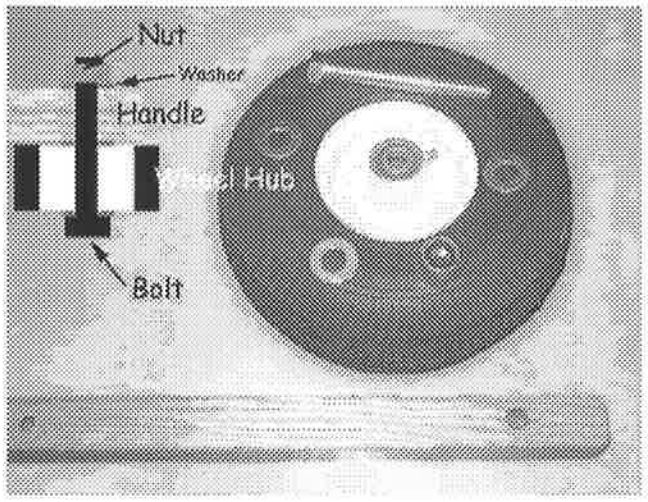
- ☐ Turn off Sky Tracker
- ☐ Turn off Sky Commander
- ☐ Disengage clutches
- ☐ Disconnect and remove battery
- ☐ Remove Telrad finder
- ☐ Unplug Sky Tracker hand controller
- ☐ Remove Sky Tracker hand controller
- ☐ Unplug Sky Commander cables
- ☐ Remove Sky Commander
- ☐ Remove altitude encoder
- ☐ **Insert fuzzy dowel to prevent tipping of scope when mirror is removed!**
- ☐ Place support under upper cage
- ☐ Remove eyepieces and/or Paracorr
- ☐ Carefully remove mirror frame from mirror box
- ☐ Store mirror from its transport box
- ☐ Remove fuzzy dowel and raise telescope upright
- ☐ Remove upper cage assembly
- ☐ Remove trusses
- ☐ Remove mirror box from rocker box
- ☐ Store rocker box

Transport Handles - Assembly

Transport handles allow you to move your Starmaster telescope without disassembly. When the handles are attached to the scope, you can move it around just like you would a wheelbarrow. The transport handles attach to the rocker box (see figure on next page). The rest of this section describes initial assembly of the handles, and how to attach them to the scope.

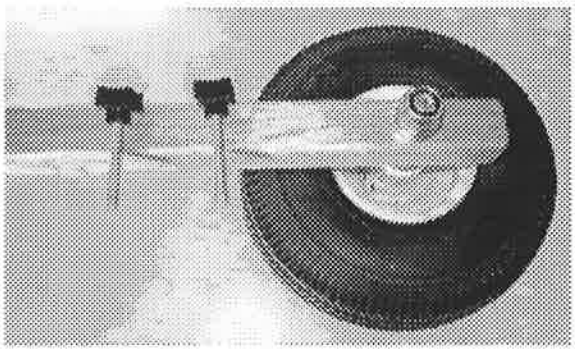
IMPORTANT: Please see "Important Safety Note about Transporting the Assembled Scope" on page 5 for important safety information about use of the transport latch.

The wheels must be attached to the transport handles before you can use them. The figure below shows how the wheels are attached. Note that there are three washers: one between the bolt head and wheel hub; one between the wheel hub and handle, and one between the handle and nut.



Attaching a wheel to a transport handle.

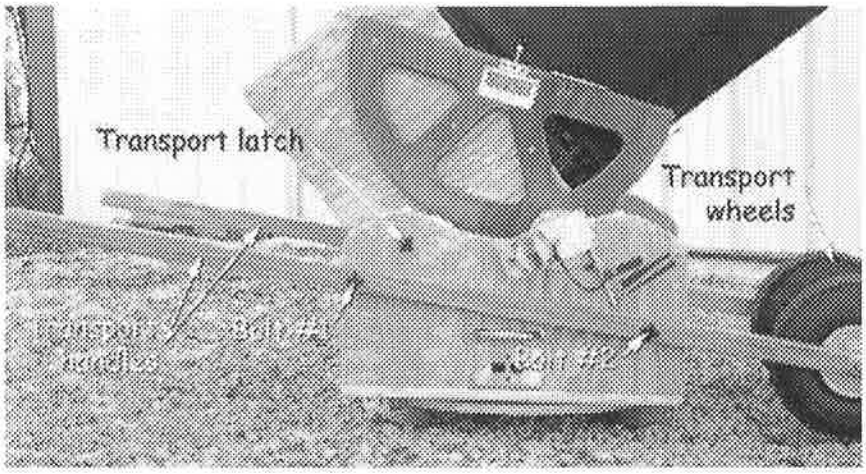
The figure below shows the wheel attached to the handle. The two bolts are used to attach the handle to the rocker box (see next page).



The wheel properly attached to the transport handle.

The figure below shows how the transport handles are attached to the rocker box. Note that it also shows the location of the Transport latch, and the angle of the telescope when the transport latch is used.

IMPORTANT: Always use the transport latch when transporting the assembled telescope!



The transport handles attached to the rocker box.

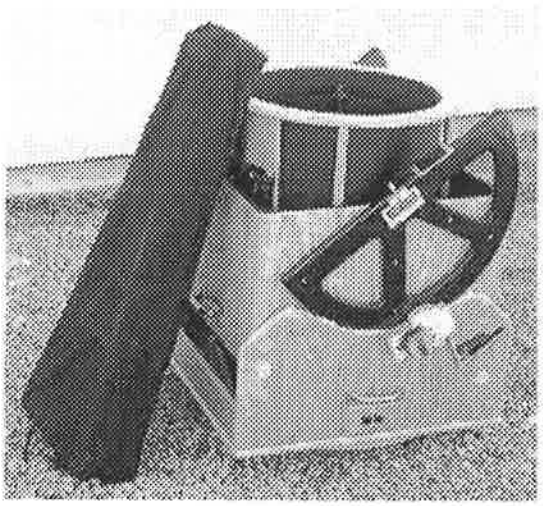
To attach the transport handles:

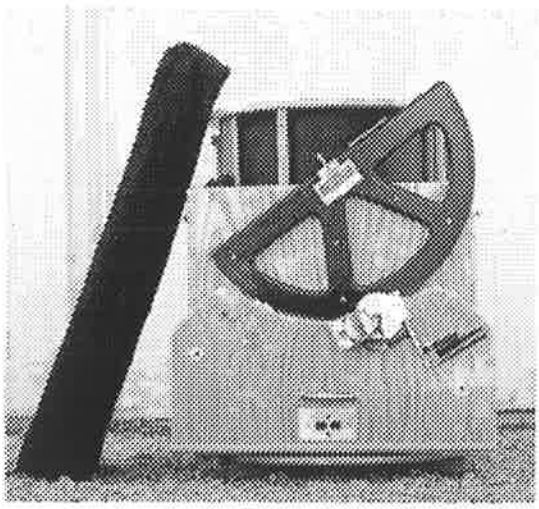
- First insert the transport latch (see page 5)
- Make sure that the wheels are on the inside of the handles as shown above.
- Use two bolts for each handle, in the locations shown. There are matching holes in t he rocker box for the bolts.
- Remove any loose cables before moving the scope. The cables can easily catch on obstacles, and you may not notice this because of the weight and momentum of the telescope.
- Before moving the scope, make sure that all bolts are securely tightened, but do not over tighten. Hand tight will do the job.

Storing Your Starmaster Telescope

The components of your Starmaster telescope are designed to store compactly. The trusses slip into the black cloth bag in which they were shipped. The upper case assembly fits into the mirror box, sitting on the edge of the circular baffle inside the mirror box.

The components can be stacked and stored as shown below in a relatively small space compared to the size of the fully-assembled telescope.





Caring for Your Starmaster

We recommend that you clean your mirror surfaces only when dust and dirt are ***very*** obvious. Over-cleaning mirror surfaces can do more harm than good. Smears and scratches can do more damage to your mirror's ultra-thin coatings than dust.

If your mirrors do need cleaning, see the sections below on cleaning your primary and secondary mirrors.

Cleaning Wood Surfaces

To clean the portions of the telescope that are coated with clear polyurethane, use a damp rag to remove dust. If the telescope is really dirty, use a mild dish soap.

Cleaning the Primary Mirror

To clean the primary mirror, place the mirror in its cell at an angle that allows liquids to drain easily. If the mirror is in the telescope, remove the cell from the mirror box according to the instructions in the section "Taking Down the Scope." Follow all precautions in that section so the unbalanced telescope is secure while the mirror is out.

You can lean the mirror cell against a firm wall or table. The slope of the mirror should be steep enough for good drainage, but **pay attention to balance.** The mirror should not be able to tip away from the support! The larger mirrors are very heavy, and you should use caution or ask for help when moving the mirror and cell.

Use a one-pint or larger hand-held spray bottle to hold your cleaning solution. The solution you use should consist of:

- Distilled water
- Two or three drops of household dish detergent

To clean your primary mirror:

1. Spray ***all*** of the cleaning solution continuously onto the mirror surface. Allow the solution to run off of the mirror surface.
2. Immediately rinse thoroughly with more distilled water.
3. Allow the mirror to air dry, or pat it lightly with 100% cotton balls. You can purchase these at most drug stores. Viva or Bounty paper towels are OK on large mirrors. Use 4-5 cotton balls at a time. This keeps your fingers from touching the mirror surface. Cotton balls become wet quickly. Change to fresh cotton balls several times to eliminate all of the excess water from the mirror.

Cleaning the Secondary Mirror

You do not need to remove the secondary mirror from its holder, or even from the spider assembly, in order to clean it.

To clean your secondary mirror, use the same cleaning solution described above for cleaning the primary mirror.

1. Completely submerge four or five 100% cotton balls in the cleaning solution.
2. Use the cotton balls to lightly wipe the secondary mirror in a single direction (no back and forth!).
3. Completely submerge four or five cotton balls in distilled water.
4. Lightly wipe the secondary mirror in the same direction.
5. Allow to air dry, or dab with dry cotton balls until the moisture is gone.

Cleaning Eyepieces/Oculars

To clean your eyepieces, use the same cleaning solution described above for cleaning the primary and secondary mirrors.

1. Completely submerge one or two 100% cotton balls in the cleaning solution.
2. Use the cotton balls to lightly wipe the lens surface in a circular direction.
3. Completely submerge one or two cotton balls in distilled water.
4. Use the cotton balls to lightly wipe the lens surface in a circular direction.
5. Allow to air dry, or dab with dry cotton balls until the moisture is gone.

Other Documentation

Other Documentation Included with Scope

The documentation for the following items is supplied separate from this manual:

- Telrad finder
- Feathertouch Focuser
- Sky Commander
- Sky Tracker

Web Links

Starmaster web site

http://www.starmastertelescopes.com/

Sky Commander web site

http://www.skyeng.com/

Collimation web sites

http://www.amateurastronomy.com/collimate.html
http://zebu.uoregon.edu/~mbartels/kolli/kolli.html
http://www.fpi-protostar.com/collim.htm
http://www.efn.org/~mbartels/tm/collimat.html
http://perso.club-internet.fr/legault/collim.html
http://www.astronexus.com/gatfaq/collimate.html
http://www.earlham.edu/~rodrimi/Collimating%20Newtonian%20Optics.htm