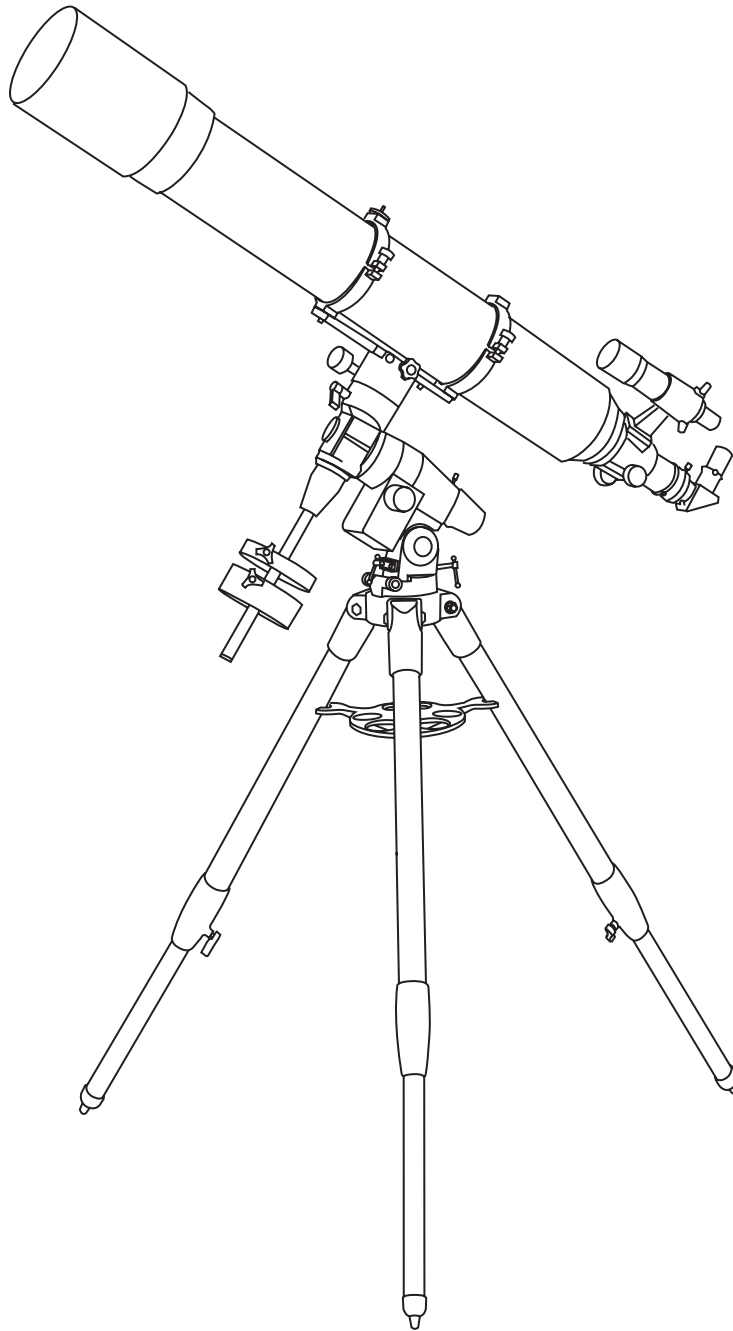
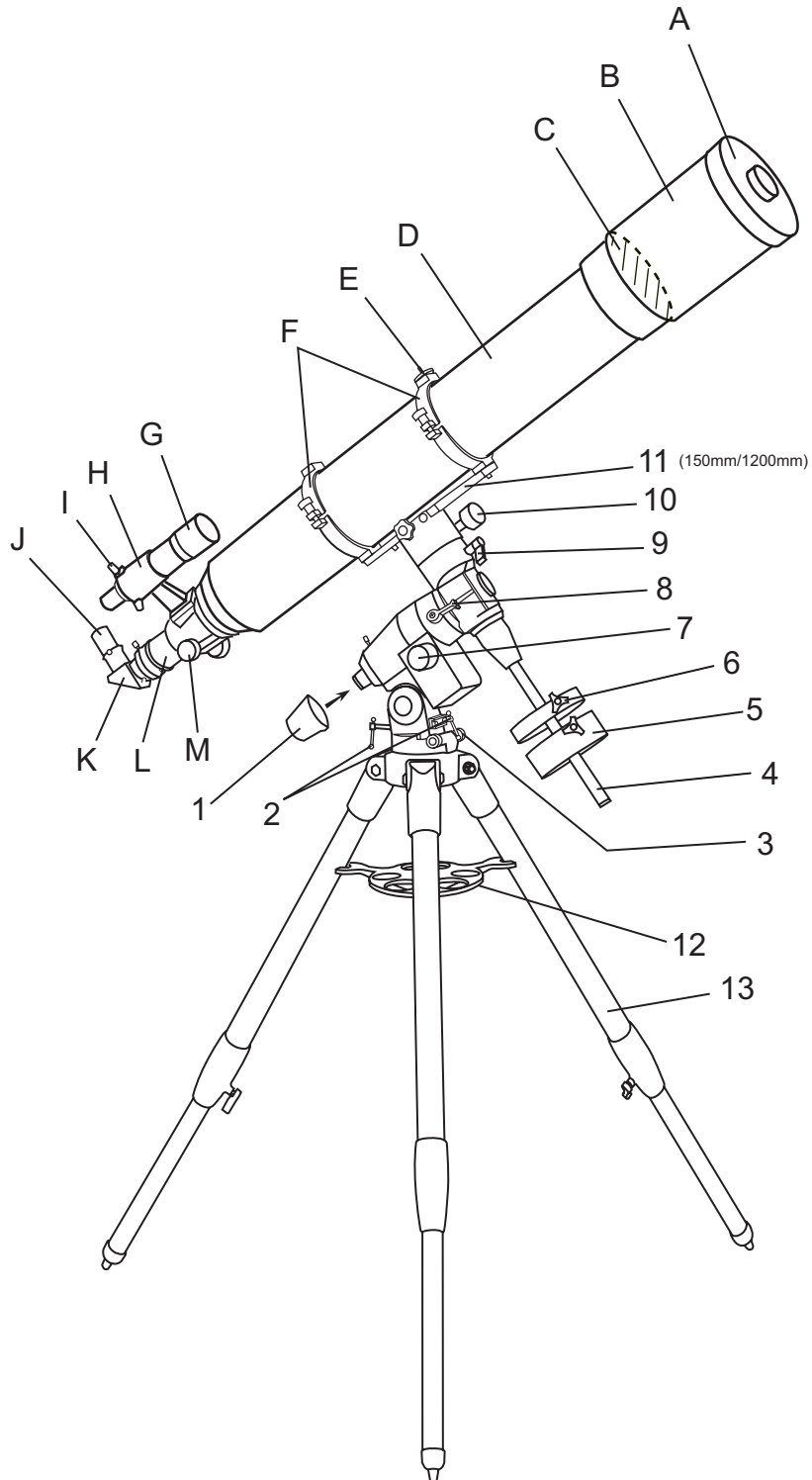


INSTRUCTION MANUAL

Telescopes with EQ5 Mount



MANUAL EQ5 PRO



EQ5

TUBE

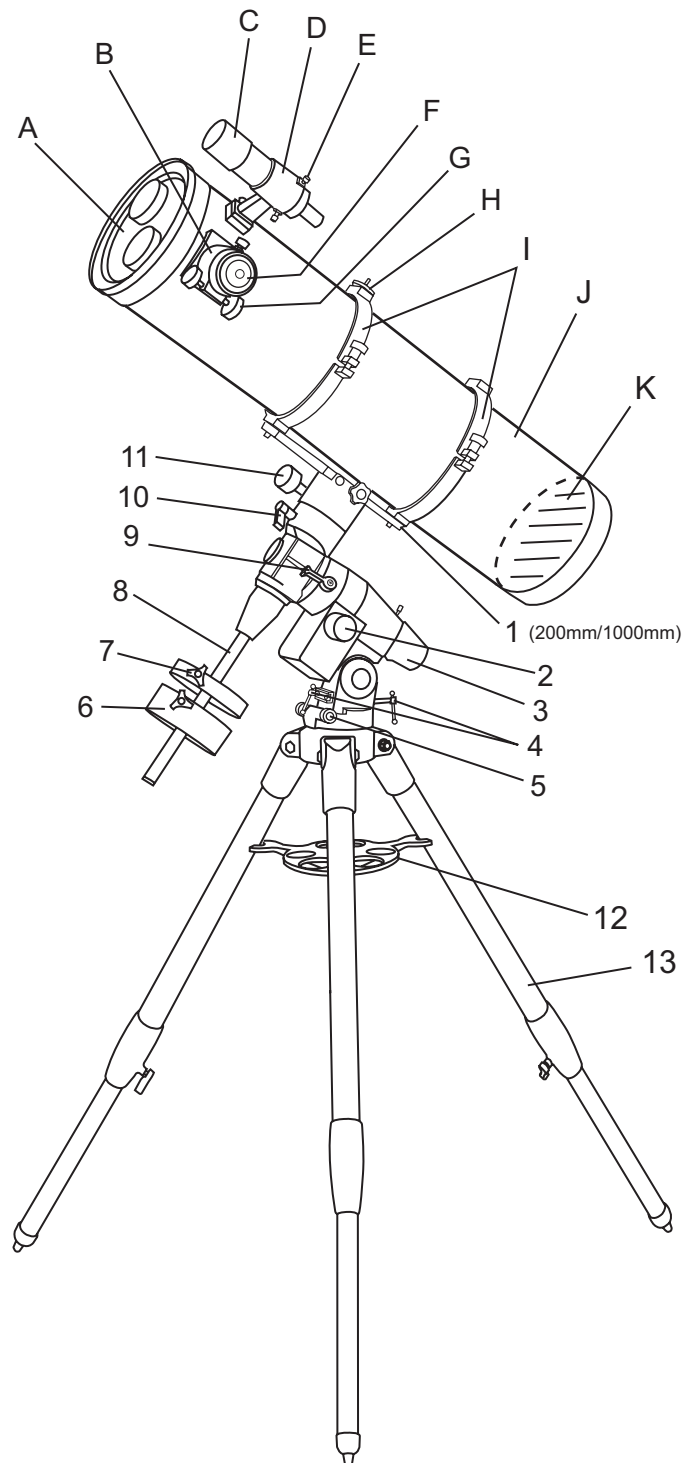
- A. Dust Cap/Mask
(Remove before Viewing)
- B. Sun Shade
- C. Objective Lens
- D. Telescope Main Body
- E. Piggyback Bracket
- F. Tube Rings
- G. Finderscope
(SW 100ED, 120ED RA, VF)
- H. Finderscope Bracket
- I. Alignment Screw
- J. Eyepiece
- K. Diagonal
- L. Focus Tube / Draw Tube
- M. Focus Knob

MOUNT / TRIPOD

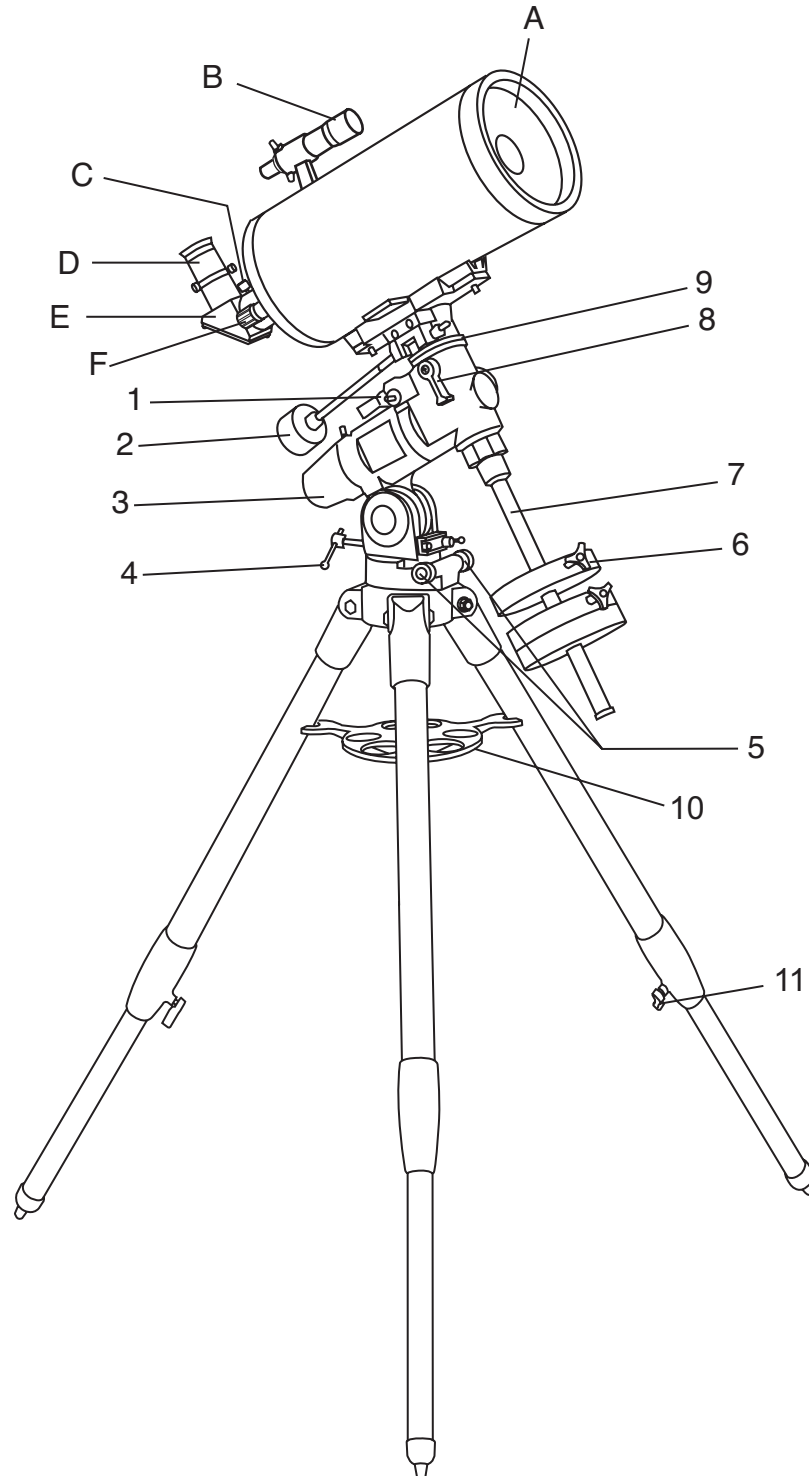
- 1. Polarscope Holder
- 2. Altitude Adjustment T-bolts
- 3. Azimuth Adjustment Knob
- 4. Counterweight Rod
- 5. Counterweight
- 6. Counterweight Thumb Screw
- 7. R.A. Control Knob
- 8. R.A. Lock Knob
- 9. Dec. Lock Knob
- 10. Dec. Control Knob
- 11. Mounting Plate
(150mm/1200mm)
- 12. Accessory Tray
- 13. Tripod Leg

MANUAL EQ5 PRO

EQ5
TUBE
A. Dust Cap/Mask (Remove before Viewing) B. Focus Tube C. Finderscope D. Finderscope Bracket E. Finderscope Adjustment Screws F. Eyepiece G. Focus Knob H. Piggyback Bracket I. Tube Rings J. Telescope Main Body K. Primary Mirror Position
MOUNT / TRIPOD
1. Mounting Plate (200mm/1000mm) 2. R.A. Control Knob 3. Polarscope Holder (not shown) 4. Altitude Adjustment T-bolts 5. Azimuth Adjustment Knob 6. Counterweight 7. Counterweight Thumb Screw 8. Counterweight Rod 9. R.A. Lock Knob 10. Dec. Lock Knob 11. Dec. Control Knob 12. Accessory Tray 13. Tripod Leg



MANUAL EQ5 PRO



EQ5

TUBE

- A. Dust Cap/Mask (Not shown remove before viewing)
- B. 8x50 Viewfinder or Red Dot Finder
- C. Focus Locking Screw
- D. Eyepiece
- E. Diagonal
- F. Focusing Knob

MOUNT / TRIPOD

- 1. R.A. Lock Knob
- 2. Dec. Flexible Control Cable
- 3. Polarscope Holder / Polarscope (not shown, optional)
- 4. Altitude Adjustment T-bolt
- 5. Azimuth Adjustment Knobs
- 6. Counterweight Locking Thumb Screw
- 7. Counterweight Rod
- 8. Dec. Lock Knob
- 9. Dec. Setting Circle
- 10. Accessory Tray
- 11. Height Adjustment Clamp

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Before you begin

This instruction manual is applicable to all the models with the EQ5 mount. Take a moment to find the model closest to your telescope on p.2, p.3, and p.4. Follow the instructions for your specific model in the manual. Read the entire instructions carefully before beginning. Your telescope should be assembled during daylight hours. Choose a large, open area to work to allow room for all parts to be unpacked.

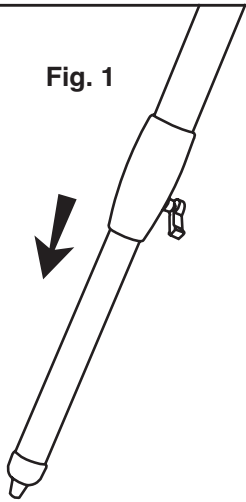
Caution!

NEVER USE YOUR TELESCOPE TO LOOK DIRECTLY AT THE SUN. PERMANENT EYE DAMAGE WILL RESULT. USE A PROPER SOLAR FILTER FOR VIEWING THE SUN. WHEN OBSERVING THE SUN, PLACE A DUST CAP OVER YOUR FINDERSCOPE TO PROTECT IT FROM EXPOSURE. NEVER USE AN EYEPIECE-TYPE SOLAR FILTER AND NEVER USE YOUR TELESCOPE TO PROJECT SUNLIGHT ONTO ANOTHER SURFACE, THE INTERNAL HEAT BUILD-UP WILL DAMAGE THE TELESCOPE OPTICAL ELEMENTS.

ASSEMBLING YOUR TELESCOPE

TRIPOD SET UP

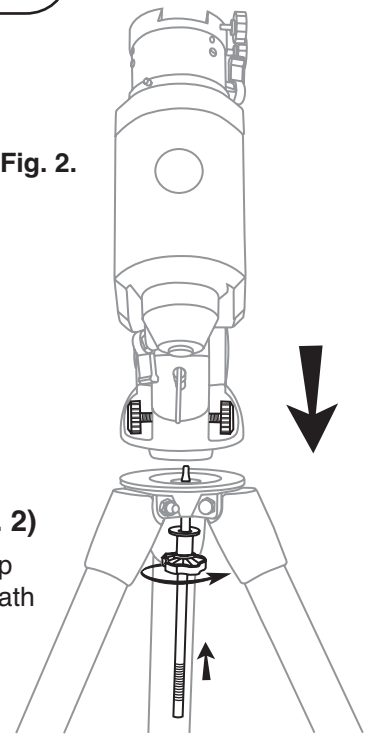
Fig. 1



ASSEMBLING THE TRIPOD LEGS (Fig.1)

- 1) Slowly loosen the height adjustment clamp and gently pull out the lower section of each tripod leg. Tighten the clamps to hold the legs in place.
- 2) Spread the tripod legs apart to stand the tripod upright.
- 3) Place a carpenter's level or bubble level on the top of the tripod legs. Adjust the height of each tripod leg until the tripod head is properly leveled. Note that the tripod legs may not be at same length when the equatorial mount is level.

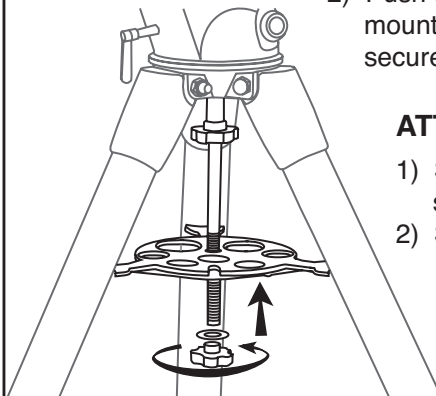
Fig. 2.



ATTACHING MOUNT TO TRIPOD LEGS (Fig. 2)

- 1) Align metal dowel on the tripod head with the gap between the azimuth adjustment knobs underneath the mount.
- 2) Push the primary locking shaft up against the mount and turn the knurled knob underneath to secure mount to tripod.

Fig. 3



ATTACHING THE ACCESSORY TRAY (Fig. 3)

- 1) Slide the accessory tray along the primary locking shaft until it pushes against the tripod legs.
- 2) Secure with the washer and locking knob.

Note: Loosen the azimuth adjustment knobs if mount does not fit into tripod head completely. Retighten knobs to secure.

MOUNT ASSEMBLY

INSTALLING COUNTERWEIGHT (Fig.4, 5)

- 1) Locate counterweight rod.
- 2) Screw counterweight rod into threaded hole on the end of the declination shaft. Tighten locknut on the counterweight rod until it is locked against the mount.
- 3) Unscrew the threaded cap from the end of the counterweight rod.
- 4) Locate the counterweights and slide them halfway along the counterweight rod. Tighten the counterweight thumb screws to secure.
- 5) Replace the cap on the end of the counterweight rod.

Fig.4

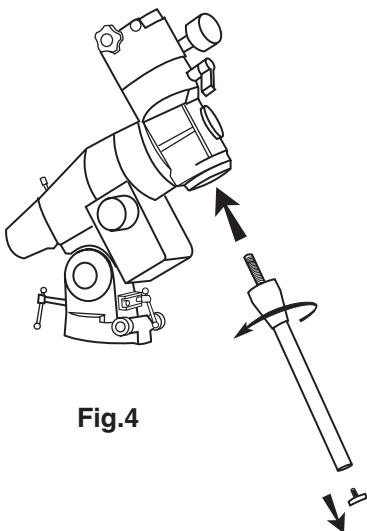
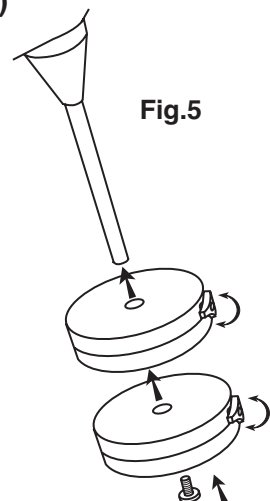


Fig.5



TELESCOPE ASSEMBLY

ATTACHING THE TUBE RINGS TO THE MOUNT (Fig.6)

- 1) Remove the telescope tube assembly from its plastic packaging.
- 2) Remove the tube rings from the telescope by releasing their thumb nuts and opening their hinges.
- 3) Using the bolts provided, fasten the tube rings to the mount with the 10mm wrench provided.

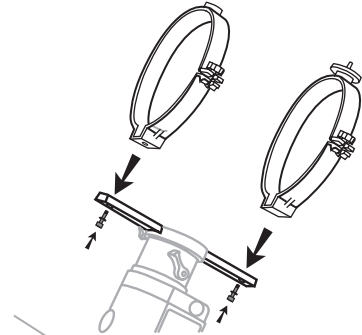


Fig.6

ATTACHING THE TELESCOPE MAIN TUBE TO THE TUBE RINGS (Fig.7)

- 1) Remove the telescope tube from the paper covering.
- 2) Find the center of balance of the telescope tube. Place this in between the two tube rings. Close the hinges around the telescope and fasten securely by tightening the thumb nuts. Do not over tighten.

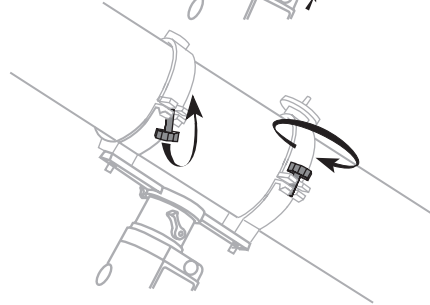


Fig.7

FINDERSCOPE/RED DOT FINDER ASSEMBLY

ATTACHING THE FINDERSCOPE BRACKET/RED DOT FINDER (Fig. 8)

Reflector and Maksutov

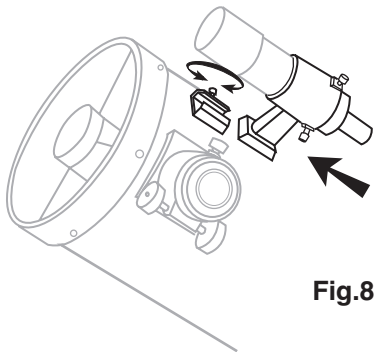


Fig.8

- 1) Locate the finderscope optical assembly or Red Dot Finder.
- 2) Slide the finderscope bracket/Red Dot Finder into the rectangular slot and tighten the screw to hold the mount in place.

ATTACHING THE FINDERSCOPE (Fig. 9, 10, 11)

Refractor



Fig.9

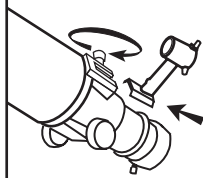


Fig.10

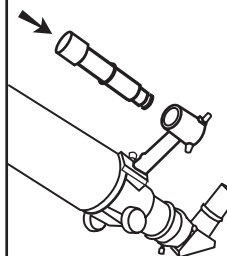


Fig.11

- 1) Locate the finderscope bracket. Carefully remove the rubber-o-ring from the finderscope bracket.
- 2) Position the o-ring into the groove located approximately half-way along the finderscope tube.
- 3) Locate the finderscope optical assembly.
- 4) Slide the finderscope bracket into the rectangular slot and tighten the screw to hold the mount in place.
- 5) Position the finderscope into its mount by sliding it backwards until the rubber o-ring seats in the finderscope mount.

EYEPIECE ASSEMBLY

INSERTING THE EYEPIECE (Fig.12, 13)

Reflector

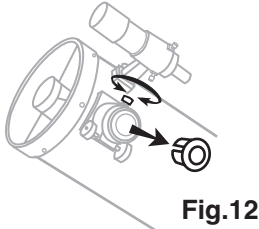


Fig.12

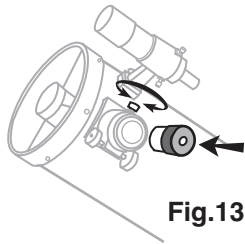


Fig.13

- 1) Unscrew the thumbscrews on the end of the focus tube to remove the black plastic end-cap.
- 2) Insert the desired eyepiece and secure it by retightening the thumbscrews.

INSERTING THE EYEPIECE (Fig.14)

Refractor and Maksutov

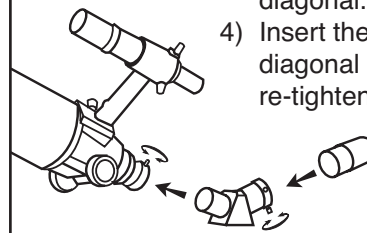


Fig.14

- 1) Loosen the thumbscrew on the end of the focus tube.
- 2) Insert the diagonal into the focus tube and re-tighten the thumbscrew to hold the diagonal in place.
- 3) Loosen the thumbscrews on the diagonal.
- 4) Insert the desired eyepiece into diagonal and secure by re-tightening the thumbscrews.

HAND CONTROL HOLDER INSTALLATION

INSTALLING THE HAND CONTROL HOLDER (Fig.15, 16) (for SynScan only)

Locate the hand control holder. Slide the holder onto the accessory tray as shown in Fig.16.

Fig.15

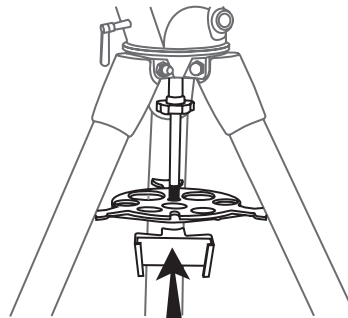
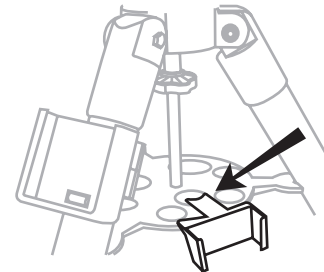


Fig.16



TELESCOPE ASSEMBLY

ATTACHING THE MOUNTING PLATE (Fig.17)

- 1) Position the mounting plate on the mounting bracket.
- 2) Secure by tightening the two locking screws.

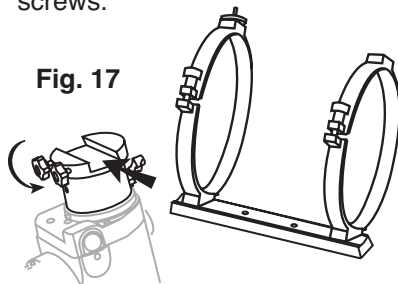


Fig. 17

(diagram applicable to both mounts)

ATTACHING THE TUBE RINGS (Fig.18)

- 1) Remove the telescope tube assembly from its plastic packaging.
- 2) Remove the tube rings from the telescope by releasing their thumb nuts and opening their hinges.
- 3) Using the bolts provided, fasten the tube rings to the mount with the 10mm wrench provided.

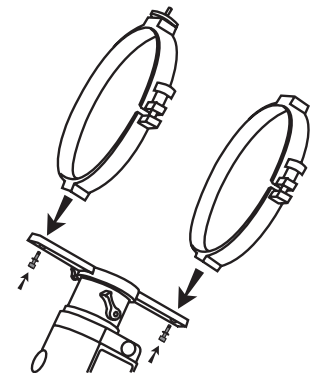
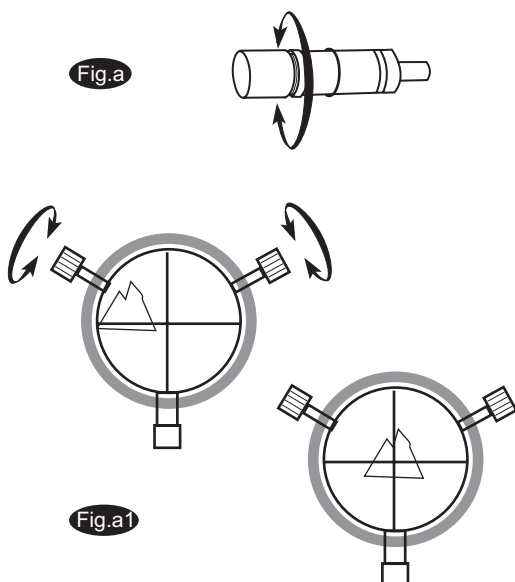


Fig. 18

(Please attach the tube rings to the mounting plate as shown if the rings are not already attached)

Aligning the finderscope



These fixed magnification scopes mounted on the optical tube are very useful accessories. When they are correctly aligned with the telescope, objects can be quickly located and brought to the centre of the field. Alignment is best done outdoors in day light when it's easier to locate objects. If it is necessary to refocus your finderscope, sight on an object that is at least 500 yards (metres) away. Loosen the locking ring by unscrewing it back towards the bracket. The front lens holder can now be turned in and out to focus. When focus is reached, lock it in position with the locking ring (Fig.a).

- 1) Choose a distant object that is at least 500 yards away and point the main telescope at the object. Adjust the telescope so that the object is in the centre of the view in your eyepiece.
- 2) Check the finderscope to see if the object centred in the main telescope view is centred on the crosshairs.
- 3) Adjust the two small screws to centre the finderscope crosshairs on the object (Fig.a1).

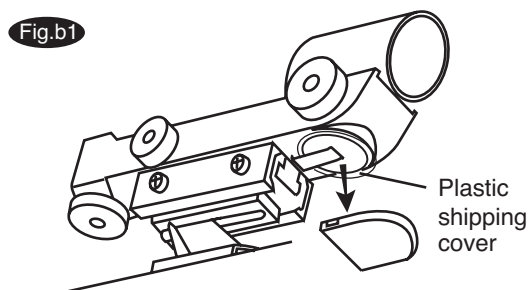
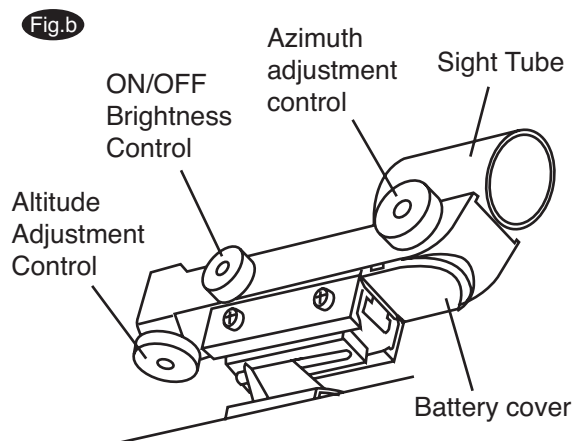
Using the Red Dot Finder

The Red Dot Finder is a zero magnification pointing tool that uses a coated glass window to superimpose the image of a small red dot onto the night sky. The Red Dot Finder is equipped with a variable brightness control, azimuth adjustment control, and altitude adjustment control (Fig.b). The Red Dot Finder is powered by a 3-volt lithium battery located underneath at the front. To use the Finder, simply look through the sight tube and move your telescope until the red dot merges with the object. Make sure to keep both eyes open when sighting.

Aligning the Red Dot Finder

Like all finderscopes, the Red Dot Finder must be properly aligned with the main telescope before use. This is a simple process using the azimuth and altitude control knobs.

- 1) Open the battery cover by pulling it down (you can gently pry at the 2 small slots) and remove the plastic shipping cover over the battery (Fig.b1).
- 2) Turn on the Red Dot Finder by rotating the variable brightness control clockwise until you hear a "click". Continue rotating the control knob to increase the brightness level.
- 3) Insert a low power eyepiece into the telescope's focuser. Locate a bright object and position the telescope so that the object is in the centre of the field of view. With both eyes open, look through the sight tube at the
- 4) object. If the red dot overlaps the object, your Red Dot Finder is perfectly aligned. If not, turn its azimuth and altitude adjustment controls until the red dot is merged with the object.

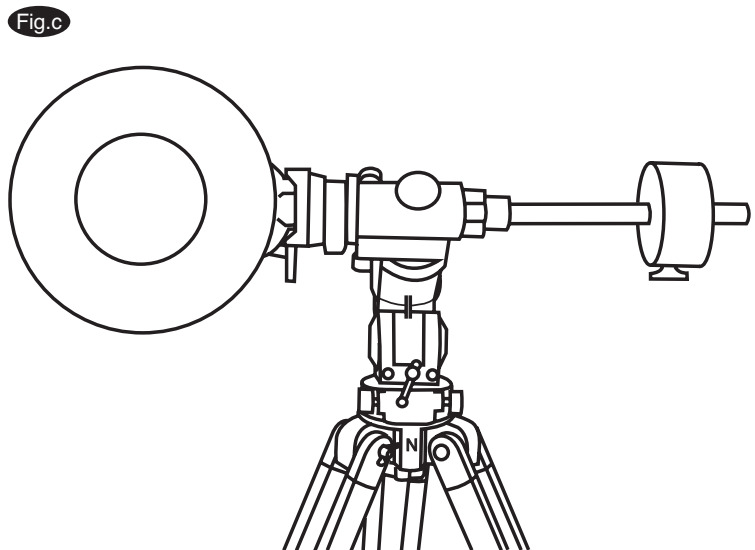


Balancing the telescope

A Telescope should be balanced before each observing session. Balancing reduces stress on the telescope mount and allows precise control of micro-adjustment. A balanced telescope is specially critical when using the optional clock drive for astrophotography. The telescope should be balanced after all accessories (eyepiece, camera, etc.) have been attached. Before balancing your telescope, make sure that your tripod is balanced and on a stable surface. For photography, point the telescope in the direction you will be taking photos before performing the balancing steps.

R.A. Balancing

- 1) For best results, adjust the altitude of the mount to between 15° and 30° if possible, by using the altitude adjustment T-bolt.
- 2) Slowly unlock the R.A. and Dec. lock knobs. Rotate the telescope until both the optical tube and the counterweight rod are horizontal to the ground, and the telescope tube is to the side of the mount (Fig.c).
- 3) Tighten the Dec. lock knob.
- 4) Move the counterweight(s) along the counterweight rod until the telescope is balanced and remains stationary when released.
- 5) Tighten the counterweight thumb screws to hold counterweight(s) in their new position.



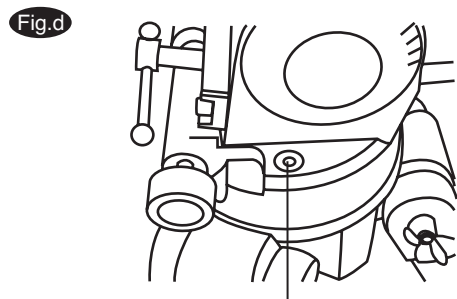
Dec. Balancing

All accessories should be attached to the telescope before balancing around the declination axis. The R.A. balancing should be done before proceeding with Dec. balancing.

- 1) For best results, adjust the altitude of the mount to between 60° and 75° if possible.
- 2) Release the R.A. lock knob and rotate around the R.A. axis so that the counterweight rod is in a horizontal position. Tighten the R.A. lock knob.
- 3) Unlock the Dec. lock knob and rotate the telescope tube until it is parallel to the ground.
- 4) Slowly release the telescope and determine in which direction it rotates. Loosen the telescope tube rings and slide the telescope tube forward or backward in the rings until it is balanced.
- 5) Once the telescope no longer rotates from its parallel starting position, re-tighten the tube rings and the Dec. lock knob. Reset the altitude axis to your local latitude.

Using the leveling bubble

For best telescope performance, the equatorial mount should be properly leveled. A level tripod allows easier fine adjustment of controls and better weight distribution. This equatorial mount includes a small leveling bubble near its base (Fig.d). Adjust the height of each tripod leg until the bubble appears in the center of the circle. Note that the tripod legs may not be at same length when the equatorial mount is level.

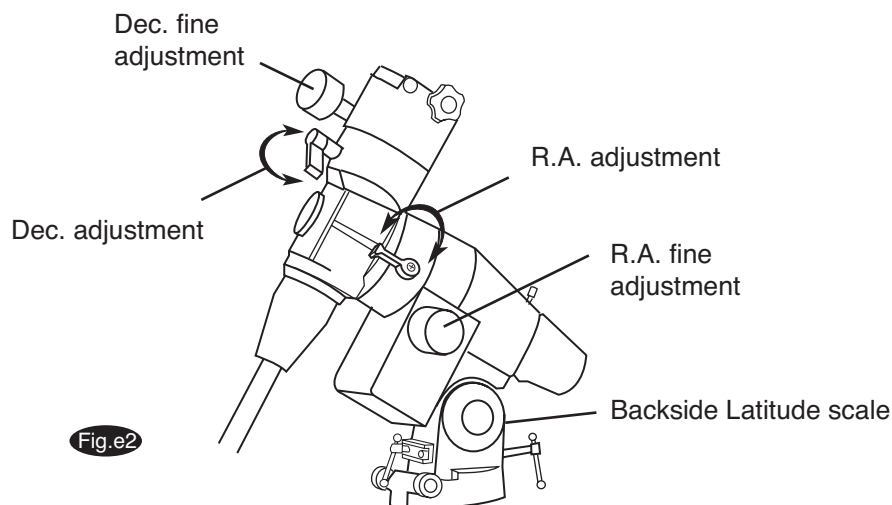
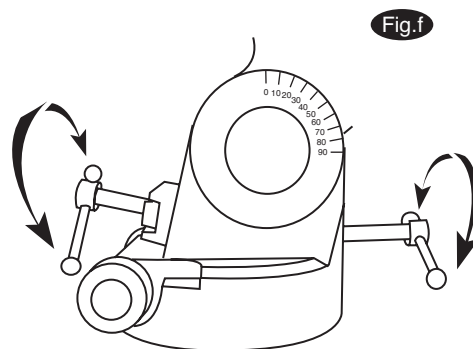
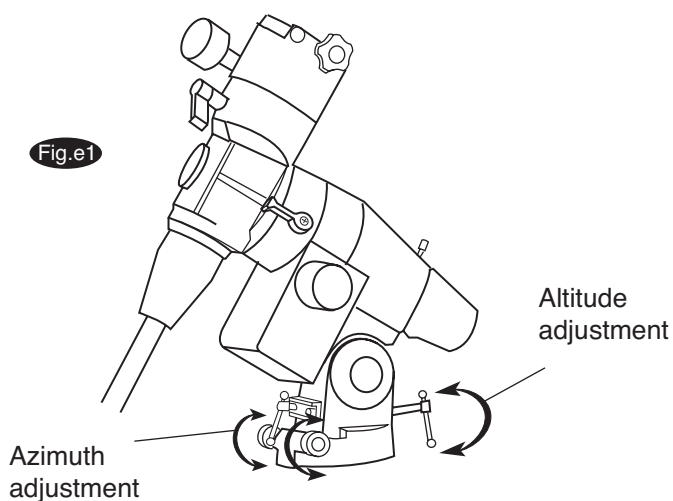


Leveling bubble

Operating the EQ5 mount

The EQ5 mount has controls for both conventional altitude (up-down) and azimuth (left-right) directions of motion. These two adjustments are suggested for large direction changes and for terrestrial viewing. The two azimuth adjustment knobs located near the tripod head allow fine-adjustment of azimuth for polar alignment. Use the altitude adjustment T-bolts for altitude adjustments. These allow fine-adjustment for setting the mount to your local latitude. (Fig.e1).

In addition, this mount has Right Ascension (hour angle) and declination direction controls for polar-aligned astronomical observing. Loosen the lock knobs to make large direction changes. Use the control cables for fine adjustment after the lock knobs have both been locked (Fig.e2). An additional scale is included for the altitude axis. This allows polar alignment for your local latitude. (Fig.f)



Using the Barlow lens (optional)

A Barlow is a negative lens which increases the magnifying power of an eyepiece, while reducing the field of view. It expands the cone of the focussed light before it reaches the focal point, so that the telescope's focal length appears longer to the eyepiece.

The Barlow is inserted between the focuser and the eyepiece in a reflector, and usually between the diagonal and the eyepiece in a refractor or a Maksutov (Fig.g). With some telescopes, it can also be inserted between the focuser and the diagonal, and in this position it gives even greater magnification. For example, a 2X Barlow when inserted after the diagonal can become 3X when placed in front of the diagonal.

In addition to increasing magnification, the benefits of using a Barlow lens include improved eye relief, and reduced spherical aberration in the eyepiece. For this reason, a Barlow plus a lens often outperform a single lens producing the same magnification. However, its greatest value may be that a Barlow can potentially double the number of eyepieces in your collection.

Focusing

Slowly turn the focus knobs under the focuser, one way or the other, until the image in the eyepiece is sharp (Fig.h). The image usually has to be finely refocused over time, due to small variations caused by temperature changes, flexures, etc. This often happens with short focal ratio telescopes, particularly when they haven't yet reached outside temperature. Refocusing is almost always necessary when you change an eyepiece or add or remove a Barlow lens.

Polar Alignment

In order for your telescope to track objects in the sky you have to align your mount. This means tilting the head over so that it points to the North (or South) celestial pole. For people in the Northern Hemisphere this is rather easy as the bright star Polaris is very near the North Celestial Pole. For casual observing, rough polar alignment is adequate. Make sure your equatorial mount is level and the red dot finder is aligned with the telescope before beginning.

Setting the latitude

Look up your latitude on a map, road maps are good for this purpose. Now look at the side of your mount head, there you will see a scale running from 0-90 degrees. At the base of the head, just above the legs, are two screws opposite each other under the hinge. All you have to do is loosen one side and tighten the other until your latitude is shown by the indicator pointer (Fig.i).

Fig.g

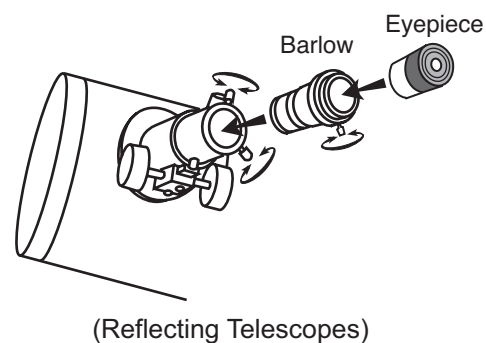
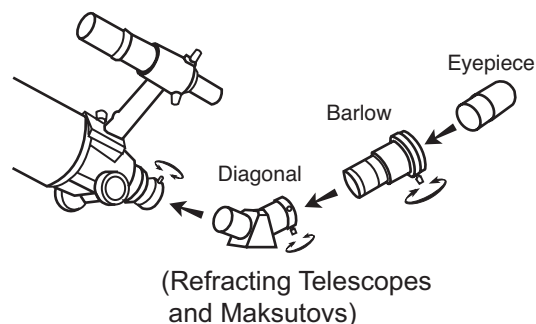


Fig.h

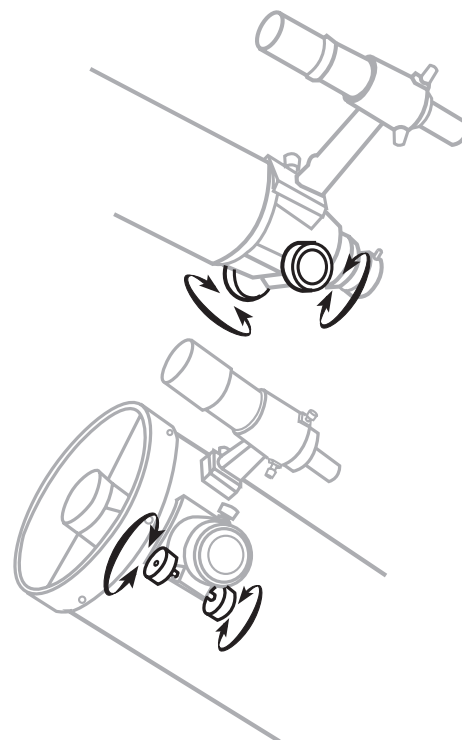
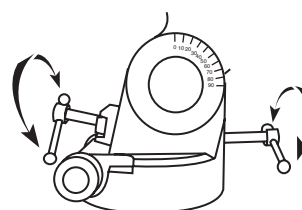


Fig.i



Polaris, the "Pole Star" is less than one degree from the North Celestial Pole (NCP). Because it is not exactly at the NCP, Polaris appears to trace a small circle around it as the Earth rotates. Polaris is offset from the NCP, toward Cassiopeia and away from the end of the handle of the Big Dipper (Fig.i1).

Aligning your telescope to Polaris

Unlock the DEC lock knob and rotate the telescope tube until the pointer on the setting circle reads 90°. Retighten the DEC lock knob. Move the tripod so that the "N" at the base of the equatorial mount faces north and the R.A. axis points roughly at Polaris. Use the two azimuth adjustment knobs above the "N" to make fine adjustments in azimuth if needed (Fig.i2). For more accurate alignment, look through the finderscope and centre the Polaris on the crosshairs.

Along the R.A. axis shaft, the farther away from the back of the shaft that you are the more accurate you will be (Fig.i3). Even though the true celestial pole may be up to twice the moon's diameter away (Polaris circles the pole once a day) you won't find this a problem unless you are doing long exposure photography.

After a while you will notice your target drifting slowly North or South depending on the direction of the pole relative to Polaris. To keep the target in the center of the view, turn only the R.A. slow-motion cable. After your telescope is polar aligned, no further adjustments in the azimuth and latitude of the mount should be made in the observing session, nor should you move the tripod. Only movements in R.A. and DEC axis should be made in order to keep an object in the field.

Southern Hemisphere

In the Southern Hemisphere you must align the mount to the SCP by locating its position with star patterns, without the convenience of a nearby bright star. The closest star is the faint 5.5-mag. Sigma Octanis which is about one degree away. Two sets of pointers which help to locate the SCP are alpha and beta Crucis (in the Southern Cross) and a pointer running at a right angle to a line connecting alpha and beta Centauri (Fig.i4).

Tracking celestial objects

When observing through a telescope, astronomical objects appear to move slowly through the telescope's field of view. When the mount is correctly polar aligned, you only need to turn the R.A. slow-motion to follow or track objects as they move through the field. The DEC. slow-motion control is not needed for tracking. A R.A. motor drive can be added to automatically track celestial objects by counteracting the rotation of the Earth. The rotation speed of the R.A. drive matches the Earth's rotation rate for stars to appear stationary in the telescope eyepiece. Different tracking speeds are also available in some models. A second drive can be added to give DEC control which is very useful for doing astrophotography.

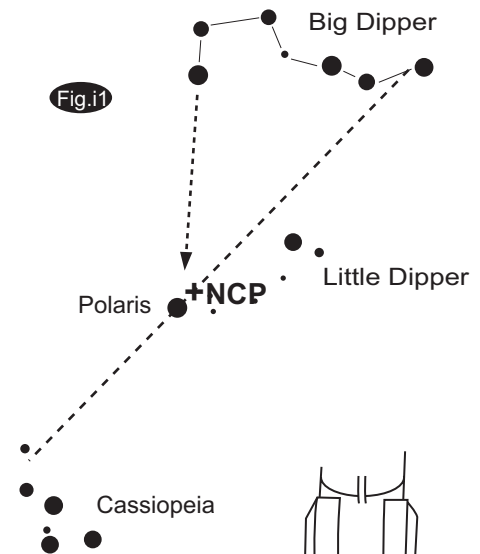


Fig.i2

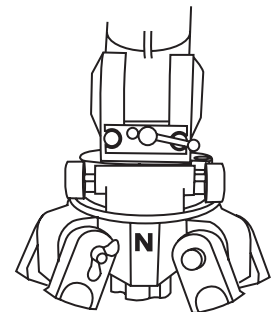


Fig.i3

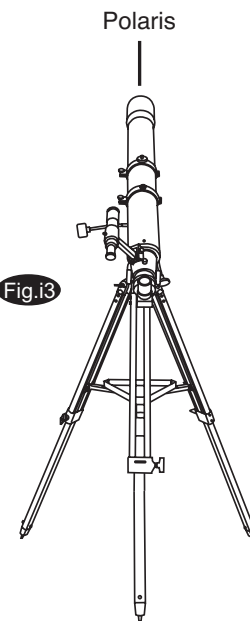
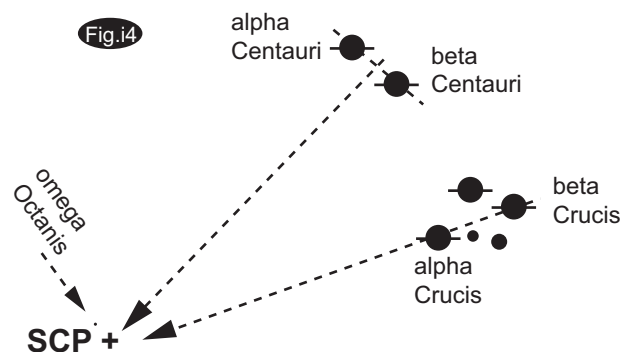


Fig.i4



Using the setting circles

The quickest way to find objects is to learn the Constellations and use the finderscope, but if the object is too faint you may want to use setting circles on an equatorial mount. Setting circles enable you to locate celestial objects whose celestial co-ordinates have been determined from star charts. Your telescope must be Polar aligned and the R.A. setting circle must be calibrated before using the setting circles.

Reading the R.A. setting circle

The telescope's R.A. setting circle is scaled in hours, from 1 through 24, with small lines in between representing 10 minute increments. The upper set of numbers apply to viewing in the Northern Hemisphere, while the numbers below them apply to viewing in the Southern Hemisphere. The section next to the set screw is scaled in minutes, from 1 through 10, representing the exact minute within the 10 minute increments.

In the case of Fig.j, the R.A. setting circle pointer indicates approximately 8 hours and 20 minutes. Now look for the number in the minute scale that aligns with any line on the main R.A. setting circle. In this case, it is 1. The reading on this R.A. setting circle, therefore, is 8 hours and 21 minutes.

Setting (calibrating) the R.A. setting circle

In order to set your Right Ascension circle you must first find a star in your field of view with known coordinates. A good one would be the 0.0 magnitude star Vega in the Constellation Lyra. From a star chart we know the R.A. coordinate of Vega is 18h 36m. Loosen the R.A. and DEC. lock knobs on the mount and adjust the telescope so that Vega is centred in the field of view of the eyepiece. Tighten the R.A. and DEC. lock knobs to lock the mount in place. Now rotate the R.A. setting circle until it reads 18h36m. You are now ready to use the setting circles to find objects in the sky.

Finding objects using the setting circles

Example: Finding the faint planetary nebula M57; "The Ring"

From a star chart, we know the coordinates of the Ring are Dec. 33° and R.A. 18h52m. Unlock the DEC lock knob and rotate your telescope in DEC until the pointer on the DEC setting circle reads 33°. Re-tighten the DEC lock knob. Loosen the R.A. lock knob and rotate the telescope in R.A. until the pointer on the R.A. setting circle reads 18h52m (do not move the R.A. circle). Re-tighten the R.A. lock knob. Now look through the Red Dot Finder to see if you have found M57. Adjust the telescope with R.A. and DEC. flexible cables until M57 is centred in the Red Dot Finder. Now look through the telescope using a low power eyepiece. Centre M57 in the field of view of the eyepiece.

If you are familiar with the night sky, it is sometimes convenient to find an object using only the DEC coordinate. Loosen the DEC. lock knob and rotate the telescope in DEC. until the pointer on the DEC setting circle reads 33°. Re-tighten the DEC. lock knob. Now traverse through Lyra in R.A. axis until M57 appears in the field of view.

The setting circles will get you close to the object you wish to observe, but are not accurate enough to put it in the centre of your Red Dot Finder's field of view. The accuracy of your setting circles also depends on how accurate your telescope is polar aligned.

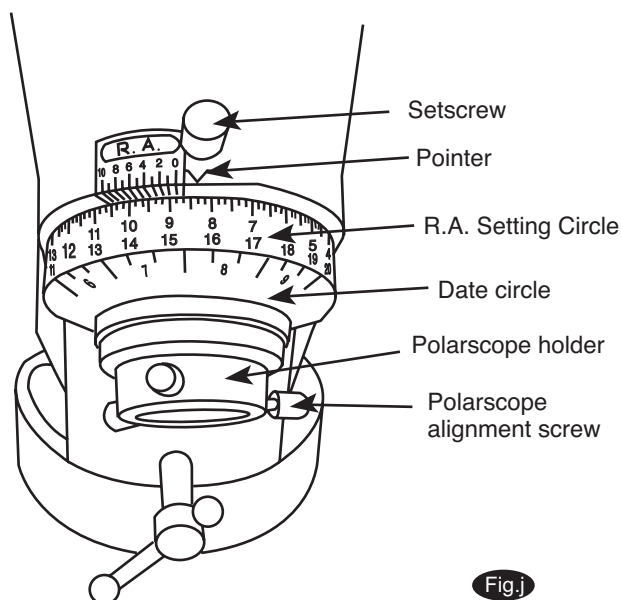
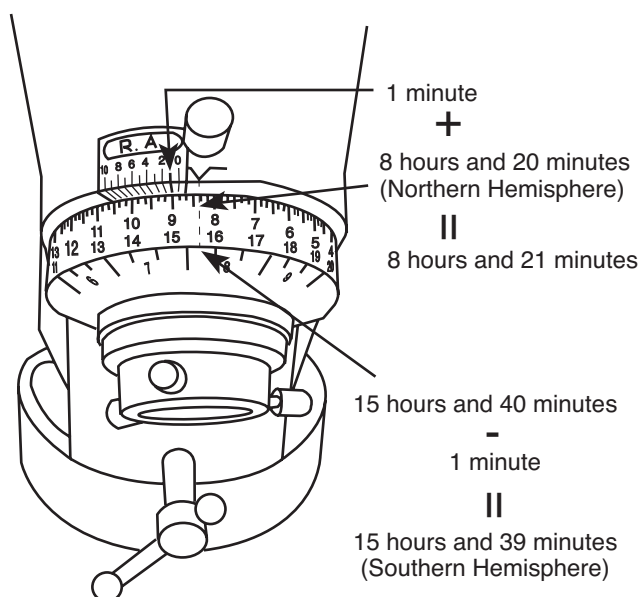


Fig.j



Using the polarscope (optional)

The Polar Alignment Finderscope or 'polarscope' gives Northern Hemisphere users a convenient tool for pointing at the NCP. It has a large circle circumscribing the path of Polaris, with the NCP located at the crosshair, and it has a smaller circle to indicate the direction of Polaris. However, the Earth rotates and the orientation of the stars changes, so a method is needed to obtain the correct alignment of Polaris in the polarscope, for the date and time of your viewing session.

Aligning the polarscope to the mount's polar axis:

This is most easily done by pointing at a terrestrial target with the RA drive turned off. To allow full rotation around the RA axis, remove the telescope and the counterweight, including the rod. Unlock the Dec clutch and rotate to Dec 0°, then lock the Dec clutch. Remove the cap from the bottom of the RA axis shaft and the plug from the top (Fig.k, EQ5 shown here).

At the bottom of the polar shaft is a black, 24-hour clock dial. The top row of numbers is for Northern Hemisphere use, the lower for the Southern Hemisphere. Unlock the setscrew just above it and rotate the dial until zero is aligned with the indicator cast into the metal just below the screw. Tighten the setscrew to lock the dial (Fig.k1).

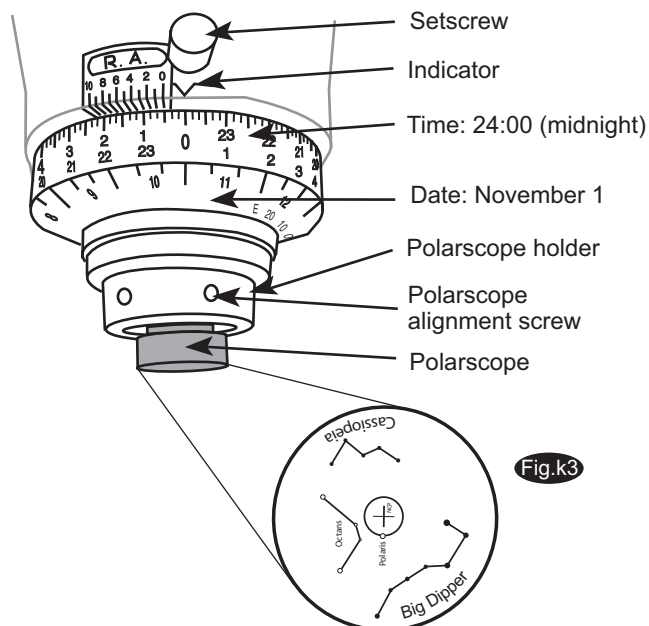
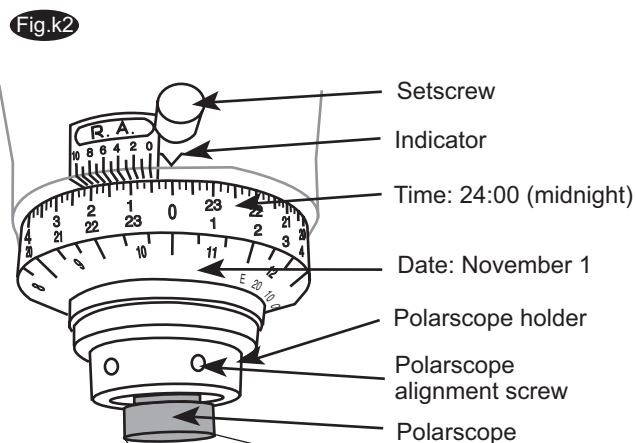
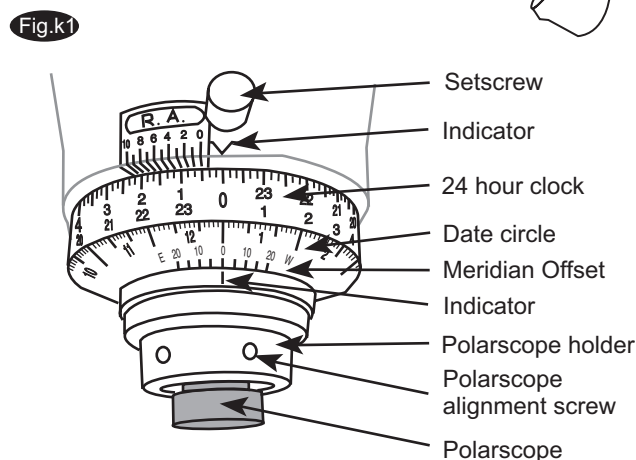
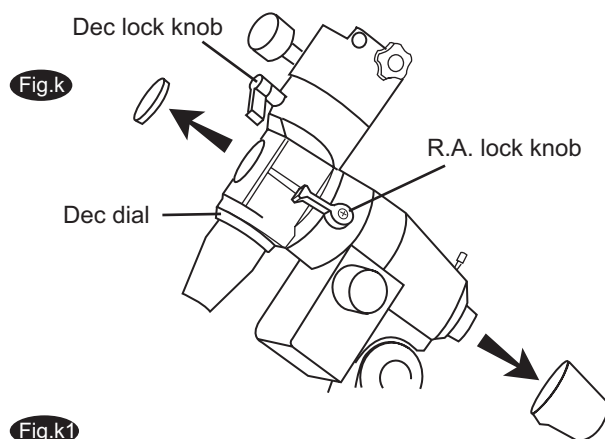
The silver dial just below it is a calendar dial. The months are numbered 1-12. The longest lines separate the months, the middle-length lines are ten days apart, and the short lines between them are two days apart.

The black collar holding this silver dial in place, has an indicator line inscribed on it. The numbers nearest this collar are marked "E 20 10 0 10 20 W". These will be explained later, but for now rotate the silver dial until the middle zero is aligned with the indicator line on the black collar.

At midnight on November 1, on the Central Meridian of your local time zone, Polaris is directly above the NCP. It is therefore directly below when viewed through the inverted view of the polarscope. This provides a good way to orient the polarscope in the mount.

Unlock the R.A. clutch and rotate the mount in R.A. until 'November 1' (long line between 10 and 11) on the calendar dial is lined up with '0' (midnight) on the 24-hour clock dial, then lock the clutch again (Fig.k2). Loosen the three polarscope alignment screws.

Look into the polarscope and you will see the Polaris Location Indicator diagram. Locate a smaller circle (Polaris written next to it) off on the big circle (Fig.k3). Turn the polarscope until the little offset circle is at the bottom and then slide it into the polarscope holder, lined up with the zero on the clock dial. Insert the polarscope far enough so that later it will not interfere with the protective cap.



Once you have it inserted you will have to centre it. The easiest way to do this is to lower the mount head in azimuth and sight on a distant object in daylight. This may involve taking out the latitude t-screw, shortening one leg, or both to get the head down low enough. After you have done this unlock the R.A. clutch again and rotate the mount back and forth in R.A. while keeping your target in view. The idea is to gently tweak the three alignment screws, while rotating the mount, until the target remains at the centre of rotation. This shouldn't take long and after that keep the plastic cap on to protect it from getting bumped off alignment. Set the azimuth of the mount back to the correct latitude.

Using the polarscope:

- 1) Now about the numbers "E 20 10 0 10 20 W". First, you need to find your present Longitude. You can do this by consulting a map, chart, GPS, etc. The idea is to find how far east or west your viewing site is from the reference meridian for your time zone. For example, the Longitude of Vancouver, BC is 123° and the reference meridian for the Pacific Time Zone is 120° , so the setting will be 3° W. The lines on the dial are 5° apart so rotate the silver dial until the indicator on the black collar points between the zero and 5° line (Fig.1). If you observe from a significantly different longitude, this setting will have to be changed.

Fig.1

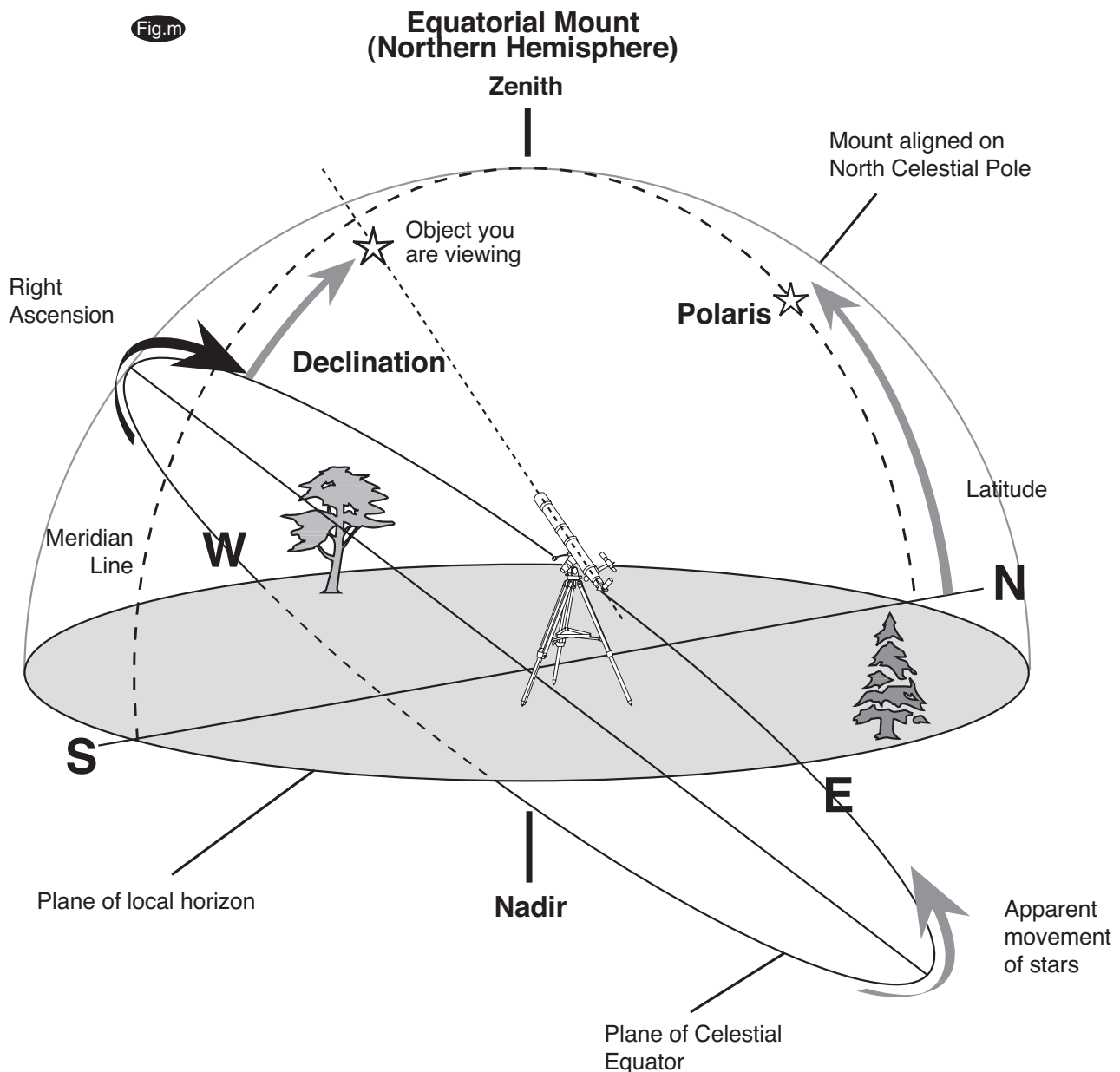


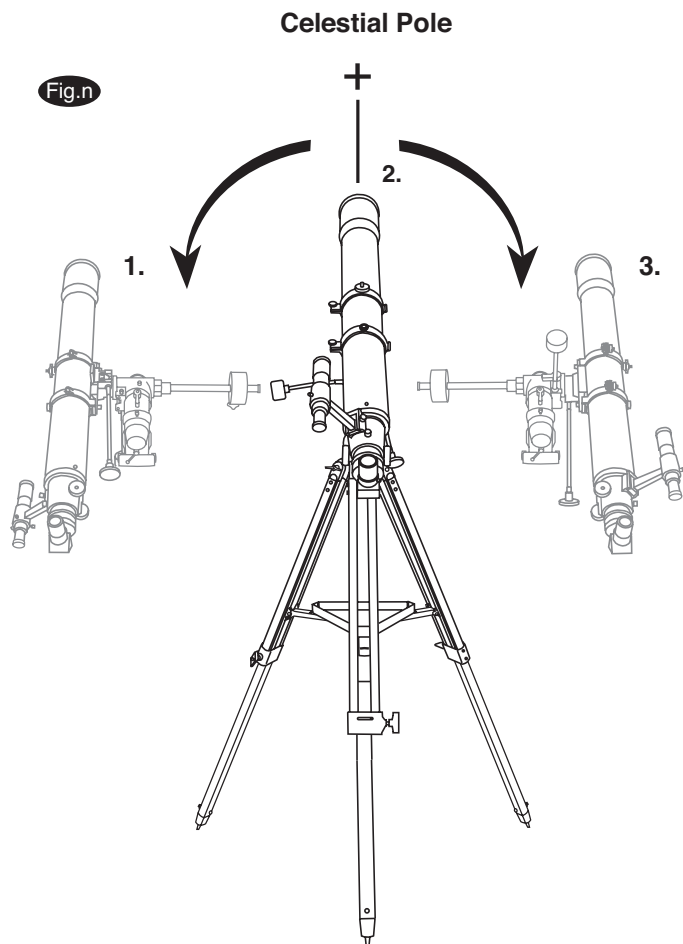
- 2) At your viewing site, set the mount (without weights and scope) facing North. Adjust it to a convenient height for viewing and carefully level it. Unlock the Dec clutch and rotate to Dec 0° , then lock the Dec clutch. Remove the cap from the bottom of the RA axis shaft and the plug from the top.
- 3) Set the 24-hour clock dial so that the hour '0' aligns with the top indicator, and lock it in place with the setscrew. Remember this dial is a clock face running from 0-23 hours. Northern hemisphere users use the top row of numbers and all times are in Standard Time. Do not use Daylight Saving Time for the following setting.
- 4) Unlock the R.A. clutch, and rotate the mount in R.A. until the current date on the silver calendar dial, is aligned with the current time using the black 24-hour clock dial (Standard Time), then lock the R.A. clutch.
- 5) Using only the latitude adjustment t-screws for up and down, and the azimuth adjustment off-set screws on the north side of your mount for left-right, centre Polaris in the little offset circle. You may have to shine your red flashlight at an angle across the front to illuminate the crosshair or better yet have a friend hold the light while you do the adjustments.
- 6) Lastly, loosen the top setscrew, unlock the R.A. clutch, put on the counterweights and then the scope and finally adjust the balance position of the counterweight.

Pointing Your Telescope

A German Equatorial mount has an adjustment, sometimes called a wedge, which tilts the mount's polar axis so that it points at the appropriate Celestial Pole (NCP or SCP). Once the mount has been polar aligned, it needs to be rotated around only the polar axis to keep an object centred. Do not reposition the mount base or change the latitude setting. The mount has already been correctly aligned for your geographical location (i.e. Latitude), and all remaining telescope pointing is done by rotating the optical tube around the polar (R.A.) and declination axes.

A problem for many beginners is recognizing that a polar-aligned, equatorial mount acts like an alt-azimuth mount which has been aligned to a celestial pole. The wedge tilts the mount to an angle equal to the observer's Latitude, and therefore it swivels around a plane which parallels the celestial (and Earth's) equator (Fig.m). This is now its "horizon"; but remember that part of the new horizon is usually blocked by the Earth. This new "azimuth" motion is called Right Ascension (R.A). In addition, the mount swivels North(+) and South(-) from the Celestial Equator towards the celestial poles. This plus or minus "altitude" from the celestial equator is called Declination (Dec).



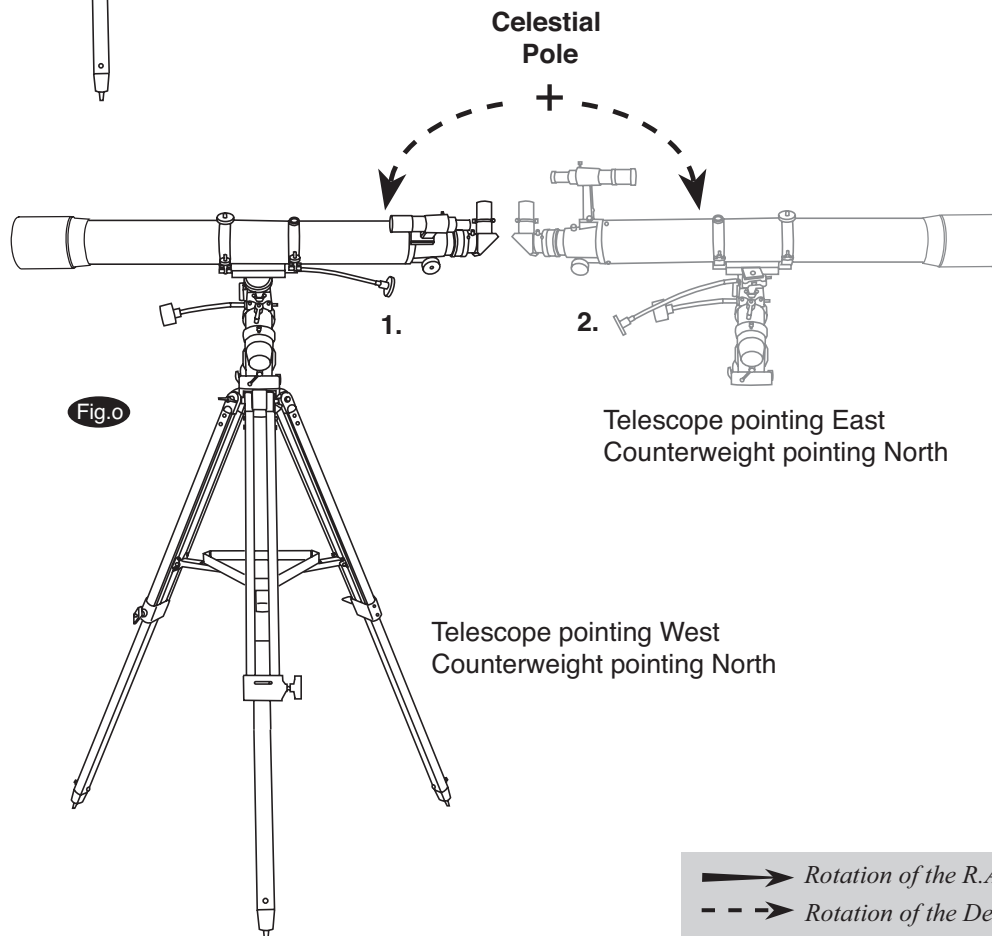


Pointing to the NCP

For the following examples, it is assumed that the observing site is in the Northern Hemisphere. In the first case (Fig.n2), the optical tube is pointing to the NCP. This is its probable position following the polar-alignment step. Since the telescope is pointing parallel to the polar axis, it still points to the NCP as it is rotated around that axis counter-clockwise, (Fig.n1) or clockwise (Fig.n3).

Pointing toward the western or eastern horizon

Now, consider pointing the telescope to the western (Fig.o1) or eastern (Fig.o2) horizon. If the counterweight is pointing North, the telescope can be swivelled from one horizon to the other around the Dec axis in an arc that passes through the NCP (any Dec arc will pass through the NCP if the mount is polar-aligned). It can be seen then that if the optical tube needs to be pointed at an object north or south of this arc, it has to be also rotated around the R.A. axis.



—→ Rotation of the R.A. axis
- - -→ Rotation of the Dec. axis

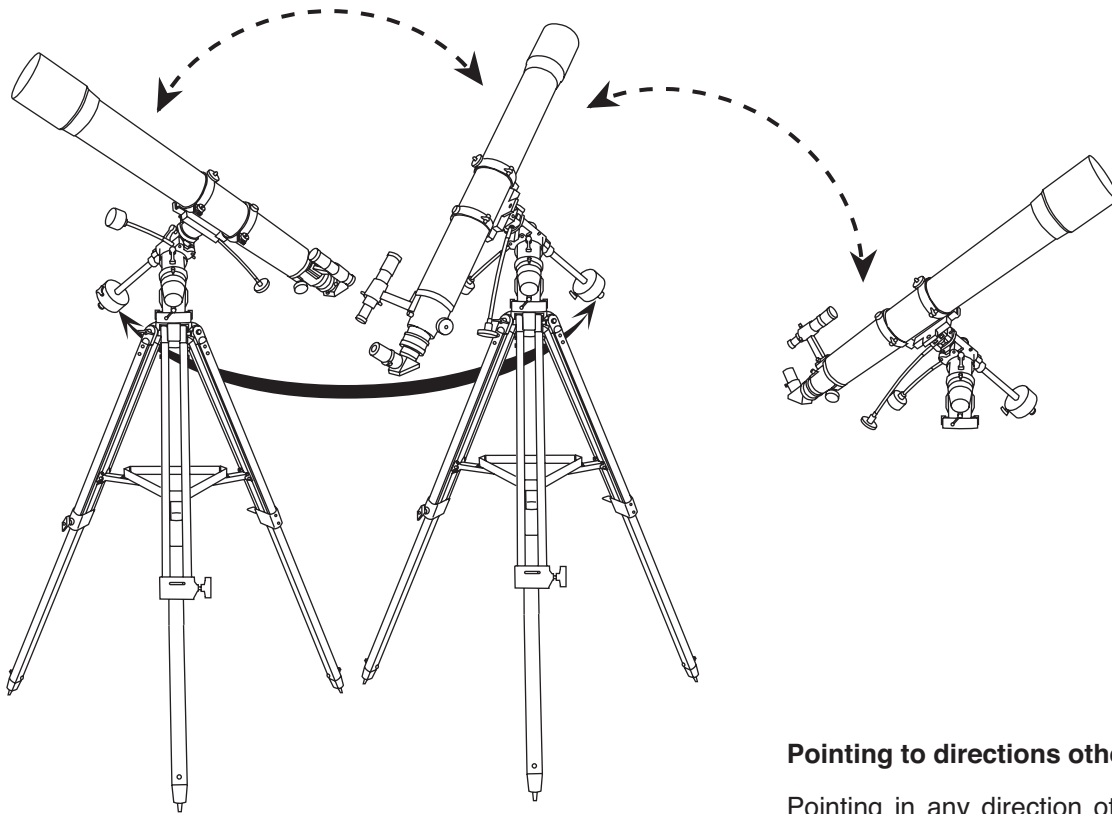


Fig.p Examples of the telescope moved in R.A. and Dec

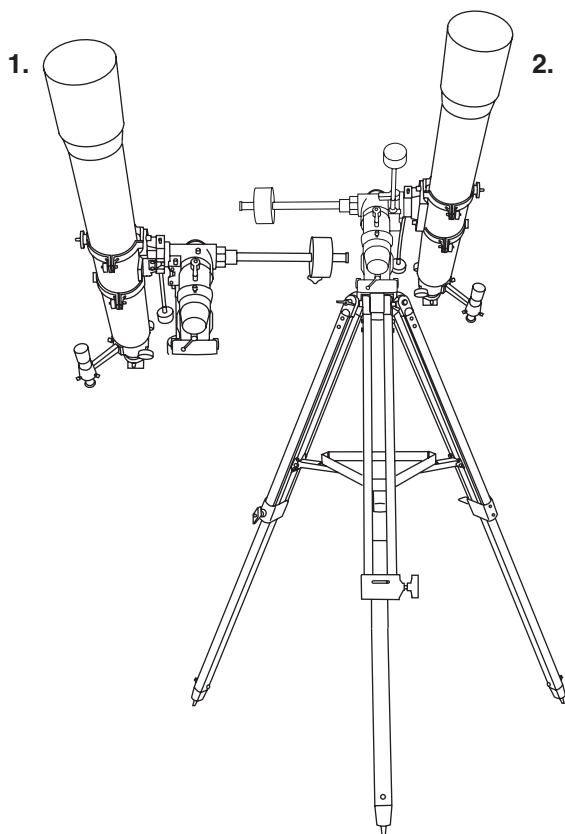


Fig.q Telescope pointing South

Pointing to directions other than due North

Pointing in any direction other than due North requires a combination of R.A. and Dec positions (Fig.p). This can be visualized as a series of Dec arcs, each resulting from the position of rotation of the R.A. axis. In practice however, the telescope is usually pointed, with the aid of a finderscope, by loosening both the R.A. and Dec locks and swivelling the mount around both axes until the object is centred in the eyepiece field. The swivelling is best done by placing one hand on the optical tube and the other on the counter-weight bar, so that the movement around both axes is smooth, and no extra lateral force is applied to the axis-bearings. When the object is centred, make sure the R.A and Dec locks are both re-tightened to hold the object in the field and allow tracking by adjusting only in R.A.

Pointing at an object

Pointing at an object, for example to the South (Fig.q), can often be achieved with the optical tube positioned on either side of the mount. When there is a choice of sides, particularly when there could be a long observing period, the East side (Fig.q2) should be chosen in the Northern Hemisphere because tracking in R.A. will move it away from the mount's legs. This is particularly important when using an R.A. motor, because if the optical tube jams against the mount's legs, it can result in damage to the motor and/or the gears.

Telescopes with long focal lengths often have a "blind spot" when pointing near the zenith, because the eyepiece-end of the optical tube bumps into the mount's legs (Fig.r1). To adapt for this, the optical tube can be very carefully slipped up inside the tube rings (Fig.r2). This can be done safely because the tube is pointing almost vertically, and therefore moving it does not cause a Dec-balance problem. It is very important to move the tube back to the Dec-balanced position before observing other sky areas.

Something which can be a problem is that the optical tube often rotates so that the eyepiece, finderscope and the focussing knobs are in less convenient positions. The diagonal can be rotated to adjust the eyepiece. However, to adjust the positions of the finderscope and focussing knobs, loosen the tube rings holding the optical tube and gently rotate it. Do this when you are going to view an area for while, but it is inconvenient to do every time you briefly go to a new area.

Finally, there are a few things to consider to ensure that you are comfortable during the viewing session. First is setting the height of the mount above the ground by adjusting the tripod legs. You must consider the height that you want your eyepiece to be, and if possible plan on sitting on a comfortable chair or stool. Very long optical tubes need to be mounted higher or you will end up crouching or lying on the ground when looking at objects near the zenith. On the other hand, a short optical tube can be mounted lower so that there is less movement due to vibration sources, such as wind. This is something that should be decided before going through the effort of polar aligning the mount.

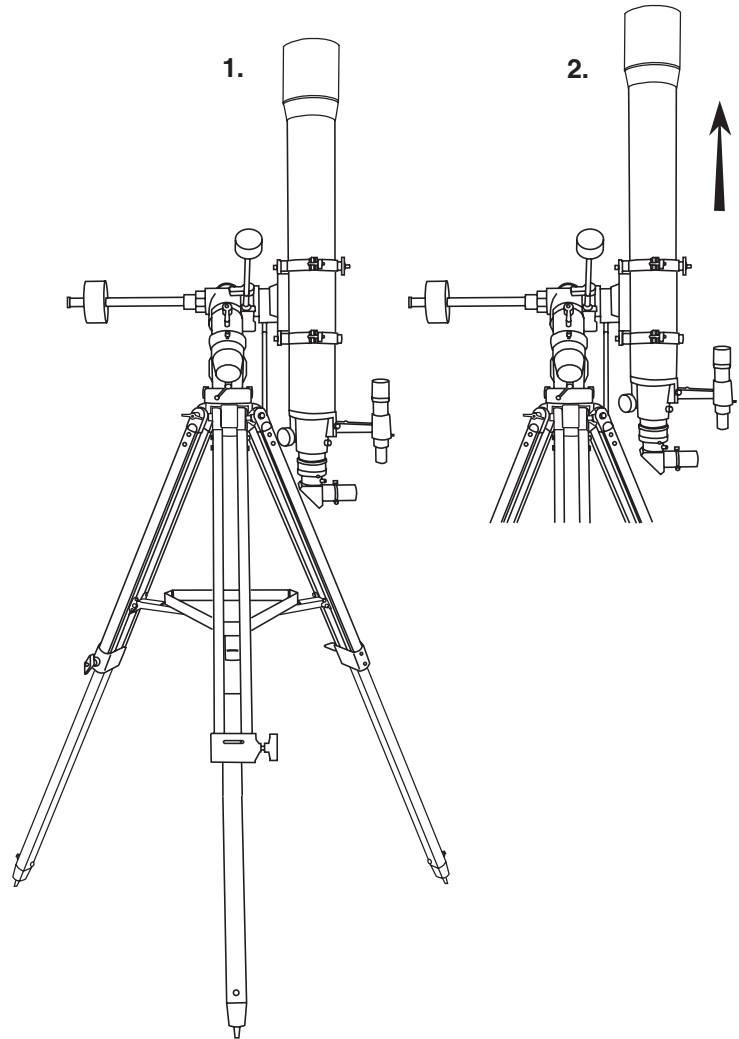


Fig.r Telescope pointing at the Zenith

Choosing the appropriate eyepiece

Calculating the magnification (power)

The magnification produced by a telescope is determined by the focal length of the eyepiece that is used with it. To determine a magnification for your telescope, divide its focal length by the focal length of the eyepieces you are going to use. For example, a 10mm focal length eyepiece will give 80X magnification with an 800mm focal length telescope.

$$\text{magnification} = \frac{\text{Focal length of the telescope}}{\text{Focal length of the eyepiece}} = \frac{800\text{mm}}{10\text{mm}} = 80\text{X}$$

When you are looking at astronomical objects, you are looking through a column of air that reaches to the edge of space and that column seldom stays still. Similarly, when viewing over land you are often looking through heat waves radiating from the ground, house, buildings, etc. Your telescope may be able to give very high magnification but what you end up magnifying is all the turbulence between the telescope and the subject. A good rule of thumb is that the usable magnification of a telescope is about 2X per mm of aperture under good conditions.

Calculating the field of view

The size of the view that you see through your telescope is called the true (or actual) field of view and it is determined by the design of the eyepiece. Every eyepiece has a value, called the apparent field of view, which is supplied by the manufacturer. Field of view is usually measured in degrees and/or arc-minutes (there are 60 arc-minutes in a degree). The true field of view produced by your telescope is calculated by dividing the eyepiece's apparent field of view by the magnification that you previously calculated for the combination. Using the figures in the previous magnification example, if your 10mm eyepiece has an apparent field of view of 52 degrees, then the true field of view is 0.65 degrees or 39 arc-minutes.

$$\text{True Field of View} = \frac{\text{Apparent Field of View}}{\text{Magnification}} = \frac{52^\circ}{80\text{X}} = 0.65^\circ$$

To put this in perspective, the moon is about 0.5° or 30 arc-minutes in diameter, so this combination would be fine for viewing the whole moon with a little room to spare. Remember, too much magnification and too small a field of view can make it very hard to find things. It is usually best to start at a lower magnification with its wider field and then increase the magnification when you have found what you are looking for. First find the moon then look at the shadows in the craters!

Calculating the exit pupil

The Exit Pupil is the diameter (in mm) of the narrowest point of the cone of light leaving your telescope. Knowing this value for a telescope-eyepiece combination tells you whether your eye is receiving all of the light that your primary lens or mirror is providing. The average person has a fully dilated pupil diameter of about 7mm. This value varies a bit from person to person, is less until your eyes become fully dark adapted and decreases as you get older. To determine an exit pupil, you divide the diameter of the primary of your telescope (in mm) by the magnification.

$$\text{Exit Pupil} = \frac{\text{Diameter of Primary mirror in mm}}{\text{Magnification}}$$

For example, a 200mm f/5 telescope with a 40mm eyepiece produces a magnification of 25x and an exit pupil of 8mm. This combination can probably be used by a young person but would not be of much value to a senior citizen. The same telescope used with a 32mm eyepiece gives a magnification of about 31x and an exit pupil of 6.4mm which should be fine for most dark adapted eyes. In contrast, a 200mm f/10 telescope with the 40mm eyepiece gives a magnification of 50x and an exit pupil of 4mm, which is fine for everyone.

Sky conditions

Sky conditions are usually defined by two atmospheric characteristics, seeing, or the steadiness of the air, and transparency, light scattering due to the amount of water vapor and particulate material in the air. When you observe the Moon and the planets, and they appear as though water is running over them, you probably have bad "seeing" because you are observing through turbulent air. In conditions of good "seeing", the stars appear steady, without twinkling, when you look at them with unassisted eyes (without a telescope). Ideal "transparency" is when the sky is inky black and the air is unpolluted.

Selecting an observing site

Travel to the best site that is reasonably accessible. It should be away from city lights, and upwind from any source of air pollution. Always choose as high an elevation as possible; this will get you above some of the lights and pollution and will ensure that you aren't in any ground fog. Sometimes low fog banks help to block light pollution if you get above them. Try to have a dark, unobstructed view of the horizon, especially the southern horizon if you are in the Northern Hemisphere and vice versa. However, remember that the darkest sky is usually at the "Zenith", directly above your head. It is the shortest path through the atmosphere. Do not try to observe any object when the light path passes near any protrusion on the ground. Even extremely light winds can cause major air turbulence as they flow over the top of a building or wall.

Observing through a window is not recommended because the window glass will distort images considerably. And an open window can be even worse, because warmer indoor air will escape out the window, causing turbulence which also affects images. Astronomy is an outdoor activity.

Choosing the best time to observe

The best conditions will have still air, and obviously, a clear view of the sky. It is not necessary that the sky be cloud-free. Often broken cloud conditions provide excellent seeing. Do not view immediately after sunset. After the sun goes down, the Earth is still cooling, causing air turbulence. As the night goes on, not only will seeing improve, but air pollution and ground lights will often diminish. Some of the best observing time is often in the early morning hours. Objects are best observed as they cross the meridian, which is an imaginary line that runs through the Zenith, due North-South. This is the point at which objects reach their highest points in the sky. Observing at this time reduces bad atmospheric effects. When observing near the horizon, you look through lots of atmosphere, complete with turbulence, dust particles and increased light pollution.

Cooling the telescope

Telescopes require at least 10 to 30 minutes to cool down to outside air temperature. This may take longer if there is a big difference between the temperature of the telescope and the outside air. This minimizes heat wave distortion inside telescope tube (tube currents). Allow a longer cooling time for larger optics. If you are using an equatorial mount, use this time for polar alignment.

Adapting your eyes

Do not expose your eyes to anything except red light for 30 minutes prior to observing. This allows your pupils to expand to their maximum diameter and build up the levels of optical pigments, which are rapidly lost if exposed to bright light. It is important to observe with both eyes open. This avoids fatigue at the eyepiece. If you find this too distracting, cover the non-used eye with your hand or an eye patch. Use averted vision on faint objects: The center of your eye is the least sensitive to low light levels. When viewing a faint object, don't look directly at it. Instead, look slightly to the side, and the object will appear brighter.

Collimating a Newtonian reflector

Collimation is the process of aligning the mirrors of your telescope so that they work in concert with each other to deliver properly focused light to your eyepiece. By observing out-of-focus star images, you can test whether your telescope's optics are aligned. Place a star in the centre of the field of view and move the focuser so that the image is slightly out of focus. If the seeing conditions are good, you will see a central circle of light (the Airy disc) surrounded by a number of diffraction rings. If the rings are symmetrical about the Airy disc, the telescope's optics are correctly collimated (Fig.s).

If you do not have a collimating tool, we suggest that you make a "collimating cap" out of a plastic 35mm film canister (black with gray lid). Drill or punch a small pinhole in the exact center of the lid and cut off the bottom of the canister. This device will keep your eye centered of the focuser tube. Insert the collimating cap into the focuser in place of a regular eyepiece.

Collimation is a painless process and works like this:

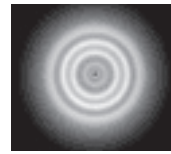
Pull off the lens cap which covers the front of the telescope and look down the optical tube. At the bottom you will see the primary mirror held in place by three clips 120° apart, and at the top the small oval secondary mirror held in a support and tilted 45° toward the focuser outside the tube wall (Fig.s1).

The secondary mirror is aligned by adjusting the three smaller screws surrounding the central bolt. The primary mirror is adjusted by the three adjusting screws at the back of your scope. The three locking screws beside them serve to hold the mirror in place after collimation. (Fig.s2)

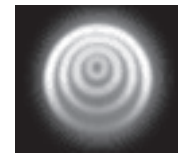
Aligning the Secondary Mirror

Point the telescope at a lit wall and insert the collimating cap into the focuser in place of a regular eyepiece. Look into the focuser through your collimating cap. You may have to twist the focus knob a few turns until the reflected image of the focuser is out of your view. Note: keep your eye against the back of the focus tube if collimating without a collimating cap. Ignore the reflected image of the collimating cap or your eye for now, instead look for the three clips holding the primary mirror in place. If you can't see them (Fig.s3), it means that you will have to adjust the three bolts on the top of the secondary mirror holder, with possibly an Allen wrench or Phillip's screwdriver.

Fig.s



Correctly aligned



Needs collimation

Fig.s1

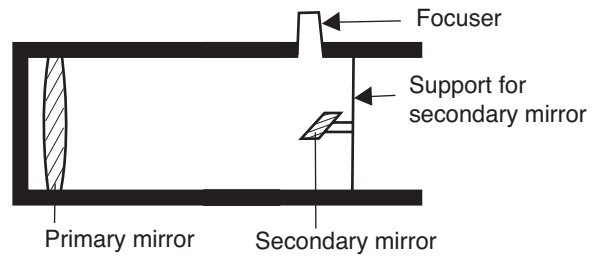


Fig.s2

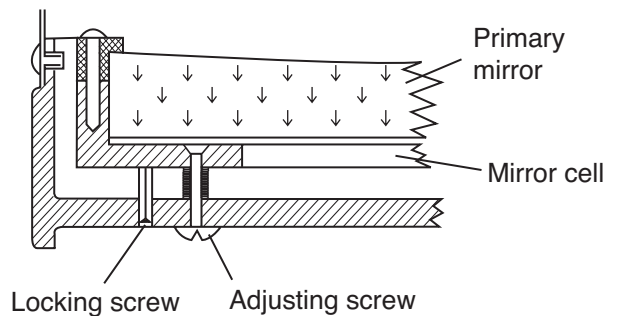


Fig.s3

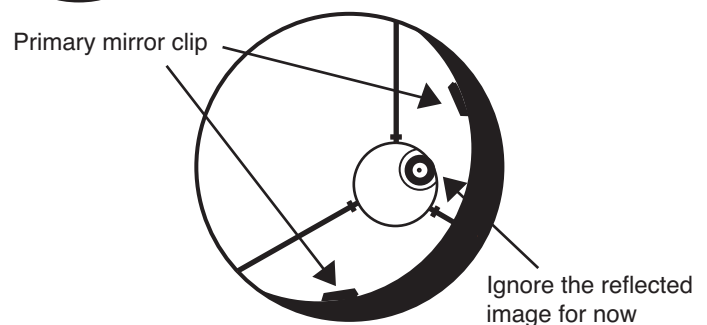
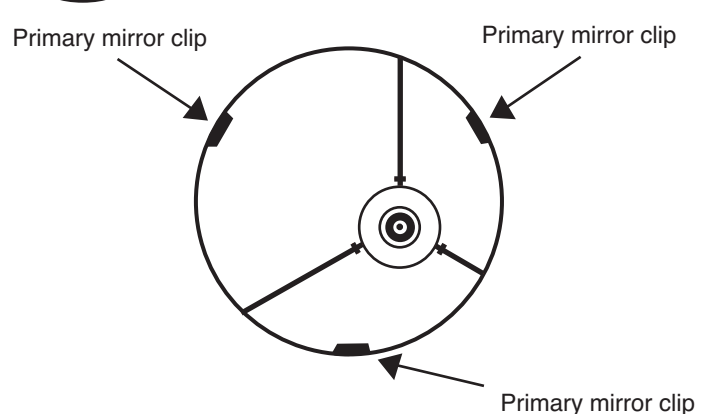


Fig.s4

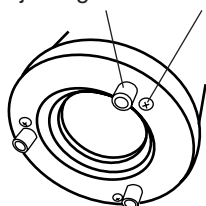


You will have to alternately loosen one and then compensate for the slack by tightening the other two. Stop when you see all three mirror clips (Fig.s4). Make sure that all three small alignment screws are tightened to secure the secondary mirror in place.

Aligning the Primary Mirror

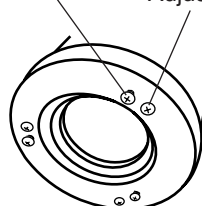
Find the three locking screws at the back of your telescope and loosen them by a few turns.

Adjusting screw Locking screw



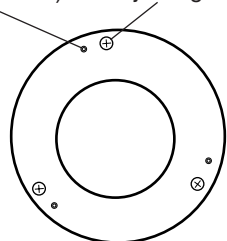
If you see 3 large nuts protruding from the back of your telescope and 3 small Phillip's-head screws besides them, the Phillip's-head screws are the locking screws and the large nuts are the adjusting screws.

Locking screw Adjusting screw



If you see 6 Phillip's-head screws but 3 protruding from the back of your telescope, the 3 protruding screws are locking screws and the ones next to them are adjusting screws.

Hex bolt (Locking screw) Adjusting screw



If you see 3 hex bolts and 3 Phillip's head screws, the hex bolts are the locking screws and the Phillip's-head screws are the adjusting screws. You will need an Allen wrench to adjust the locking screws.

Now run your hand around the front of your telescope keeping your eye to the focuser, you will see the reflected image of your hand. The idea here being to see which way the primary mirror is deflected, you do this by stopping at the point where the reflected image of the secondary mirror is closest to the primary mirrors' edge (Fig.s5).

When you get to that point, stop and keep your hand there while looking at the back end of your telescope, is there an adjusting screw there? If there is you will want to loosen it (turn the screw to the left) to bring the mirror away from that point. If there isn't an adjusting screw there, then go across to the other side and tighten the adjusting screw on the other side. This will gradually bring the mirror into line until it looks like Fig.s6. (It helps to have a friend to help for primary mirror collimation. Have your partner adjust the adjusting screws according to your directions while you look in the focuser.)

After dark go out and point your telescope at Polaris, the North Star. With an eyepiece in the focuser, take the image out of focus. You will see the same image only now, it will be illuminated by starlight. If necessary, repeat the collimating process only keep the star centered while tweaking the mirror.

Fig.s5

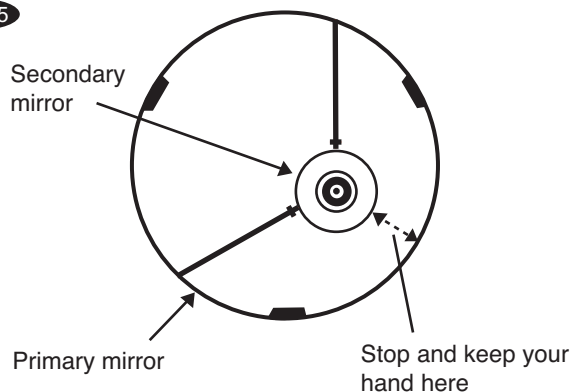
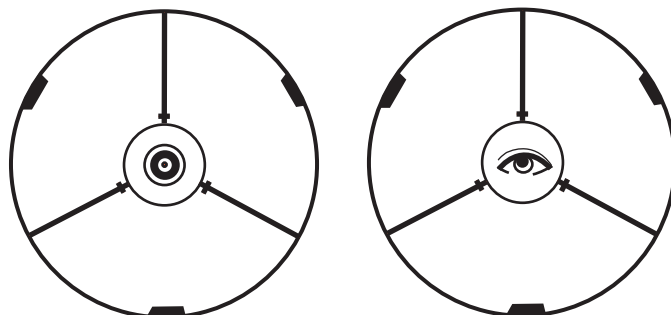


Fig.s6



Both mirrors aligned with collimating cap in

Both mirrors aligned with eye looking in focuser

Collimating a refractor with the adjustable objective-lens cell

Collimation is the process of aligning the lenses of your telescope so that the light they collect will focus at the right spot at the back of your telescope for your eyepieces to work.

Collimation is a simple process and works like this:

Pull off the dew cap at the front of your telescope and look into the scope. The pair of lenses are held in a cell by a threaded ring. This cell is held in place by three pairs of screws spaced 120 degrees apart. The larger Phillip's head screws actually hold the cell on, while the smaller, buried Allen screws push against a ledge at the front of the tube and allow the cell to tilt slightly, by tension against the Phillips screws (Fig.t). The idea being to alternately loosen and tighten each against the other until you have a round star image.

There are a number of devices available for collimation. One of the best is your eyepiece and Polaris. (See Fig.h for the location of Polaris.) For this purpose it is best that your telescope not be polar aligned, in fact point the mount head due east or west. This is because German Equatorial Mounts can have a small blind spot near the pole. Also turn off the motor drive if you have one attached to the mount.

Use your lowest power (largest number eyepiece) to acquire Polaris, centre it using your slow motion controls. Now switch to your next higher power eyepiece, while keeping the image centred. The in-focus star image will have a bright innermost point, a slightly fainter inner ring and a fainter still outer ring that is hard to see (Fig.t1). If it doesn't look like this, or you can't reach focus then start with: take out your star diagonal and look at the image slightly out of focus, this will allow you to gauge the deflection. A typical off-collimation image will have a bright spot off to one side when you bring the focus out (Fig.t2).

The actual process is to slightly loosen the pair on the side the deflection is, slacken the Allen head screws then tighten the Phillip's head screws against them again. Check the star image again after moving it into the centre of the eyepiece. If you find your image getting worse, then go the other way, or slacken the other two Allen screws a little. Once you have a round star image you are set. It helps to have a friend to help with the collimation. Have your partner adjust the screws according to your directions while you look in the eyepiece.

Fig.t

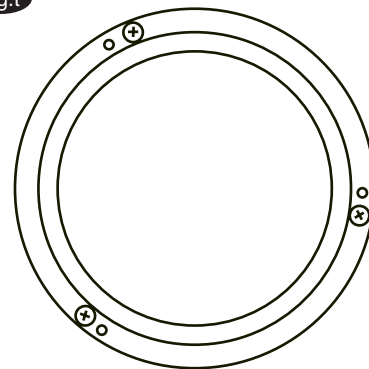
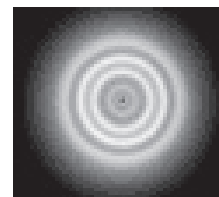
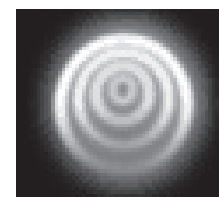


Fig.t1



Correctly aligned

Fig.t2

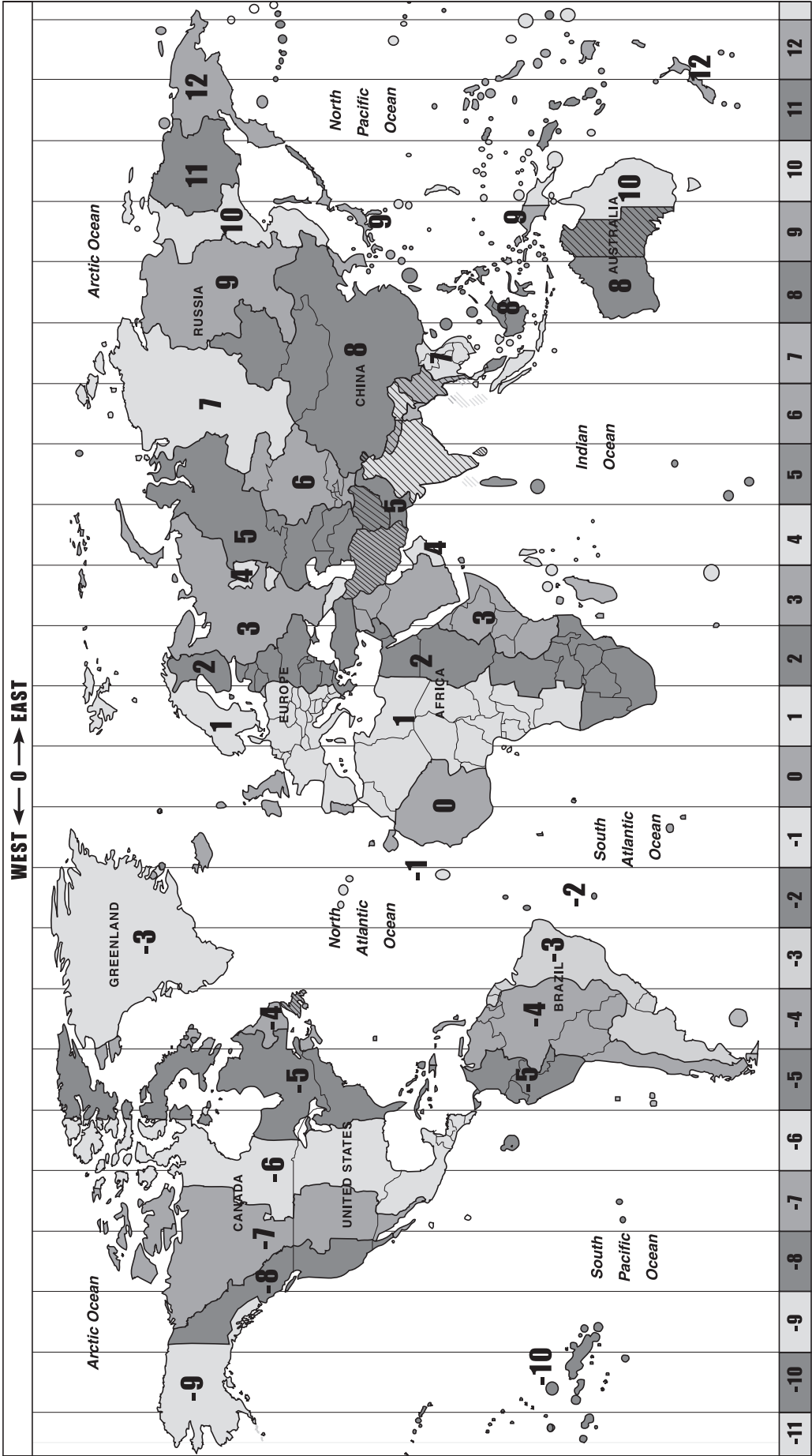


Needs collimation

Cleaning your telescope

Replace the dust cap over the end of the telescope whenever it is not in use. This prevents dust from settling on the mirror or lens surfaces. Do not clean the mirror or lens unless you are familiar with optical surfaces. Clean the finderscope and eyepieces with special lens paper only. Eyepieces should be handled with care, avoid touching optical surfaces.

APPENDIX A – STANDARD TIME ZONES OF THE WORLD



APPENDIX B – OPTIONAL ACCESSORIES

LONG EYE-RELIEF EYEPIECES

These multi-coated eyepieces provide a generous 20mm eye relief, and all focal lengths including the 2mm model feature particularly wide diameter eye lenses for maximum viewing comfort. These eyepieces are especially valuable for spectacle wearers, as the long eye relief allows the entire field to be viewed whilst spectacles are being worn. Soft rubber eyecups are provided for added comfort and to keep out extraneous light.

Available in: 25mm (50° apparent field), 20mm (50° apparent field), 15mm (50° apparent field), 10mm (50° apparent field), 9mm (50° apparent field), 5mm (45° apparent field), 2mm (45° apparent field).



WIDE-ANGLE EYEPIECES

These ultra-wide angle, multi-Coated eyepieces offer a generous 66° apparent field of view, allowing more sky objects to be viewed at one time. They provide sharp images right across the field. Rubber eyepieces are included for viewing comfort and to exclude extraneous light.

Available in: 20mm (18mm Eye Relief), 15mm (13mm Eye Relief), 9mm (15mm Eye Relief), 6mm (14.8mm Eye Relief).



2" EYEPIECES

These 2"/50.8mm fully multi-coated eyepieces offer exceptional value for the money. They feature long eye relief, a wide field of view and soft rubber eyecups. The multi-coatings ensure maximum light transmission and enhance image contrast.

Available in: 42mm (50° apparent field), 35mm (56° apparent field), 28mm (56° apparent field).

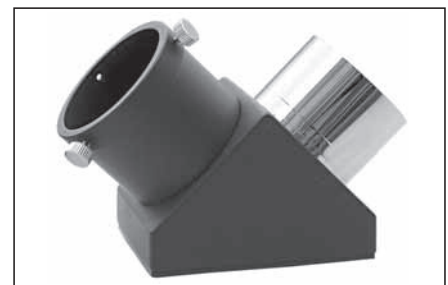


**To be used with telescopes with a 2" focuser.*

2" 90° STAR DIAGONAL

Made to yield maximum astronomical viewing performance, the 2"/50.8mm star diagonal is perfect with telescopes with a 2" focuser and 2" eyepieces. It comes with a 1.25" adapter to accept standard 1.25" eyepieces.

**To be used with telescopes with a 2" focuser.*



APPENDIX C – RECOMMENDED READING

Amateur Astronomy

Beginner's Guide to Amateur Astronomy: An Owner's Manual for the Night Sky by David J. Eicher and, Michael Emmerich (Kalmbach Publishing Co., Books Division, Waukesha, WI, 1993).

NightWatch: A Practical Guide to Viewing the Universe by Terence Dickinson, (Firefly Books, Willowdale, ON, Canada, 3rd edition, 1999).

Star Testing Astronomical Telescopes by Harold Richard Suiter, (Willmann-Bell, Inc., Richmond, VA, 1994).

Star Ware: The Amateur Astronomer's Ultimate Guide to Choosing, Buying, and Using Telescopes and Accessories by Philip S. Harrington (John Wiley & Sons, New York, 1998).

The Backyard Astronomer's Guide by Terence Dickinson and Alan Dyer (Firefly Books Ltd., Willowdale, ON, Canada, revised edition, 1994).

The Beginner's Observing Guide: An Introduction to the Night Sky for the Novice Stargazer by Leo Enright, (The Royal Astronomical Society of Canada, Toronto, ON, Canada, 1999).

The Deep Sky: An Introduction by Philip S. Harrington (Sky Publishing Corporation, Cambridge, MA, Sky & Telescope Observer's Guides Series, ed. Leif J. Robinson, 1997).

The Universe from Your Backyard: A Guide to Deep Sky Objects by David J. Eicher (Kalmbach Publishing Co., Books Division, Waukesha, WI, 1988).

Turn Left at Orion: A Hundred Night Sky Objects to See in a Small Telescope--and how to Find Them by Guy J. Consolmagno and Dan M. Davis, (Cambridge University Press, New York, 3rd edition, 2000)

Astro-photography

The Great Atlas of the Stars by Serge Brunier, Constellation photography by Akira Fujii (Firefly Books; Willowdale, ON, Canada 2001).

A Manual Of Advanced Celestial Photography by Brad D. Wallis and Robert W. Provin (Cambridge University Press; New York; 1984).

Astrophotography An Introduction by H.J.P. Arnold (Sky Publishing Corp., Cambridge, MA, Sky & Telescope Observer's Guides Series, ed. Leif J. Robinson, 1995).

Astrophotography for the Amateur by Michael Covington (Cambridge University Press, Cambridge, UK, 2nd edition, 1999).

Splendors of the Universe: A Practical Guide to Photographing the Night Sky by Terence Dickinson and Jack Newton (Firefly Books, Willowdale, ON, Canada, 1997).

Wide-Field Astrophotography by Robert Reeves (Willmann-Bell, Inc., Richmond, VA, 2000).

Observational References

A Field Guide to the Stars and Planets by Jay M. Pasachoff, (Houghton Mifflin Company, 1999).

Atlas of the Moon by Antonín Rükl (Kalmbach Publishing Co., Books Division, Waukesha, WI, 1993).

Burnham's Celestial Handbook: An Observer's Guide to the Universe Beyond the Solar System by Robert Burnham (Dover Publications, New York; 3-volume set, 1978).

Observer's Handbook by The Royal Astronomical Society of Canada, (University of Toronto Press, Toronto, ON, Canada, published annually).

Sky Atlas 2000.0 by Wil Tirion and Roger W. Sinnott (Sky Publishing Corp., Cambridge, MA, 2nd edition, 1998).

Absolute Magnitude

The apparent brightness a star would have if placed at a distance of 10 parsecs from the earth.

Achromatic Lens

A refractor lens, made of two or sometimes three separate lenses, which has the effect of bringing most of the viewed colors to a sharp focus, thus reducing chromatic aberration.

Alt-azimuth

A simple mount that allows movement in altitude (up and down) and in azimuth (side to side).

Anti-reflection Coating

A thin layer of film applied to an optical surface that reduces the loss of transmission of light.

Aperture

The diameter of the primary mirror or lens.

Barlow Lens

A “negative” lens which, when placed in front of the eyepiece, increases the focal length and magnification and decreases the field.

Collimation

The process of aligning all the elements of an optical system. Collimation is routinely needed in reflectors, often in Catadioptric systems but seldom in refractors.

Declinatoin

Similar to Latitude on the Earth's surface, it is the distance in degrees North or South of the Celestial Equator (the projection of the Earth's Equator onto the Celestial Sphere). The degrees can be sub-divided into minutes and seconds.

Dew Cap

A tube extending forward from the front lens of a telescope. It prevents dew from forming on the lens as it cools down, and acts as a sunshade to reduce reflections during the day.

Diagonal

A mirror or prism system which changes the angle and orientation of the light rays coming from the telescope to the eyepiece.

Equatorial Mount

A telescope mount with an axis parallel to the axis of the earth. This provides easy tracking of sky objects and for photography when combined with a clock drive.

Eyepiece

Also called an ocular. This is a small tube that contains the lenses needed to bring a telescope's focus to a final image in the eye. Telescopes usually come with at least two eyepieces: one for low power and a second for a higher power view.

Eye Relief

The distance between the eyepiece lens and the position in which the eye must be placed to see through the telescope. Telescope users who wear eyeglasses while observing, appreciate the benefits of longer eye relief.

Exit Pupil

This is the diameter of the beam of light from the eyepiece which reaches the pupil of the eye. It is usually expressed in mm, and determined by dividing the diameter of the primary (in mm) by the Magnification. Knowing this value and the diameter of your dilated pupil allows you to choose the eyepieces which will work best for you with a specific telescope.

Field of View

The maximum view angle of an optical instrument. The number, in degrees, supplied by the manufacturer is the Apparent Field of View. To find the True Field of View (also known as the Actual Field of View), divide the Apparent Field of View by the Magnification.

Finderscope

A low power telescope attached parallel to the main instrument which provides easy object locating and telescope aiming.

Focal Length

The distance of the light path from the objective (primary lens or mirror) to the convergence of the beam. The convergent spot is called the Focus or Focal Point.

Focal Ratio

This is found by dividing an optical system's Focal Length by its Aperture. The resulting value is sometimes called the system's “speed”.

Focuser

A device which brings the light rays in a telescope to a precise focus. Common designs include geared (rack-and-pinion), gearless (Crayford-style) and helical.

Lens

A transparent optical element consisting of one or more pieces of glass. A lens has curved surfaces that bring distant light to a focus.

Magnifying Power

The amount by which a system increases the apparent size of objects. Magnification is determined by dividing the Focal Length of the telescope by the Focal Length of the eyepiece.

Mirror

In a telescope, it is a highly polished surface made to reflect light. Primary mirrors are usually made spherical or paraboloidal (parabolic) to focus the light rays.

Objective

The primary or largest element in an optical system; sometimes called the "fixed optics."

Optical Tube Assembly

The housing and optical train of a telescope; not including the mount, diagonal, eyepiece or accessories.

Parabolic Mirror

A parabolic or more accurately a "paraboloidal" mirror, is ground to a shape which brings all incoming light rays to a perfect focus, on axis.

Polar Axis

A telescope mount's axis that is parallel with the earth's axis. With a drive motor, the motion of stars due to the earth's movement can be counteracted so that they remain in the field.

Power

See Magnifying Power.

Prime Focus

The focal point of the objective mirror or lens.

Resolution

The ability of an optical system to reveal details.

Resolving Power

The ability of a telescope to separate closely positioned points.

Right Ascension

Similar to but not the same as Latitude on the Earth's surface. It is the position eastwards from the Vernal Equinox, in 24 one-hour units. The hours can be sub-divided into minutes and seconds.

Setting Circles

Circular scales attached to the telescope. They are marked off in degrees of Declination and hours of Right Ascension. Together, the circles allow the position of a known object to be found by setting the dials to the equatorial coordinates.

T rue Field of View

How much sky, in angular measure, is available at the eyepiece. It is contrasted with Apparent Field of View, which measures the field of the eyepiece alone.

Wide Angle Eyepiece

An eyepiece with an Apparent field of view of more than 50 degrees.

Zoom Eyepiece

An optical system which provides a variable focal length.



NEVER USE YOUR TELESCOPE TO LOOK DIRECTLY AT THE SUN. PERMANENT EYE DAMAGE WILL RESULT. USE A PROPER SOLAR FILTER FIRMLY MOUNTED ON THE FRONT OF THE TELESCOPE FOR VIEWING THE SUN. WHEN OBSERVING THE SUN, PLACE A DUST CAP OVER YOUR FINDERSCOPE OR REMOVE IT TO PROTECT YOU FROM ACCIDENTAL EXPOSURE. NEVER USE AN EYEPiece-TYPE SOLAR FILTER AND NEVER USE YOUR TELESCOPE TO PROJECT SUNLIGHT ONTO ANOTHER SURFACE, THE INTERNAL HEAT BUILD-UP WILL DAMAGE THE TELESCOPE OPTICAL ELEMENTS.

