NGT-18

Owner's Manual

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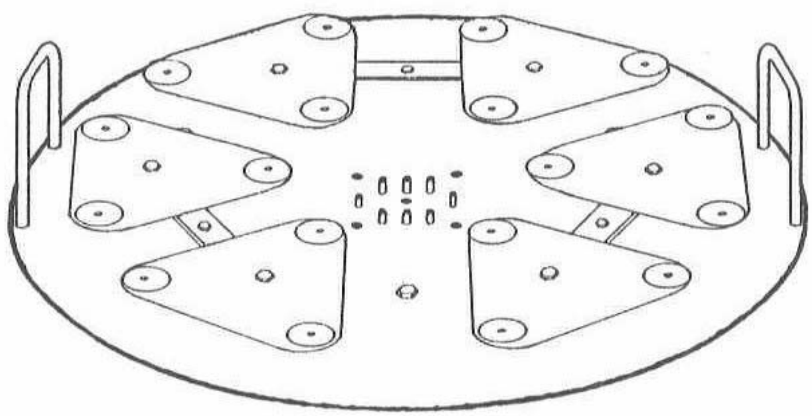
Introduction

The NGT—Next Generation Telescope—is the result of eight years of research and development, representing a radical departure from current trends in commercial telescopes. Rather than follow traditional paths in telescope design, we have explored new territory and adopted new designs whenever they have advanced our goals of precision, stability, portability and ease-of-use. Examples of our innovation include the distinctive split-ring design and our unique mirror-flotation system.

The split-ring design used in the NGT has been implemented in some of the world's largest telescopes, and this design also enables us to provide you with an observatory-quality telescope in an easily transportable package—when disassembled it can even fit in the back of a hatchback import-size car. Its low center-of-gravity offers inherent stability, and the 36" drive ring provides great mechanical advantage for smoother, more efficient operation.

The NGT's eighteen-point mirror-cell flotation, implemented in a unique way that originated with us, has been celebrated as one of the most outstanding design ideas of the eighties. As the January, 1991 *Sky and Telescope* noted, this is "a remarkable piece of engineering."



Top view of mirror cell, showing the 18-point flotation system

The NGT also features adjustable focal points. Three screw holes in each foot of the nose assembly permit it to be properly placed to adjust the focal point of the telescope relative to the focuser, whether the scope is being used with a camera with off-axis guider, with a camera without off-axis guider or for visual work.

Many of our design innovations require that we not only machine the unique parts, but that we also design unique tooling to create the parts.

We make every effort to ensure that each NGT is built to be the best. We hope that your new telescope gives you many thousands of hours of enjoyment, and that your pleasure in this precision instrument matches the pride we take in our work.

Set-up

We want you to begin enjoying your NGT as soon as possible, however you should carefully follow the uncrating and assembly instructions. (See Chapters 2 and 3.)

Although some owners assemble their NGT once, then seldom—if ever—move them, the NGT is designed to be easily disassembled, transported, and reassembled to let you take advantage of the dark skies away from city lights as well as celestial phenomena not visible from your home base. Once you are familiar with the steps, assembly can require less than ten minutes.

Collimation

Each NGT is collimated before shipment and should require only minor adjustment from time-to-time. See page 17 for further information on collimation.

Warning

Sunlight magnified through the NGT can cause instantaneous permanent blindness, severe burns, and even fire. Keep the dust cover in place and the aperture stop closed when the NGT is not in use.

Optional Accessories

The following accessories extend the capabilities of your NGT. They can be ordered at any time, and you will find them easy to install.

NGC-microMAX computer with 245 object database

A small, lightweight unit with a red, 8-character LED display that provides a real-time display of the telescope's Right Ascension and Declination. A guide feature assists the user in locating any of the 245 objects in its database — including 90 stars, the entire Messier catalog and 28 user-definable objects. This unit is standard equipment unless replaced by one of the upgrades below.

NGC-miniMAX computer with 4000+ object database

This unit is slightly larger than the **NGC-microMAX**, with a database which adds the brighter NGC and IC objects, as well as the Sun and planets. Though not necessary to its operation, a polar align feature greatly eases the task of polar aligning the telescope.

NGC-MAX computer with 12000+ object database

This is our top-of-the-line in dedicated setting circle computers. In addition to those objects found in the **NGC-miniMAX** database, the **NGC-MAX** database contains nearly a thousand stars, the entire NGC catalog, and most of the IC catalog. An identification feature will search the internal database for the object nearest the telescope's current pointing position — assisting with identification of unfamiliar objects or suggesting possible new targets. A serial port allows a personal computer to obtain information about the telescope's current position — useful for applications such as Software Bisque's TheSky™.

SGT-MAX desktop planetarium with interface to NGT

This IBM-compatible software beautifully represents the night sky on your computer screen, showing the position of the telescope and guiding you to any object. It provides extremely detailed infromation on each object, shows common names of objects, and allows you to toggle constellation lines on or off. The SGT-MAX plots current planetary positions, can zoom from 235° to one arc-minute fields of view, and is completely mouse-driveable. The software is available in assorted database sizes—from 55,000 to over 19,000,000 objects!

Multipurpose Coma Corrector

This option corrects for coma and flattens the optical field.

Observatory Mounting

This hardware option permits the NGT base to be secured to a concrete pad for permanent or semi-permanent mounting.

Truss Rod Counterweights

Available in sets of four, these weights slide along the serrurier truss rods to counter the weight of cameras or additoinal equipment. One set is included as standard equipment.

Specifications

Weight by component

Ring/Tub assembly:	60 lbs.	27 kg
Nose assembly:	11	5
Mirror and cell:	58	26
Truss rods (set of eight):	9	4
Sliding counterweight (ea.):	1	0.5
Base/Rocker assembly:	45	20
Mirror weights (set of three):	18	8
Primary dust cover:	3	1.4

Power 12 volts DC (direct current)

The NGT may be powered by its internal rechargeable batteries, by an external source, such as a portable power pack or automobile battery—via a cigarette lighter plug—or from AC current via a 12 vDC 800 mA transformer. Both a DC lighter plug and an AC wall transformer are supplied as standard equipment.

Uncrating the NGT

Follow the steps below to uncrate the NGT as a one-person operation. If two or more strong people are uncrating the telescope, see the note below Step 4.

1. Remove the top from the shipping pallet. Remove the truss rods and any larger accessories. (You may wish to save the foam tubing that wraps the individual rods. Cut the tubing shorter and leave it on the rods during normal use to provide insulation—especially desirable on cold nights—and also to protect the finish during transport.)

2. Remove the two cords that tie the nose assembly to the spring clips on the tub. Remove the packing material, then lift the nose assembly out and set it aside.

3. Remove the box of NGT accessories. The wood blocks that hold it in place are glued; they can be pried loose with a flat-head screwdriver if necessary.

4. Remove the two cords tying the tub to the handles of the base assembly.

   If two or more people are uncrating the telescope, remove the four nuts that hold the levelling screws to the crate bottom. The telescope can now be lifted out by the four handles. Continue with step 5, and skip steps 8, 9 and 13.

5. Remove the dust cover from the primary mirror.

6. Remove the packing material from inside the tub, including the pieces of foam wedged between the edge of the mirror and the side of the tub. Do not remove the fine tissue from the mirror at this time.

7. Remove the packing material from between the bottom of the tub and the split-ring assembly.

8. Remove the protective wrapping of tape from around the three chromed counterweights located underneath the tub. Unscrew the counterweights by turning them counter-clockwise, taking care not to tip the tub too close to vertical, as these counterweights hold the mirror cell in place.

9. Grasp the mirror cell handles and lift the mirror and its cell out of the tub, setting it aside gently.

10. Carefully remove the protective tissue covering the primary mirror. Lift it straight up and off. **Do not drag the tissue across the face of the mirror. Do not touch the mirror.**

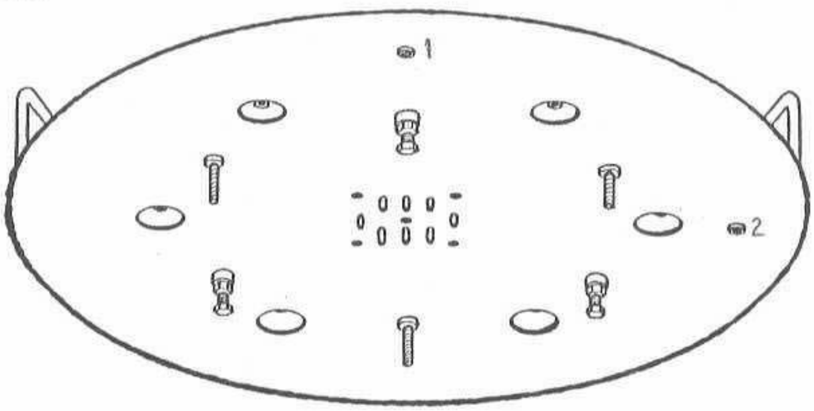
11. Remove the cord tied between the split-ring assembly and the latitude adjustment knob on the base assembly. Carefully remove the packing material from between the drive roller bearings and the drive ring. Do not allow the drive ring to drop on the drive roller bearings.

12. Remove the four bolts holding the base frame to the shipping pallet and remove the telescope from the crate.

Primary mirror installation

When installing the primary mirror, take care to align the studs on the underside of the mirror cell with the corresponding holes in the bottom of the tub. See the mirror cell illustration for help in locating the studs.

If the mirror cell is installed without the alignment studs in proper orientation, the mirror will rest at an angle in the tub, negating the collimation. When aligned properly, the studs are visible in their holes and can be felt underneath the tub.



Bottom view of mirror cell, showing alignment studs

Internal power supply

Although the batteries are charged at the factory just prior to shipment, we recommend that they be topped off with a one- to two-hour charge before their first use. Because these are lead-acid batteries (and not nickel-cadmium), they do not have a memory effect. While an 8-12 hour charge should be adequate after a single evening's use, 12-24 hours should restore their capacity after they have triggered the low-voltage alarm described on page 10.

If the batteries will not be used for an extended period, they should be recharged approximately every three months. If they are allowed to remain in a discharge state for too great a time (approximately four to six months), they may lose their ability to sustain a charge, and require replacement.

Packing list

Refer to this list as you unpack your NGT. We recommend that you check off each item as you unpack and ensure that nothing is missing before you begin to assemble your telescope. The NGT illustration on the next page will help you identify each item.

If any item appears to be missing, please contact your retailer or Jim's Mobile Incorporated, 810 Quail St., Unit E, Lakewood, CO 80215, U.S.A./Phone: 303-233-5353. The original packaging material may be required to file any claims with the shipper. Please do not discard.

Standard equipment

☐ Nose assembly
☐ Diagonal mirror and holder
☐ 2-inch NGF-2 focuser with motor
☐ Finder scope mounting bracket
☐ 9x60 finder scope
☐ 25mm Plössl eyepiece (1.25 inch)
☐ 2-inch to 1.25-inch adaptor
☐ 2-inch extension tube
☐ 4 vinyl nose assembly foot covers
☐ 8 Serrurier truss rods
☐ 6 truss rod thumbscrews (two spares)
☐ 2 truss rod sliding counterweights
☐ Primary dust cover
☐ Primary mirror (unless ordered without)
☐ 18-point flotation mirror cell
☐ 3 tub counterweights
☐ Right Ascension motor
☐ Declination motor
☐ Dual-axis drive corrector
☐ Right Ascension encoder box
☐ Declination encoder with two gears
☐ **NGC-microMAX** computer with manual
☐ Computer mounting bracket
☐ Muffin fan (on bottom of mirror tub)
☐ Base assembly
☐ Coiled power cord for fan
☐ 4 levelling screw pads (metal disks)
☐ Power panel with rechargeable battery

Optional equipment

☐ Focuser upgrade (**NGF-1**, **NGF-1M**)
☐ **EZAlign** polar alignment scope
☐ Computer upgrade (**NGC-miniMAX**, **NGC-MAX**)
☐ Truss rod light shroud

Options

SGT-MAX

☐ TheSky™ software
☐ BBox serial interface (or **NGC-MAX**)
☐ Serial cable
☐ User's manual

☐ **Coma Corrector** (corrects field-edge distortion)

☐ **Nose assembly Light Baffle** (clip-on nose extension to prevent stray light from entering the focuser)

☐ **Observatory Mounting hardware** (to secure base assembly to a concrete pad or pier)

☐ **Truss rod Sliding Counterweights** (CW2 — set of two additional counterweights)

☐ **Telrad™ Adaptor Plate** (mounting adaptor for Telrad reflex finder)

☐ **Truss rod Light Shroud** (lightweight black fabric sleeve to block stray light, dust and air currents)

Handlebar and wheels (enables fully assembled telescope to be rolled easily over most surfaces)

☐ 6-inch ball-bearing solid rubber wheels
☐ Handlebars

Assembling the NGT

Following these steps, the NGT can be easily assembled by one person. However, until you are comfortable with the assembly steps, we recommend that you have another person on hand to help. (Refer to the illustration on page 17 for parts identification.)

1. Remove the primary mirror and cell from the tub (this step may be omitted for two-person setup).
2. Place the rocker/base assembly on a flat surface in its intended location, using the supplied ground pads if necessary. If the base is not level, you may adjust the leveling screws. For tracking purposes, point the power panel side toward the equator, the opposite end toward the pole.
3. Place the split-ring/tub assembly into the rocker/base assembly. Set the ring gently onto the rollers.
4. Be sure that the polar bearing is properly seated and then secure with the bearing thumb screws.
5. Place the primary mirror and cell back in the tub, orienting the mirror cell alignment studs over the corresponding holes in the tub. Install the dust cover before continuing.
6. Screw the three counterweights onto the bottom of the mirror cell beneath the tub.
7. Tighten the Right Ascension and Declination tension knobs.
8. Four truss rod clips are located 90° apart around the rim of the tub. Each clip holds two rods. Grasp the outside of a clip and open it to insert the ball-end of a truss rod. When released, the spring-steel clip snaps back and locks the rod into place. Any two neighboring truss rods located in **adjacent** clips (not the same clip) make up a pair and are joined together at their upper ends.

   Insert a pair of truss rods and align the holes at their upper ends. Then insert one of the four thumbscrews into the hole by pushing it from the outside toward the center of the telescope. Repeat this procedure for two of the remaining truss rod pairs, leaving one pair for later. (This allows you to insert the nose assembly through this opening, rather than lift it high over the truss rods.)
9. Lift the nose assembly into position to permit the truss rod thumbscrews to be threaded into the nose assembly feet. (Use one hand to lift the nose assembly by one of the spider arms, and the other hand to thread the thumbscrews.) Determine which screw-hole level is appropriate to adjust the focal point of the scope. First secure the two rod pairs on either side of the missing pair; then secure the third pair. Finally, install the last pair of rods and secure them to the nose assembly. Be sure to secure all four pairs of truss rods at the same screw-hole level.

Focal Points and Eyepieces

The three screw holes in each foot of the nose assembly permit the nose assembly to be properly placed to adjust the focal point of the telescope relative to the focuser. The upper thumbscrew hole places the focal plane farthest from the diagonal (secondary) mirror, effective for use with a camera with off-axis guider. The middle hole is appropriate for a camera without off-axis guider as well as for visual focus. The lower hole, which places the focal plane closest to the diagonal mirror, is intended for visual work.

The NGT is ready for use with 2-inch eyepieces. A 1.25" adaptor included with the focuser allows the use of smaller-diameter eyepieces. A 2-inch extension tube is also provided to extend the focuser's travel, if necessary. Note that if you cannot achieve focus with the additional travel, you may need to reposition the height of the nose assembly as described above.

Electrical connections

The wiring for various electrical and electronic accessories is designed to be simple and straightforward. Your NGT is shipped with a cable bundle running from the ring assembly near the polar bearing. These cables must be plugged into their respective components before you operate the telescope. Refer to wiring descriptions below to learn the function and installation of each cable.

Connecting auxiliary devices

All other connections should be made prior to plugging in the power cable.

Motor connector (female)—15-socket D subminiature connector at telescope; 15-pin D subminiature connector from device, e.g. Command Center.

Right Ascension motor cable

This longest cable (48") terminates in a 6-conductor modular phone plug which connects to the motor located next to the driver roller on the base assembly. Disconnect this cable prior to removing the ring assembly from the base assembly (as is done when one person transports the NGT).

Declination motor cable

This cable is connected prior to shipment and runs directly from the 15-position connector near the Declination bearing to the motor attached to the tangent arm.

Encoder connector (male)—15-pin D subminiature connector at telescope; 15-socket D subminiature connector from device, e.g. NGC-microMAX.

Right Ascension encoder cable (4000 tics/rev CW)

This shortest cable (8") terminates in a 6-conductor modular phone plug which connects to the Right Ascension encoder, which is contained in the polar bearing.

Declination encoder cable (4000 tics/rev CW)

This cable—connected prior to shipment—terminates near the Declination bearing which is opposite the Declination motor. It utilizes a 6-conductor modular phone plug which is connected to the Declination encoder jack.

Power cable

This short cable (13") terminates in a 2-position Jones plug which can be connected to either of the two Jones sockets on the power panel in the base assembly. This cable should be disconnected when not in use.

Low-battery alarm

A low-battery alarm built into the panel will remind the user when to charge the batteries. An enable/disable switch permits the audible alarm to be turned off while the user finishes a session, or when the telescope won't be used for some time. Restrict further use of the telescope after the alarm has sounded, and recharge the batteries as soon as possible to avoid voltage drainage. If the batteries are permitted to completely drain they will no longer take a charge, and must be replaced. **Batteries should be fully charged prior to any prolonged period of non-use, and should be recharged every four months, even during non-use.**

Mirror cell cooling fan

The mirror cooling fan helps to acclimatize the mirror after it is moved from one temperature zone to another (from indoors to outside, for example). It is located under the mirror cell, and is attached to the bottom of the mirror tub. A cord is included to provide power to the fan from the power panel. The fan has no on/off switch.

Using the Command Center

The NGT-18 is equipped with a triple-control hand unit which controls the dual-axis Command Center drive corrector, as well as the focusing motor. Lunar and Sidereal tracking rates are provided, two-speed correction, variable-speed focus, autoguider interface, and a red chart LED.

Connecting the Hand Unit

The Command Center can operate with the Hand Unit detached, however, if you wish to make tracking corrections, you will need to attach it. To do so, simply plug the Hand Unit's cable into the Command Center, which is located below the right-hand Declination bearing (as viewed from the pole side of the mount).

Tracking

When the unit is powered on, tracking is set for Sidereal operation (the LED labelled by the "star" is lit). The user may press the **RATE** button to change between the Sidereal and Lunar tracking rates. The Command Center can be set for either Northern or Southern Hemisphere use. If the telescope drives in the opposite direction (the stars drift by twice as fast as when the drive is off), then the unit is set for the incorrect hemisphere. This may be corrected by pressing the **REV** button while turning on the Command Center. You should not need to perform this operation again, as the unit will remember which hemisphere it is set for, even without power.

Dual-Speed Correction

The Hand Unit may be used to make occasional corrections to the tracking. Pushing either the N, S, E, or W button will cause the telescope to move at 2X Sidereal rate in the direction indicated. This is useful for photographic guiding or visual fine-tuning. When faster movement is desired, you may hold the intended direction button down, then simultaneously press the opposite button to increase to 8X Sidereal rate. For example, to momentarily jump to 8X in an Eastward direction, hold down the East button on the hand unit, then press the West button. Release the West button to return to the normal rate.

If you would prefer to reverse the direction of the N-S or E-W button pairs, you may do so by pressing the **REV** button on the Command Center until the appropriate LED is lit (**DEC** for N-S, **R.A.** for E-W). You may reverse either or both of these pairs. Note that the tracking direction is unaffected by this setting.

Focusing

The two round buttons on the Hand Unit are used to drive the **MOTOFOCUS** focusing motor in and out. The knob to the left of these buttons may be adjusted to alter the motor's speed. Turning this knob clockwise increases focusing speed. The coiled **MOTOFOCUS** cable must be connected between the motor and the Hand Unit. Power to the motor is supplied by a separate, internal 9-volt alkaline battery. This battery may be changed by removing the four screws from the Hand Unit's sides, then pulling the back off to reveal the battery inside. Take care to avoid puncturing the new battery when replacing the screws. It is strongly recommended that only alkaline batteries be used.

CCD Autoguider

An autoguider (such as the ST-4 from Santa Barbara Instrument Group) can be used to control the Command Center by connecting the autoguider's relay output to the jack for the Hand Unit. If not provided with your autoguider, a cable suited to this purpose is available from JMI. For simultaneous manual and autoguider correction, you may plug the autoguider cable into the Hand Unit's **CCD** jack instead.

When You Suspect Improper Tracking

If you suspect that your NGT is not tracking properly, check the following items.

Polar Alignment—If the telescope is not properly polar-aligned, the telescope will not track properly. See the instruction manual for your computerized setting circles.

Hemisphere—If this is set incorrectly, the telescope will be driven in the same direction as the Earth's rotation, making the sky appear to drift at twice its actual rate. See the instructions under "Tracking" above to change this setting.

Clutch Tension—If clutch tension is too loose, the drive ring may slip rather than be driven by the R.A. motor. Turn the clutch tension adjustment knob clockwise to increase tension and counterclockwise to decrease tension. Set the tension loose enough to permit the telescope to be moved manually, yet tight enough to allow the drive motor to function properly.

Grease—Over time, grease can accumulate on the drive roller. Clean the drive ring surface and drive roller with alcohol as necessary to maintain proper friction.

Maintaining Your NGT

The following maintenance routines will preserve the accuracy and reliability of your telescope and help prolong its life.

Cleaning Front-Surface Mirrors

Never wipe a dry mirror with a lens tissue or other material, as this will scratch the surface coating.

Follow these steps to properly clean the NGT mirror and preserve its life. Do not clean the mirror too frequently. If properly handled and protected from dirt, the mirror should require cleaning only once or twice a year. The mirror can be cleaned without removing it from the cell, however the cell should dry completely before it is returned to the telescope.

First, gather the following materials:

- A large box (100 count) of soft, absorbent cotton balls. Be sure the cotton is 100% pure (such as Red Cross). Other cottons may contain wood pulp or other foreign matter that will scratch the mirror surface.
- Mild detergent
- A source of running water (tap water)
- Distilled water
- Acetone or ethanol. Observe the cautions and warnings on the label. Acetone and its vapors are harmful. Rubber gloves are recommended to prevent absorption of acetone through the skin. Acetone is available at most paint or hardware stores. (If acetone is used, remove the central dot prior to cleaning, as the acetone will dissolve the adhesive causing it to run and stain the mirror surface. The dot is required for collimation; replace it after cleaning.) Ethanol—also known as ethyl alcohol, 200-proof alcohol or drinking alcohol—may be substituted for acetone. **Do not use rubbing alcohol on your mirror surface**, as it adversely reacts to the aluminized surface and can ruin the mirror coating over time.
- A tub large enough to allow you to fully immerse the mirror.

Fill the tub with a solution of lukewarm water and mild soap. Rinse the mirror under running water, flooding the surface to remove loose dirt and dust—unless large particles are removed they will scratch the mirror during the cleaning process. Then immerse the mirror in the tub and allow it to soak for 15 to 20 minutes. Let the liquid do the work as much as possible to minimize contact with the mirror surface.

After the mirror soaks, raise it to within 1cm (1/2-inch) of the water's surface and use the cotton balls to remove any remaining particles. It is best to roll the cotton ball over the mirror's surface—with the leading edge rolling upward—allowing the particles to be lifted away. Replace the cotton ball after one rotation, thus preventing the dirtied cotton from contacting the mirror surface. Do not apply pressure to the cotton—simply allow the weight of the wet cotton to do the work. Clean the entire surface of the mirror in this fashion. You may find it easiest to work from the mirror's center, spiraling outward.

Lift the mirror out of the tub and place it at an angle to drain as you rinse. Rinse with running tap water to remove all soap solution from the mirror surface. Before the mirror dries, rinse again with distilled water to remove all minerals and impurities which may have been dissolved in the tap water.

Finally, before the mirror can dry, rinse again with acetone or ethanol. The acetone or ethanol will chase the water from the surface and evaporate to leave a pristine surface. (If necessary, remove any remaining water spots by dabbing them lightly with clean, dry Red Cross cotton. Dab, but do not wipe.)

If you have not removed the mirror from the mirror cell, be sure to allow the cell to dry completely before returning it to the telescope. A blow dryer can help speed the drying process. If the secondary mirror is not removed from its cell, position it during the drying process so the the fiberfill in the holder can drain and dry—a minimum of 24 hours is recommended. If the fiberfill is not completely dry it can drip, leaving water spots on the primary mirror.

Collimating the NGT

Collimating is the process of aligning the optical components of the telescope for optimum performance. When a telescope is in need of collimating, you are likely to note that a star in the center of the eyepiece field will not focus precisely and will appear to be non-circular (elliptical or fan-shaped) when the image is out of focus (i.e. showing a larger image).

In a newtonian reflector such as the NGT, there are three components to align: the eyepiece, the secondary mirror, and the primary mirror. All three must be accurately aligned with respect to each other. Information in this section will enable the NGT owner to align the secondary and primary mirrors of the telescope. The focuser (eyepiece) is permanently set at JMI prior to shipment, and should require no further adjustment.

The NGT is carefully collimated at the factory. Alignment between the focusing assembly and the diagonal (secondary mirror) is set to maintain a high degree of accuracy indefinitely, and rarely requires adjustment unless the focuser and/or diagonal are tampered with or severely jarred. If adjustment does become necessary, it is unlikely that the axial placement or the tilt of the diagonal will require correction.

The First Step in Collimating—Use of the Sight-Tube

A sight-tube with accurate crosshairs is essential to collimation of a newtonian reflector. Accurate placement of the secondary mirror is the first step in collimating and absolutely crucial to the performance of the NGT. In newtonian reflectors with fixed focusers, the diagonal (secondary)) mirror can be slightly off without dramatically affecting collimation. The NGT's rotating nose assembly, however, requires that diagonal mirror placement be exact to maintain proper collimation—not too high, not too low, with tilt and rotation just right. The sight-tube is used to achieve accurate placement of the secondary.

First, adjust axial placement of the secondary by placing the sight-tube in the focuser and moving it in or out until the outside edge of the secondary mirror is just inside the bottom edge or rim of the sight-tube. The two circular images should be concentric. If the secondary is high or low, loosen the retaining nut and move the secondary axially (toward or away from the primary) until concentricity is achieved.

Next, adjust the rotation of the secondary by rotating left or right until the reflection of the primary mirror as seen in the secondary mirror is perfectly centered left to right. Gently tighten the retaining nut.

Finally, adjust the tilt by loosening one or two of the three screws on top of the secondary mirror cell, and carefully tightening the opposite one or two. (If you loosen one screw, you must tighten two; if you loosen two, you must tighten one.) The goal is to adjust the tilt of the secondary such that the bullseye, or target, on the primary mirror appears centered in the crosshairs of the sight-tube. When the secondary is properly adjusted, you will see the following (as described from the outside of the field of view toward the center).

- The rim of the sight-tube.
- The outside edge of the secondary mirror, concentric with the rim of the sight-tube all the way round.
- The reflection of the primary mirror perfectly centered in the secondary.
- The bullseye of the primary centered in the crosshairs of the sight-tube.

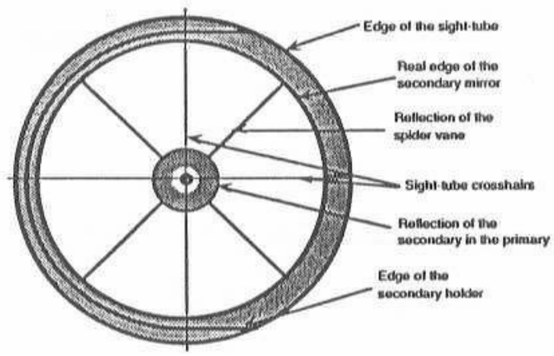


Image visible in the sight-tube

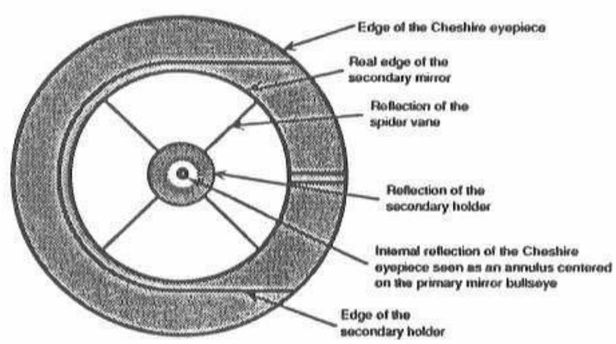
If the view does not match this description and illustration, then repeat the three adjustment steps until the view is correct.

The Second Step in Collimating— Use of the Cheshire Eyepiece

A Cheshire eyepiece is extremely useful for the next step in collimating, although the auto-collimator or star test can accomplish the same thing. Once the secondary mirror is adjusted by means of the sight-tube, insert the Cheshire eyepiece in the focuser. Do not push it all the way: the cutaway in the eyepiece must be exposed to a light source. (A red flashlight works well in the field at night.)

If you look through the eyepiece you will see the following (aside from the bullseye on the primary mirror):

- The reflection of the primary mirror in the diagonal.
- A generally dark field.
- A brightly lit annulus, or ring, in the center of the field.
- A dark spot, or bullseye, in the center of the annulus.



Detail of the image visible in the Cheshire eyepiece

Your goal is to bring the bulls-eye of the primary mirror into alignment with the central dot imaged by the Cheshire. Accomplish this by using the following steps to adjust the three collimating bolts of the primary mirror cell by adjusting in small increments while rotating the nose assembly and checking the alignment at various positions of the rotation.

First, loosen the jam-nut on each of the three collimating screws to make it possible to turn the collimating bolts. (Tighten the nuts again when collimation is complete.) Begin with the nose assembly at any position and adjust the bulls-eye toward the center of the illuminated annulus. Then rotate the nose assembly 180° and repeat the adjustment, again moving the bulls-eye toward the center of the annulus. Repeat this rotation until the bulls-eye is similarly placed toward the central dot in both positions and as close to the center as possible. Then, rotate the nose assembly 90° and repeat the above procedure at 180° until you are satisfied that both positoins are equally aligned with respect to the central dot of the Cheshire.

Continue to rotate the nose assembly and make adjustments until the bulls-eye of the primary mirror appears within the central dot of the annulus throughout a complete rotation. When you have achieved this, the telescope is collimated. (See the following illustration.)

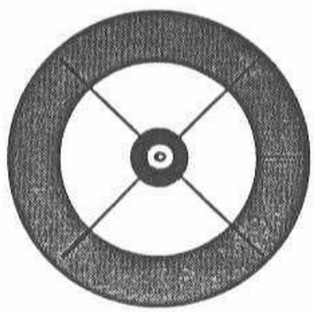


Image visible in Cheshire eyepiece when the NGT is properly collimated

If, after repeated adjustments you still cannot adjust the primary mirror into collimation, the problem is likely to be misalignment of the secondary. Check the secondary to determine whether it must be raised, lowered, rotated or tilted. While this process may require several repetitions the first few times, you will find that, with practice, you can quickly determine what adjustments to make to the secondary mirror by observing the location of the bulls-eye with respect to the central dot as you rotate the nose assembly. Once you are familiar with the process, fine-tuning the collimation can be accomplished in just a few minutes.

Use of the Auto-Collimator

An auto-collimator eyepiece is available from Tectron, along with three tools and an instruction booklet. By following instructions provided with the auto-collimator, you can make final, ever-so-slight adjustments to the secondary mirror, if necessary. The auto-collimator is not intended, however, for use in making adjustments to the primary mirror. To adjust the primary mirror, follow the steps outlined in the section above—**Use of the Cheshire Eyepiece.**

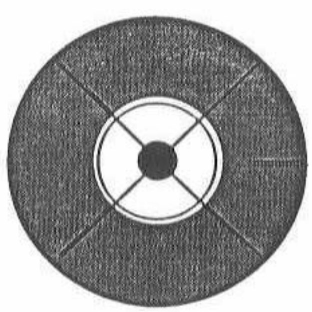


Image seen in the auto-collimator eyepiece when the NGT is properly collimated

Use of the Star Test

You can use the star test procedure to make adjustments to the primary mirror. The following method was suggested by Chris Jones of Essex, England.

1. Use the sight-tube to align the secondary mirror as described above.
2. Rotate the nose assembly until the focuser is vertically above a collimating bolt (this is not essential, but makes the process easier).
3. Loosen the lock nut on each of the collimation bolts.
4. Locate and center a star of about third magnitude in an eyepiece of about 300X; put the star slightly out of focus to create a larger image.
5. Adjust the image, using the collimating bolts, until a series of concentric, perfectly circular rings is seen.
6. Rotate the nose assembly 180° about the tube. Relocate the star and observe the disk of the star. If necessary, adjust the secondary via the screw nearest the focuser (or **both** of the other two screws) and bring the image to the same set of concentric rings described in step 5.
7. Return to the first position and repeat steps 4 and 5.
8. After several repetitions of steps 4 through 6, the image should be perfectly circular on both sides of the optical axis. Check the image at 90° to the previous locations and, if necessary, adjust the image using the collimation bolts **only**. Repeat steps 4 through 8 as needed.

Notes on Laser-Collimating

Laser-collimating is a very simple and extremely precise method of collimating your telescope. Laser-collimating will allow you to collimate with a double pass beam of light which is twice as sensitive as any other method of collimating.

It is important at the onset to be certain that your focuser is precisely aligned with the optical path of the telescope. This is the first thing that you should check. If you are working with a telescope which you have just received from JMI you can be sure that your focuser is precisely aligned and, barring any abuse to the focuser or the nose assembly, it should maintain its collimation indefinitely. In order to check your focuser it will be necessary to collimate your telescope as accurately as possible using the laser-collimation method described below or any other method with which you are familiar.

Having collimated the telescope, you should now remove the secondary mirror. Place the laser in the focuser and allow the laser beam to shine across the tube. Now, using a simple tape measure, carefully measure up from the edge of the primary mirror to the laser beam as it exits the focuser. Note this distance. Now measure up from the opposite side of the primary mirror to the laser beam on the opposite side of the tube from the focuser. These two distances should be the same. If they are not, the tilt of your focuser must be adjusted up or down until they are. Once this is confirmed, place a 3/8" diameter rod or bolt through the nut which holds your secondary mirror. Ensure that the laser beam intersects this rod in the center of the rod. If it does not you will need to adjust the tilt of your focuser side-to-side (left-to-right) until it does. You may need to double check that the vertical tilt of the focuser is correct following this adjustment.

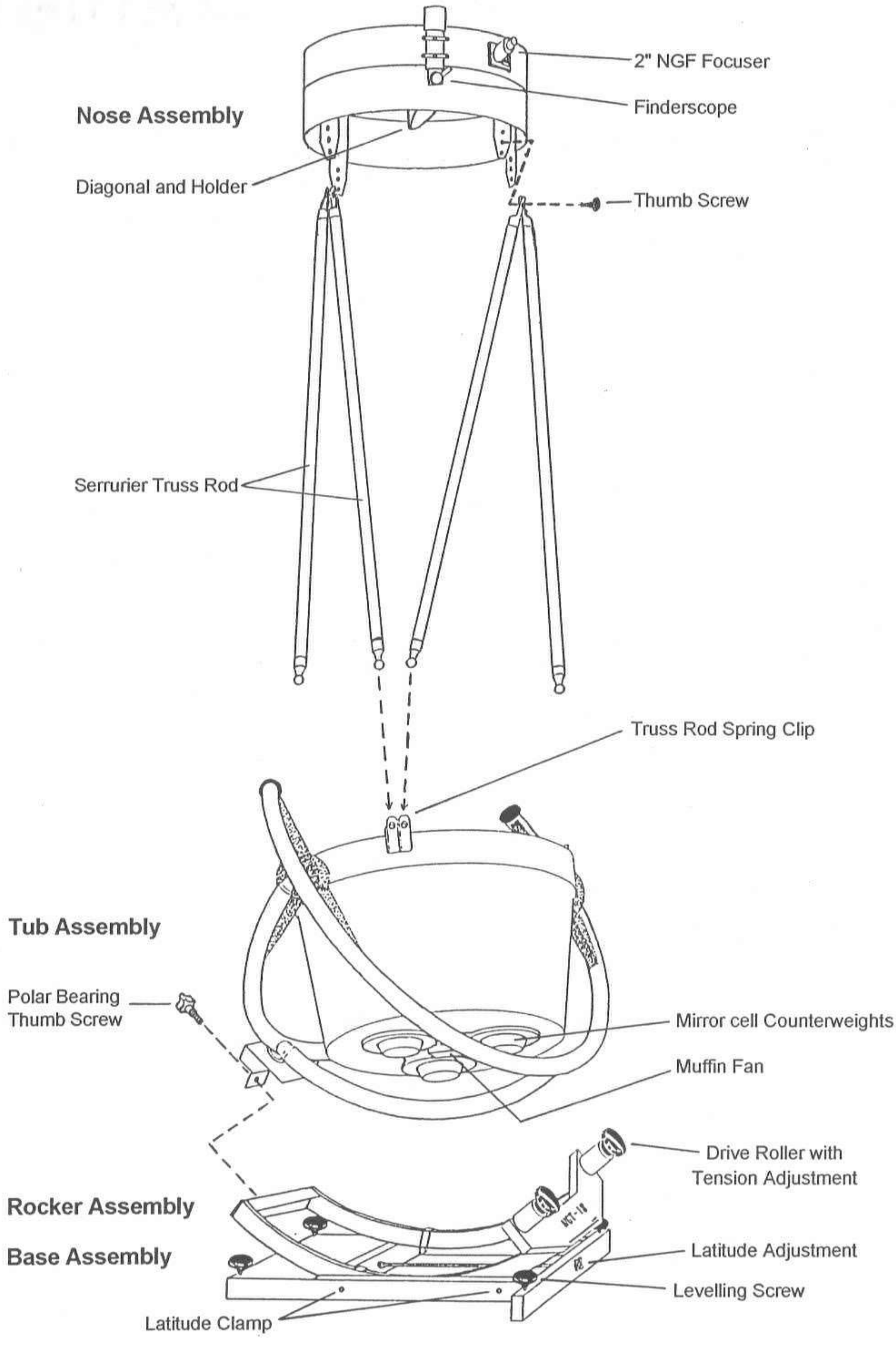
Having confirmed that your focuser is correctly aligned, reinsert your secondary mirror. Your objective at this point is to accurately place the secondary mirror along the optical axis, adjust the rotation of the secondary mirror, and adjust the tilt of the secondary mirror. Begin by placing a sight tube in the focuser and visually center the secondary mirror axially. Rotate the secondary such that the image of the primary mirror is centered left-to-right in the secondary mirror. Remove the sight tube and insert the laser into the focuser. Now adjust the tilt of the secondary mirror bringing the laser beam to the center of the primary mirror. Having accomplished this, remove the laser and reinsert the sight tube into the focuser. Check to see that the image of the primary mirror is precisely centered in the secondary mirror. If it is not, readjust the secondary mirror axially or rotationally to achieve this.

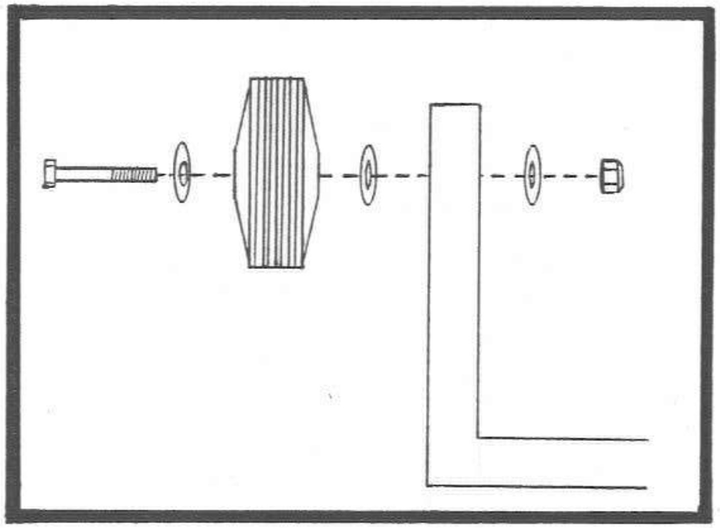
Now, remove the sight tube from the focuser and reinsert the laser. Once again, adjust the tilt of the secondary to bring the laser beam into the center of the primary mirror. You will need to repeat these two steps until you are satisfied that the visual image through the sight tube is correct and the laser beam is directed to the center of the primary mirror. Having achieved the satisfactory placement of the secondary mirror, you should now rotate the nose assembly 360°, observing the placement of the laser beam on the primary mirror. Hopefully, it remains in the center of your mirror. If it does not, you will need to adjust the tilt of the secondary mirror until the laser beam is as close to the exact center of the mirror as possible throughout the complete rotation of the nose assembly (this means you are averaging out the mechanical error of the nose assembly throughout its rotation).

The adjustment of the secondary mirror is now complete and you should not need to adjust either it or the focuser for the remainder of the collimation procedure. At this point, adjust the primary mirror to bring the reflected laser beam back into itself at the focuser. Again, you need to double check this adjustment by rotating the nose assembly by 360°. If the laser beam does not return "home" throughout the full rotation, you will need to average out the error as you did with the secondary mirror by adjusting the tilt of the primary mirror throughout the rotation of the nose assembly. Once this is accomplished, lock down the primary mirror with the jam nuts and your collimation procedure is complete.

General Maintenance

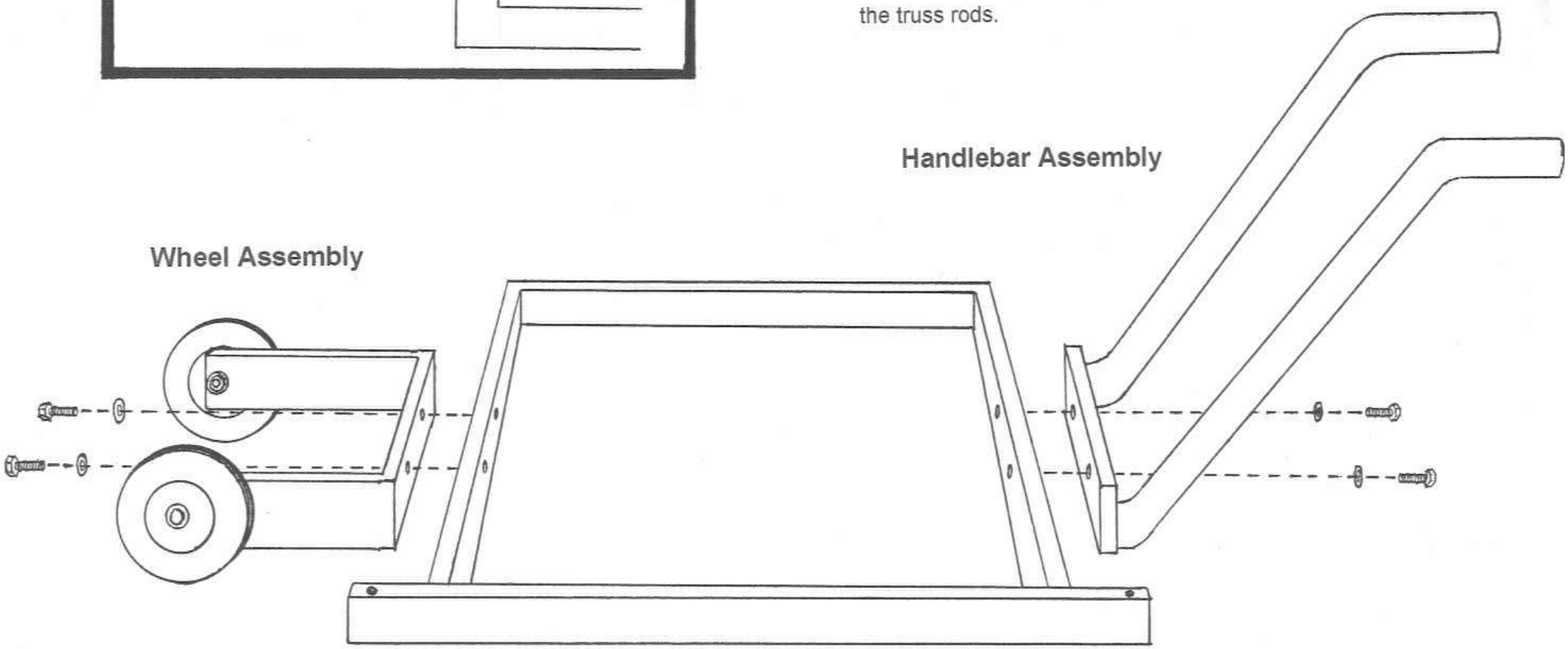
Grease—over time, grease can accumulate on the drive roller. Clean the drive ring surface and drive roller with alcohol as necessary to maintain proper friction.


2" NGF Focuser
Finderscope
Nose Assembly
Diagonal and Holder
Thumb Screw
Serrurier Truss Rod
Truss Rod Spring Clip
Tub Assembly
Polar Bearing
Thumb Screw
Mirror cell Counterweights
Muffin Fan
Drive Roller with
Tension Adjustment
Rocker Assembly
Base Assembly
Latitude Adjustment
Levelling Screw
Latitude Clamp



1. Attach both wheels to the C-shaped bracket per inset diagram at left (first time only).
2. Attach the wheel and handlebar assemblies per diagram below.
3. Be sure the primary mirror is covered.
4. Lift by handlebars to move the telescope.

The handlebar assembly may be removed for observing.
The telescope may be moved while fully assembled, however it is advisable to remove the truss rods.



Handlebar and Wheels (optional)

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