

# INSTRUCTION MANUAL

## Orion® Observer 90mm, 114mm, and 134mm Equatorial Telescopes

#52986 Observer 114mm EQ Reflector

#52987 Observer 134mm EQ Reflector

#25705 Observer 90mm EQ Refractor



Congratulations on your purchase of an Orion telescope. Your new Observer Equatorial telescope is a terrific instrument designed to provide outstanding views of celestial wonders. Any one of these three quality telescopes will reward you and your friends and family with many hours of enjoyment and discovery. These instructions will help you set up, properly use, and care for your telescope. Please read them over thoroughly before getting started.



**Corporate Offices:** 89 Hangar Way, Watsonville CA 95076 - USA  
**Toll Free USA & Canada:** (800) 447-1001  
**International:** +1(831) 763-7000  
**Customer Support:** [support@telescope.com](mailto:support@telescope.com)

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## I. Parts

Unpack all of the parts and lay them out on the floor. Make sure all the parts listed below and shown in **Figure 1** are present. Save the shipping box and packaging material. In the unlikely event that you need to return the telescope, you must use the original packaging. Initial assembly of the telescope should take only about 15 minutes

Part	Qty
A, B, or C – Optical tube assembly	1
D, E, or F – Dust cover	1
G – Tripod	1
H – Equatorial mount	1
I – Accessory tray	1
J – Slow-motion cables	2
K – Counterweight shaft	1
L – 6x30 finder scope (90mm and 134mm models)	1
M – 25mm Plossl eyepiece, 1.25"	1
N – 10mm Plossl eyepiece, 1.25"	1
O – Mirror star diagonal, 1.25" (90mm model only)	1
P – Red dot finder scope (114mm model only)	1
Q – Counterweight	1
R – 2x Barlow lens (90mm model only) (Not shown)	1

**Warning: Never look directly at the Sun through your telescope—even for an instant—without a professionally made solar filter that completely covers the front of the instrument, or permanent eye damage could result. Young children should use this telescope only with adult supervision.**

## II. Assembly

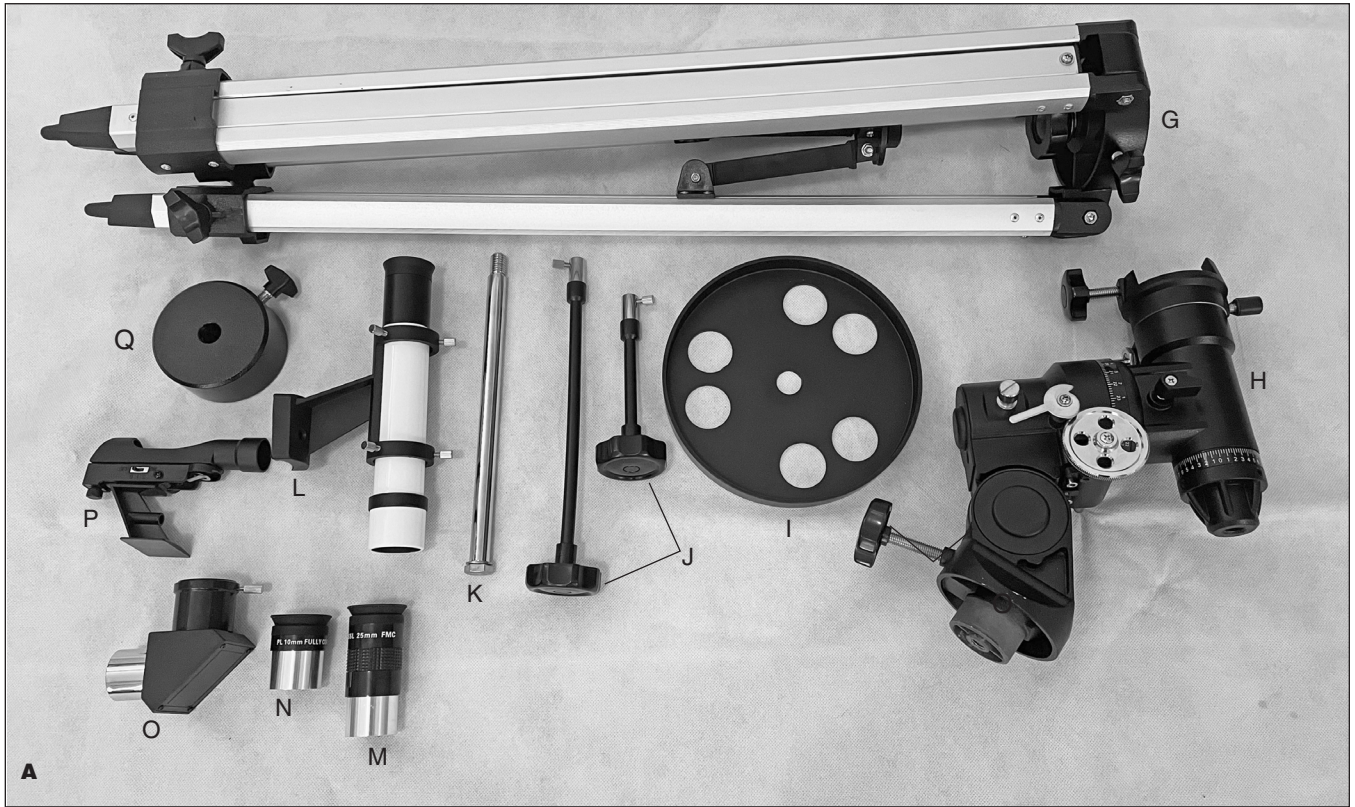
1. Spread the tripod (G) legs apart and stand it on the ground (**Figure 2**). You can extend the legs to the desired height later using the leg lock knobs. For now just keep them fully retracted.
2. Unscrew the accessory tray locking knob from the center of the tripod leg brace. Then place the tray's (I) center hole over the center of the leg brace (**Figure 3**). Finally, screw the tray locking knob clockwise into the threaded hole until tight.
3. Now you will attach the equatorial mount (H) to the tripod. Place the base of the mount over the tripod's mounting platform (**Figure 4**), then tighten by turning the mount attachment knob located under the mounting platform clockwise until just lightly tightened (**Figure 5**).
4. Next, place the counterweight (Q) onto the counterweight shaft (K), as shown in **Figure 6**. Loosen the counterweight lock knob to allow the counterweight to slide onto the shaft, then tighten the knob. Then thread the counterweight shaft into the mount housing (**Figure 7**) until tight. Alternatively, you could thread on the shaft first and then slide the counterweight onto it after removing the hex-head bolt and washer from the bottom end of the shaft.

5. Attach the slow motion cables (J) to the gear shafts by orienting the cable so that the thumbscrew seats in the groove of the gear shaft, as shown in **Figure 8**. Then firmly tighten the thumbscrew. The longer cable should be attached to the declination gear shaft; the shorter cable to the right ascension gear shaft (**Figure 9**).

The EQ mount is now properly attached to the tripod (**Figure 10**). Next, you'll attach the optical tube to the EQ mount.

6. Before proceeding, make sure the right ascension and declination lock knobs (see **Figure 10** inset) are tightened so that the mount won't swivel accidentally when you're attaching the tube rings or the optical tube.
7. The optical tube (A, B, or C) arrives in the shipping box with the tube ring(s) clamped around it, and the dovetail mounting bar attached to the bottom of the tube rings. After removing the tissue paper, make sure the tube ring assembly is secured around the optical tube by lightly tightening the tube ring clamp knobs (**Figure 11**).
8. Lift the optical tube and set the dovetail mounting bar into the mount's saddle as shown in **Figure 11** (make sure the saddle lock knob is backed sufficiently to allow the dovetail bar to seat properly). When the dovetail bar is seated in the saddle, tighten the saddle lock knob until tight.
9. Now you'll attach the finder scope (P or L) to the optical tube. For the 114mm reflector models, it will be the red dot finder scope (P). Push the bracket into the finder scope base as shown in **Figure 12** until it is all the way in. For the 90mm refractor and 134mm reflector, you will install the 6x30 achromatic finder scope (L), which provides 6x magnification and has a 30mm aperture. First remove the two round thumb nuts near the focuser (see **Figure 13**). (Do not remove the two small hex nuts underneath them!)





**Figure 1. A)** Parts included with the Orion Observer EQ telescopes. **B)** Optical tube assemblies of the Observer EQ telescopes.

Then install the 6x30 finder scope bracket over the bolts and secure it by replacing the two thumb nuts.

- Next, for the 90mm refractor only, insert the chrome barrel of the star diagonal (O) into the focuser drawtube collar and tighten it with the two thumbscrews. Then insert the 25mm eyepiece (M) into the diagonal and lightly tighten the thumbscrew on the diagonal (**Figure 14**). The 114 and 134mm reflector models do not utilize a star diagonal, so you will insert the eyepiece directly into the focuser drawtube collar and lock it with the two thumbscrews (**Figure 15**).

The telescope is now completely assembled! Before it can be effectively used, however, there are a couple of things to do to prepare the telescope for operation.

### III. Preparing the Telescope For Operation

#### Aligning and Using the Finder Scope

##### A) The Red Dot Finder Scope

The red dot finder scope (**Figure 12**) included with the Observer 114mm EQ makes pointing your telescope almost as easy as pointing your finger! It's a non-magnifying aiming device that superimposes a tiny LED red dot on the sky, showing exactly where the telescope is pointed. It permits easy object targeting prior to observation in the main telescope.

Before you can use the red dot finder scope, you must remove the paper tab sticking out from the battery compartment. Doing so will allow the pre-installed 3V CR-2032 button cell battery to make contact with the finder scope's electronic circuitry to power the finder's red LED illuminator. The tab can then be discarded.

To use the red dot finder scope properly, it must be aligned with the main telescope. This is easiest to do during daylight hours, before observing at night. Follow this procedure:

- First, remove the dust cap from the front of the telescope.
- With the 25mm eyepiece installed in the focuser, point the telescope at a well-defined land target (e.g., the top of a telephone pole) that's at least a quarter mile away. Center the target in the eyepiece by turning the slow-motion cables as needed to point the telescope. For larger telescope movement, release the RA and Dec axis lock knobs (**Figure 16**) and move the telescope tube by hand to the approximate location, then retighten the lock knobs and make finer pointing adjustments with the slow motion cables.

*Note: The image in the reflector telescope models will appear rotated, sometimes upside down. This is normal for reflector telescopes and is why reflectors are not recommended for daytime terrestrial viewing. The view through the refractor when used with a star diagonal will be right-side-up but reversed left to right.*

- Now that a distant target is centered in the main telescope's eyepiece, turn on the red dot finder scope by sliding the power switch to ON (refer to **Figure 12** inset). The



**Figure 2.** The aluminum tripod with legs spread apart.

- "1" position provides dim illumination while the "2" position provides brighter illumination. Typically the dimmer setting is used under dark skies and the brighter setting is used under light-polluted skies or in daylight. Position your eye at a comfortable distance from the rear of the unit. Look through the rear of the finder scope with both eyes open to see the illuminated red dot. The target object should appear in the field of view somewhere near the red dot.
- You'll want to center the target object on the red dot. To do so, without moving the telescope, use the finder scope's vertical and horizontal adjustment knobs (shown in **Figure 12**) to position the red dot on the object.
- When the red dot is centered on the distant object, check to make sure the object is still centered in the telescope's eyepiece. If it isn't, re-center it then adjust the finder scope's alignment again. When the object is centered in the telescope eyepiece and on the finder scope's red dot, the finder scope is properly aligned with the telescope. The red dot finder scope's alignment should be checked before every observing session.

At the end of your observing session, be sure to slide the power switch on the red dot finder scope to OFF to preserve battery life.

##### B) The 6x30 Finder Scope

A 6x30 achromatic finder scope is included with the Observer 134mm EQ reflector and Observer 90mm EQ Refractor. To align





**Figure 3.** Attach the accessory tray to the center of the tripod leg brace with the locking knob.

the 6x30 achromatic finder scope with the main telescope, aim the telescope in the general direction of an object at least 1/4-mile away, such as the top of a telephone pole. Do this by first loosening the R.A. and Dec. lock knobs on the mount so that the telescope can be freely moved (**Figure 16**). Position the telescope so the object appears in the eyepiece's field of view and then retighten the R.A. and Dec. lock knobs. Use the slow-motion control cables to center the object in the eyepiece. Now, look in the finder scope. Is the object visible? Ideally, it will be somewhere in the finder's field of view. If it is not, some coarse adjustments should be made using the alignment thumbscrews on the two-ring bracket (**Figure 13**). By loosening or tightening thumbscrews on one or both of the rings, the aim of the finder scope can be altered to center the target on the crosshairs.

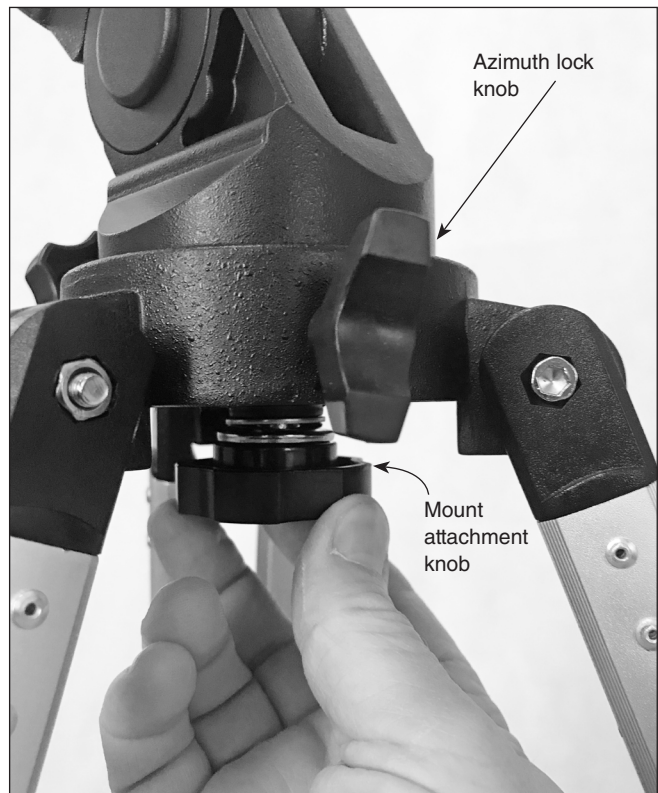
Continue making adjustments to the alignment thumbscrews until the image in both the finder scope and the telescope's eyepiece is exactly centered. When it is, no further adjustment of the finder scope will be needed for the duration of the observing session.

### Focusing the 6x30 Finder Scope

If, when looking through the 6x30 finder scope, the images appear out of focus, you will need to refocus the finder scope for your eyes. Loosen the lock ring located behind the objective lens cell on the body of the finder scope (see **Figure 13**). Back the lock ring off by a few turns, for now. Refocus the finder scope on a distant object by threading the objective lens cell in or out on the finder scope body. Precise focusing will be achieved by focusing the finder scope on a bright star. Once the image appears sharp,



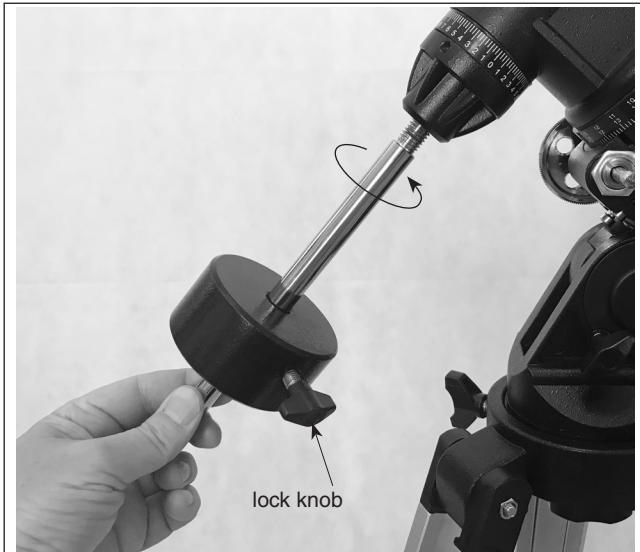
**Figure 4.** Place the equatorial mount on the tripod.



**Figure 5.** Secure the equatorial mount to the tripod by turning the mount attachment knob clockwise until tight.



**Figure 6.** Slide the counterweight onto the counterweight shaft.



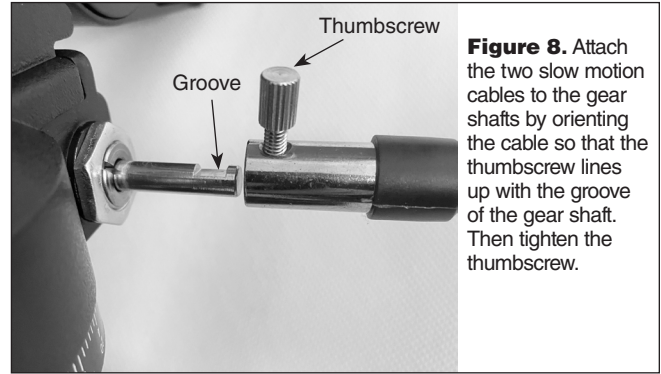
**Figure 7.** Thread the counterweight shaft into the mount housing until tight.

retighten the lock ring behind the objective lens cell. The finder scope's focus should not need to be adjusted again.

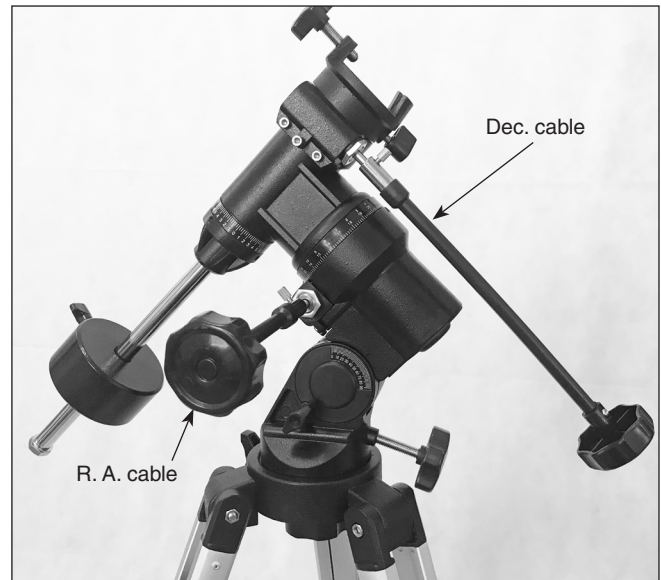
## IV. Understanding and Using the Equatorial Mount

### Balancing the Telescope

To insure smooth movement of the telescope on both axes of the equatorial mount, it is imperative that the optical tube be properly



**Figure 8.** Attach the two slow motion cables to the gear shafts by orienting the cable so that the thumbscrew lines up with the groove of the gear shaft. Then tighten the thumbscrew.



**Figure 9.** The installed slow motion cables should appear as shown, with the shorter one on the right ascension axis.

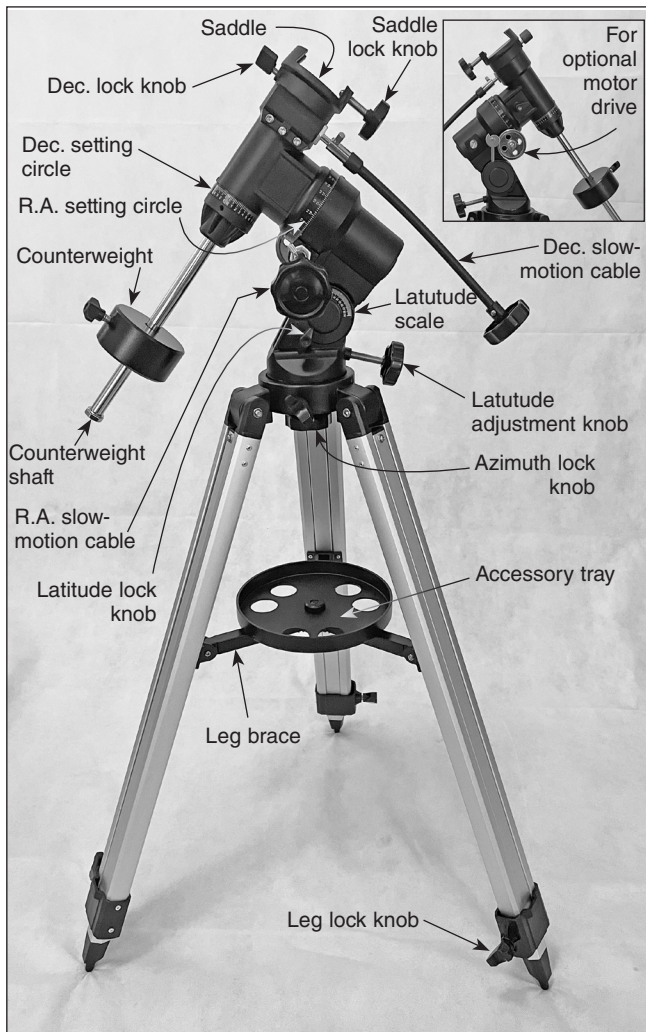
balanced. First we'll balance the telescope with respect to the R.A. axis, then the Dec. axis.

1. Keeping one hand on the telescope optical tube, loosen the R.A. lock knob (see **Figure 16**). Make sure the Dec. lock knob is locked, for now. The telescope should now be able to rotate freely about the R.A. axis. Rotate it until the counterweight shaft is parallel to the ground (i.e., horizontal), as in **Figure 17**.
2. Now loosen the counterweight lock knob and slide the weight along the shaft until it exactly counterbalances the telescope. That's the point at which the shaft remains horizontal even when you let go of the telescope with both hands.
3. Retighten the counterweight lock knob. The telescope is now balanced on the R.A. axis.
4. To balance the telescope on the Dec. axis, first tighten the R.A. lock knob, with the counterweight shaft still in the horizontal position.
5. With one hand on the telescope optical tube, loosen the Dec. lock knob. The telescope should now be able to

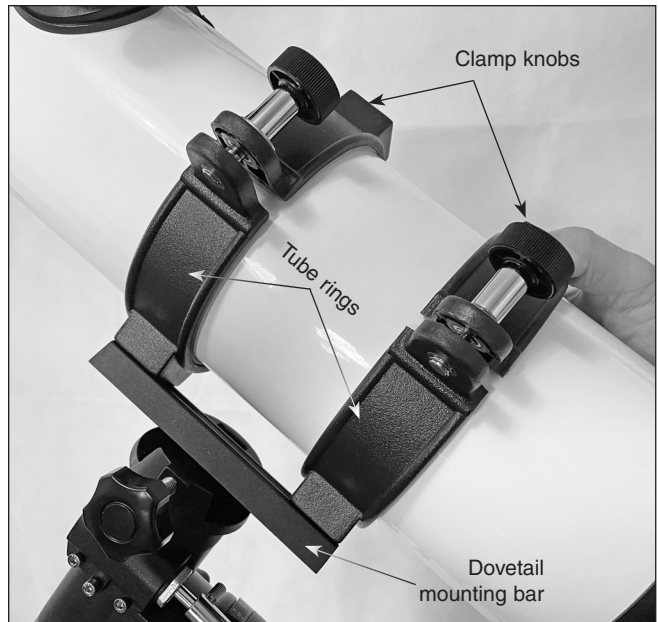


rotate freely about the Dec. axis (**Figure 18**). If you loosen the saddle lock knob just a little, you can slide the dovetail bar to move the telescope one way or the other. If that isn't enough to balance the telescope, you can loosen the tube ring clamp knobs a few turns, until you can slide the telescope tube forward and back inside the rings. Using a slight twisting motion on the optical tube can help move the tube within the rings.

- Position the telescope so it remains horizontal when you carefully let go with both hands. This is the balance point. Before clamping the tube rings tight again, rotate the telescope so the eyepiece is at a convenient angle for viewing. When you are actually observing with the telescope, you can adjust the eyepiece position by loosening the tube rings and rotating the optical tube.
- Retighten the tube ring clamp knobs. The telescope is now balanced on both axes. Now when you loosen the lock knob on one or both axes and manually point the telescope, it should move without resistance and should not drift from where you point it.



**Figure 10.** Features of the equatorial mount and tripod.



**Figure 11.** Tighten the tube ring clamp knob(s) to secure the tube ring(s) to the optical tube.

### Polar Alignment

When you look at the night sky, you no doubt have noticed the stars appear to move slowly from east to west over time. That apparent motion is caused by the Earth's rotation (from west to east). An equatorial mount is designed to compensate for that motion, allowing you to easily "track" the movement of astronomical objects, thereby keeping them from drifting out of the telescope's field of view while you're observing.

This is accomplished by slowly rotating the telescope on its right ascension (R.A.) axis, using only the R.A. slow-motion cable. But first the R.A. axis of the mount must be aligned with the Earth's rotational (polar) axis—a process called polar alignment.

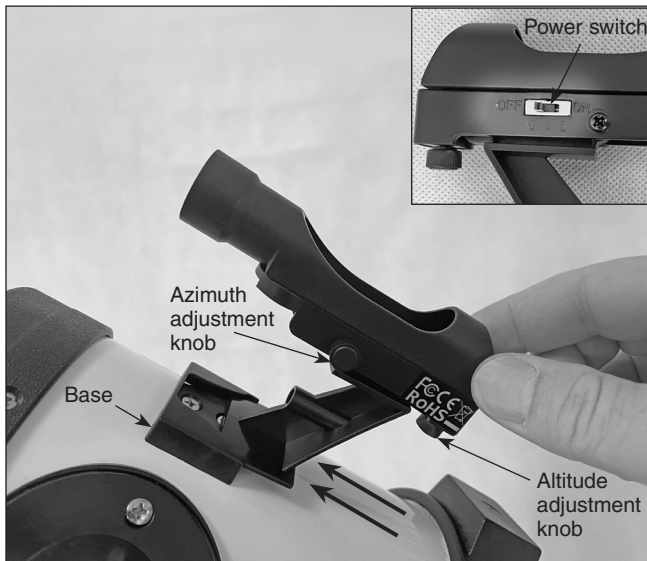
For Northern Hemisphere observers, approximate polar alignment is achieved by pointing the mount's right ascension axis at the North Star (Polaris). It lies within 1° of the north celestial pole (NCP), which is an extension of the Earth's rotational axis out into space. Stars in the Northern Hemisphere appear to revolve around the NCP.

To find Polaris in the sky, look north and locate the pattern of the Big Dipper (**Figure 19**). The two stars at the end of the "bowl" of the Big Dipper point approximately to Polaris.

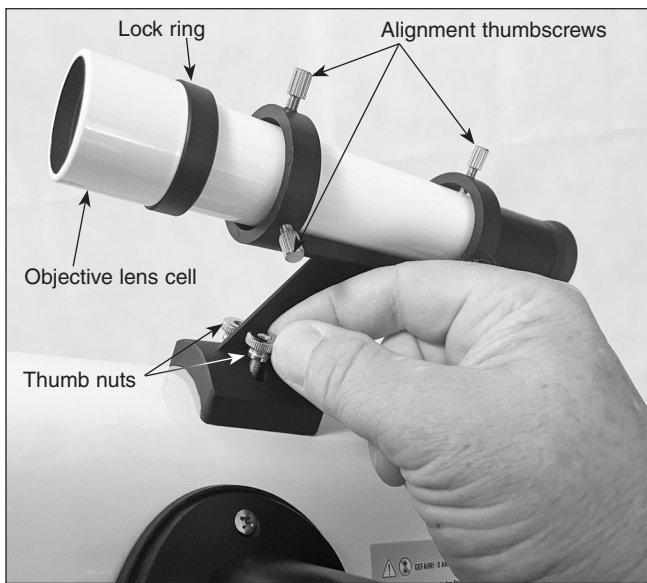
Observers in the Southern Hemisphere aren't so fortunate to have a bright star so near the south celestial pole (SCP). The star Sigma Octantis lies about 1° from the SCP, but it is barely visible with the naked eye (magnitude 5.5).

#### To polar align the equatorial mount:

- Roughly level the equatorial mount by adjusting the length of the three tripod legs as needed.
- Loosen the latitude lock knob (see **Figure 10**). Turn the latitude adjustment bolt until the pointer on the latitude



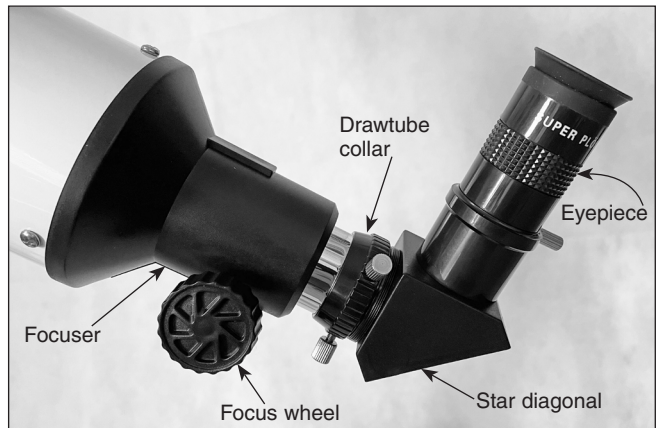
**Figure 12.** Attach the red dot scope to the Observer 114mm EQ by pushing the bracket into the finder scope base. Inset shows the power switch.



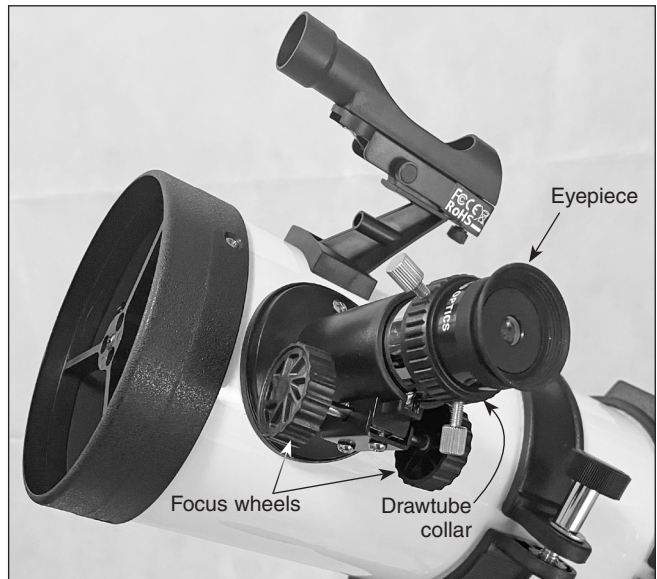
**Figure 13.** Attach the 6x30 finder scope to the Observer 90mm or 134mm EQ with the two round thumb nuts.

scale is indicating the latitude of your observing location. If you don't know your latitude, you can look it up on the internet. For example, if your latitude is 35° North, set the pointer to 35. Then retighten the latitude lock knob. The latitude setting should not have to be adjusted again unless you move to a different viewing location some distance away.

- Loosen the Dec. lock knob and rotate the telescope optical tube until it is parallel with the R.A. axis, as it is for the photos on the cover. The pointer on the Dec. setting circle should read 90°. Retighten the Dec. lock knob.



**Figure 14.** Install the star diagonal in the drawtube collar of the Observer 90mm EQ, then place an eyepiece in the diagonal and secure it with the thumbscrew.



**Figure 15.** For the two reflector models, the eyepiece is inserted in the drawtube collar and tightened with the two thumbscrews.

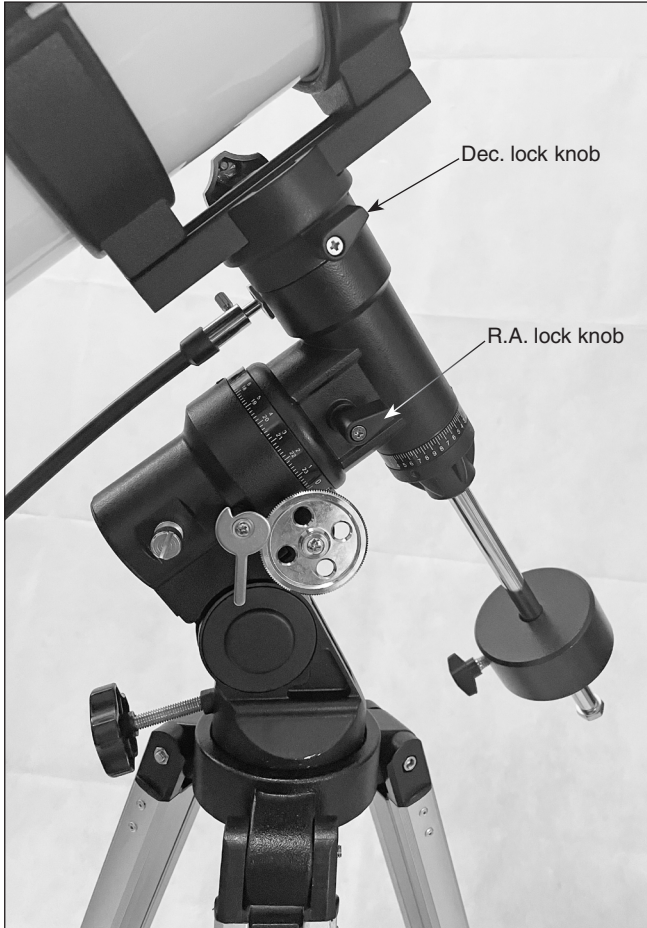
- Loosen the azimuth lock knob at the base of the equatorial mount (Figure 5) a half turn or so and rotate the mount so the R.A. axis points roughly at Polaris. If you cannot see Polaris directly from your observing site, consult a compass and rotate the mount so the telescope points North. Retighten the azimuth lock knob.

**The equatorial mount is now polar aligned. From this point on in your observing session, you should not make any further adjustments to the azimuth or the latitude of the mount, nor should you move the tripod. Doing so will ruin the polar alignment. The telescope should be moved only about its R.A. and Dec. axes.**

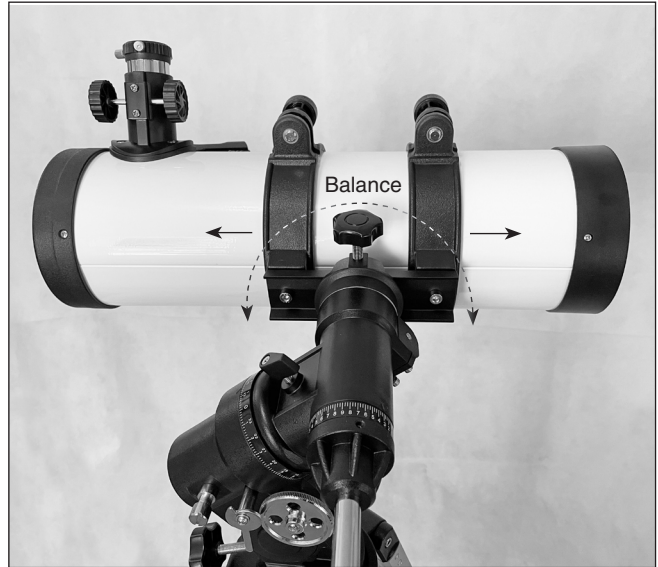
#### Using the R.A. and Dec. Slow-Motion Control Cables

The R.A. and Dec. slow-motion control cables allow fine adjustment of the telescope's position to center objects within the field of view. Before using the cables, manually "slew" the mount to





**Figure 16.** The R.A. and Dec. lock knobs.



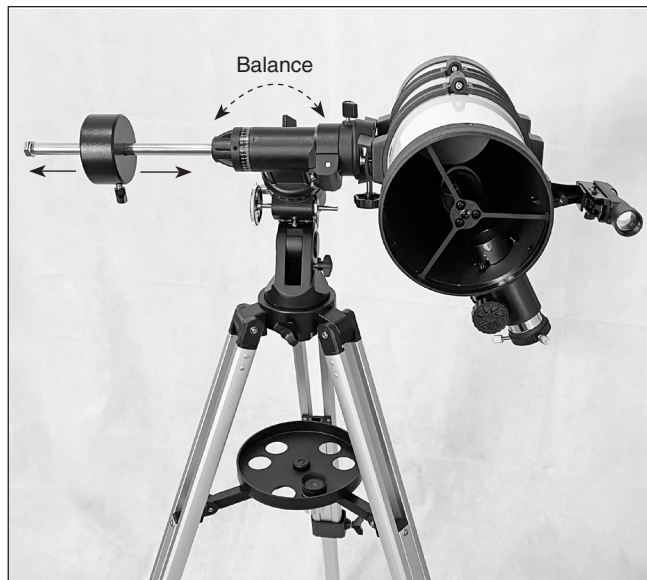
**Figure 18.** To balance the telescope in declination, loosen the Dec. lock knob and slide the dovetail mounting bar forward to back in the mount saddle and/or slide the optical tube in the tube rings until balance is achieved.

point the telescope in the vicinity of the desired target. Do this by loosening the R.A. and Dec. lock knobs (**Figure 16**) and moving the telescope about the mount's R.A. and Dec. axes. Once the telescope is pointed somewhere close to the object to be viewed, retighten the mount's R.A. and Dec. lock knobs.

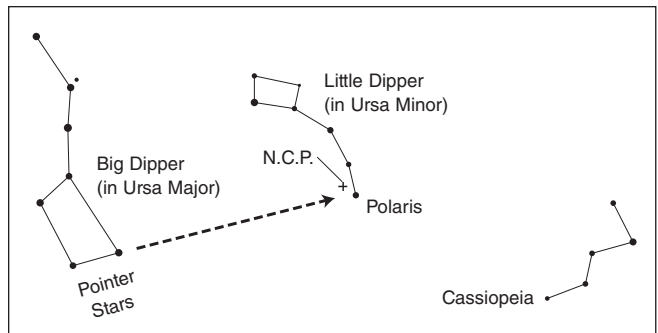
The object should now be visible somewhere in the field of view of the red dot finder scope. If it isn't, use the slow-motion controls to scan the surrounding area of sky. **Note: when using the slow motion cables, the R.A. and Dec lock knobs should be tightened, not loose.** When the object is visible in the finder scope, use the slow-motion controls to center the red dot on it. Now, look in the telescope's eyepiece and use the slow-motion controls to center it in the eyepiece.

### Tracking Celestial Objects

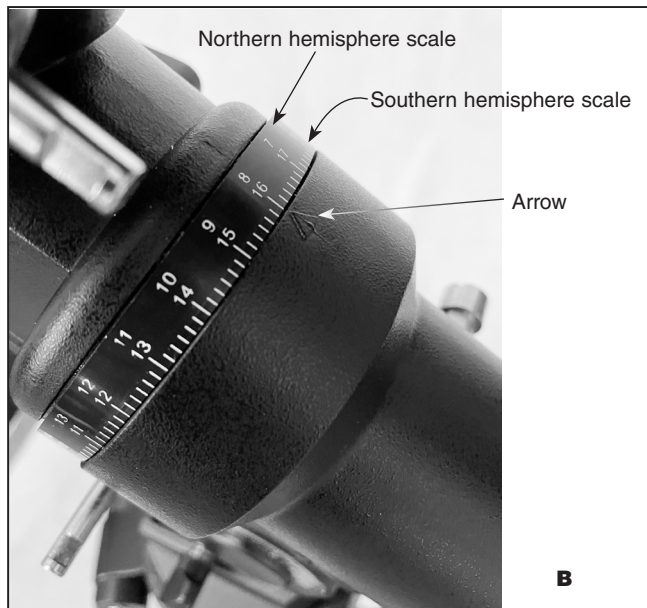
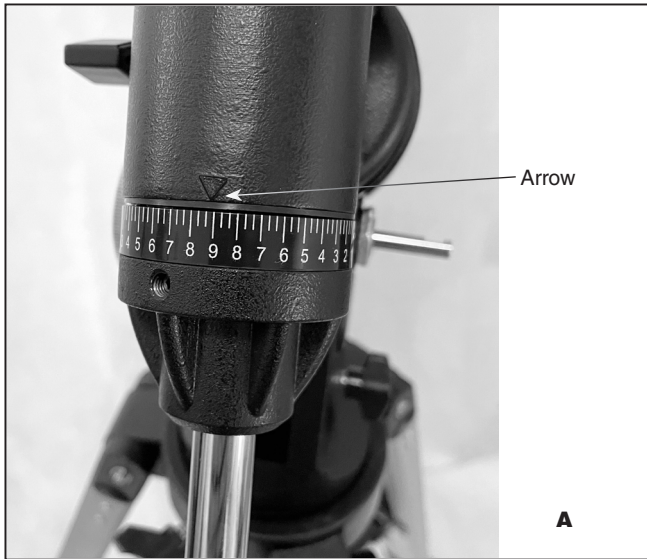
When you observe a celestial object through the telescope, you'll see it drift slowly across the field of view. To keep it in the field, assuming the equatorial mount is polar aligned, just turn the R.A.



**Figure 17.** To balance the telescope in right ascension, loosen the R.A. lock knob and slide the counterweight along the shaft until it counterbalances the optical tube.



**Figure 19.** To find Polaris in the night sky, look north and find the Big Dipper. Extend an imaginary line from the two "Pointer Stars" in the bowl of the Big Dipper. Go about five times the distance between those stars and you'll reach Polaris, which lies within 1° of the north celestial pole (NCP).



**Figure 20.** **A)** The declination setting circle. **B)** The right ascension setting circle.

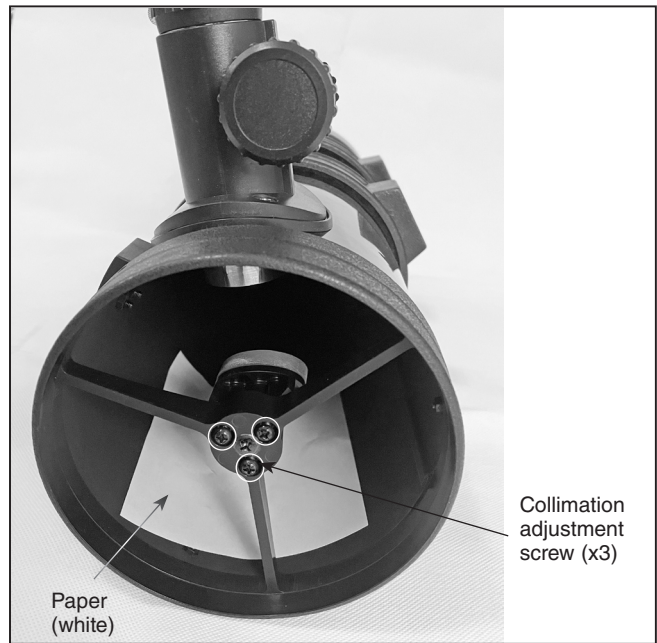
slow-motion control cable counterclockwise to track. The Dec. slow-motion control cable is not needed for tracking. Objects will appear to move faster at higher magnifications, because the field of view is narrower.

### Optional Electronic Drive for Automatic Tracking

An optional DC electronic drive can be mounted on the R.A. axis of the equatorial mount to provide hands-free tracking. Objects will then remain stationary in the field of view without any manual adjustment of the R.A. slow-motion control cable.

### Understanding the Setting Circles

The two setting circles (**Figure 20**) on an equatorial mount enable you to locate celestial objects by their “celestial coordinates”. Every object resides in a specific location on the “celestial sphere”. That location is denoted by two numbers: its right ascen-



**Figure 21.** Collimate the secondary mirror using the three screws on the secondary mirror “spider”. Place a piece of white paper inside the optical tube opposite the focuser during collimation.

sion (R.A.) and declination (Dec.). In the same way, every location on Earth can be described by its longitude and latitude. R.A. is similar to longitude on Earth, and Dec. is similar to latitude. The R.A. and Dec. values for celestial objects can be found in any star atlas or star catalog.

The mount’s R.A. setting circle is scaled in hours, from 1 through 24, with small marks in between representing 10-minute increments. The numbers at the base of the setting circle scale apply to the Southern Hemisphere while the numbers above them apply to viewing in the Northern Hemisphere.

The Dec. setting circle is denoted in degrees, with each main mark representing 10° increments (1 = 10°, 2 = 20°, etc.). Values of Dec. coordinates range from +90° to -90°. The 0° mark indicates the celestial equator. For this mount, the number scale goes to 90 on either side of 0 – there are no (+) or (-) signs. When the telescope is pointed north of the celestial equator, values of Dec. are positive, while when the telescope is pointed south of the celestial equator, values of Dec. are negative.

For example, the coordinates for the Orion Nebula (M42) are:

R.A. 5 hr 35.4 min, Dec. -5° 27'

That’s 5 hours and 35.4 minutes in right ascension, and -5 degrees and 27 arc-minutes in declination (there are 60 arc-minutes in 1 degree of declination).

Before you can use the setting circles to locate objects, the mount must be polar aligned, and the setting circles must be calibrated. The easiest way to calibrate the setting circles is to point the telescope at an identifiable bright star, center it in the eyepiece, then set the setting circles to the star’s published coordinates, which you can find in a star atlas or astronomical software program, or perhaps on the internet.



### Calibrating the Setting Circles

Using a star atlas or astronomy planetarium program, identify a bright star visible in your sky. Some smartphone apps allow you to hold your phone up to the sky and the app will identify the stars and constellations visible in the direction you're pointing to. Note the right ascension and declination coordinates of the star.

Let's take as an example Altair, in the constellation Aquila. Its coordinates are:

R.A. 19 hr 51 min, Dec 8° 52'

1. Loosen the R.A. and Dec. lock knobs on the equatorial mount, so the telescope optical tube can move freely.
2. Point the telescope at Altair. Lock the R.A. and Dec. lock knobs. Center the star in the eyepiece with the slow-motion control cables.
3. Rotate the R.A. setting circle until the metal arrow indicates 19 hr 51 min.
4. Then rotate the Dec. setting circle until the metal arrow indicates +8° 52'

### Finding Objects with the Setting Circles

Now that both setting circles are calibrated, look up the coordinates of an object you wish to view.

1. Loosen the R.A. lock knob and rotate the telescope until the R.A. value from the star atlas matches the reading on the R.A. setting circle. Remember to use the upper set of numbers on the R.A. setting circle. Retighten the lock knob.

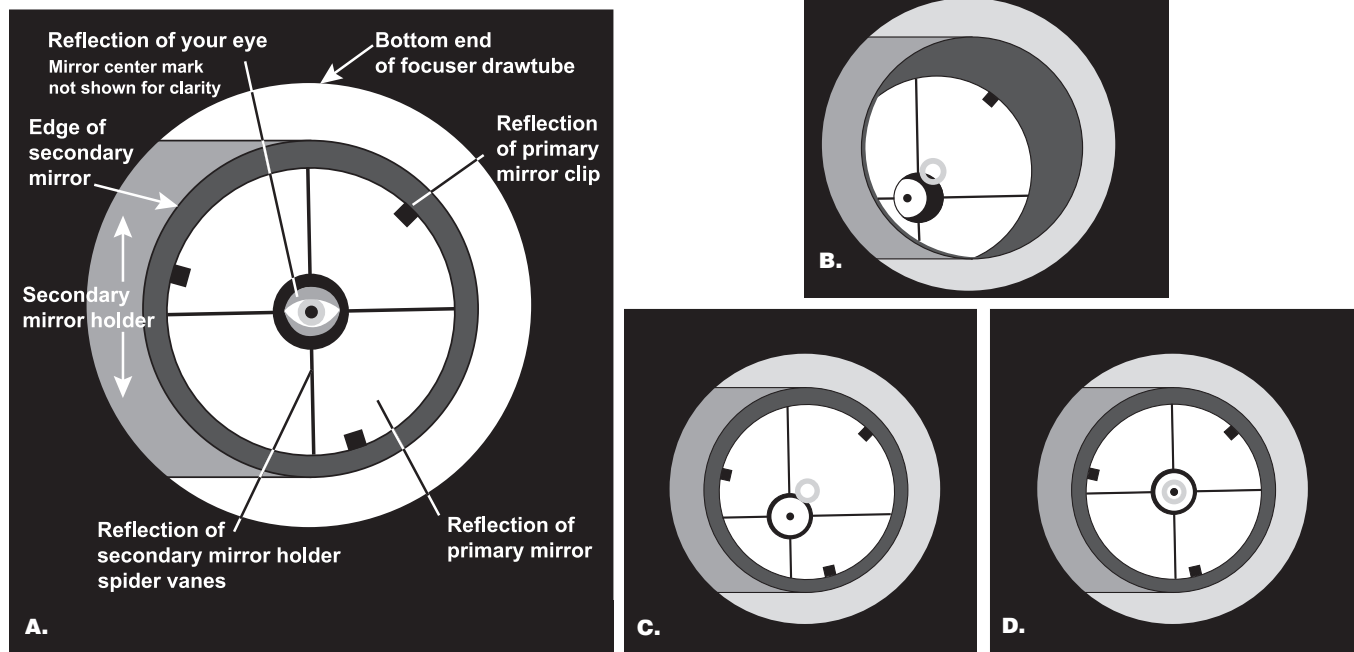
2. Loosen the Dec. lock knob and rotate the telescope until the Dec. value from the star atlas matches the reading on the Dec. setting circle. Remember that values of the Dec. setting circle are positive when the telescope is pointing north of the celestial equator (Dec. = 0°), and negative when the telescope is pointing south of the celestial equator. Retighten the lock knob.

Most setting circles are not accurate enough to put an object dead-center in the telescope's eyepiece, but they should place the object somewhere within or near the field of view of the finder scope, assuming the equatorial mount is accurately polar aligned. Use the slow-motion controls to center the object in the finder scope, and it should appear in the telescope's field of view.

The R.A. setting circle must be re-calibrated every time you wish to locate a new object. Do so by calibrating the setting circle for the centered object before moving on to the next one.

### Confused About Pointing the Telescope?

Beginners occasionally experience some confusion about how to point the telescope overhead or in other directions. One thing you DO NOT do is make any adjustment to the mount's latitude setting or to its azimuth position (don't touch the azimuth lock knob). That will throw off the mount's polar alignment. Once the mount is polar aligned, the telescope should be moved only about the R.A. and Dec. axes by loosening one or both of the R.A. and Dec. lock knobs and moving the telescope by hand, or keeping the knobs tightened and moving the telescope using the slow-motion cables.



**Figure 22.** Collimating the optics. **(A)** When the mirrors are properly aligned, the view down the focuser drawtube should look like this. **(B)** With the collimation cap in place, (with a collimation cap or Cheshire eyepiece in place). Here, only part of the primary mirror is visible in the secondary mirror, so the secondary mirror needs to be adjusted (tilted). **(C)** Here the secondary mirror is correctly aligned because the entire primary mirror is visible in it. But the reflection of the secondary mirror is off-center. So the primary mirror still needs adjustment. **(D)** Now the primary mirror is correctly aligned, so the secondary mirror is centered.

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## V. Astronomical Observing

For many, this will be your first foray into the exciting world of amateur astronomy. The following information and observing tips will help get you started.

### Choosing an Observing Site

When selecting a location for observing, get as far away as possible from direct artificial light such as street lights, porch lights, and automobile headlights. The glare from these lights will greatly impair your dark-adapted night vision. Set up on a grass or dirt surface, not asphalt, because asphalt radiates more heat. Heat disturbs the surrounding air and degrades the images seen through the telescope. Avoid viewing over rooftops and chimneys, as they often have warm air currents rising from them. Similarly, avoid observing from indoors through an open (or closed) window, because the temperature difference between the indoor and outdoor air will cause image blurring and distortion.

If at all possible, escape the light-polluted city sky and head for darker country skies. You'll be amazed at how many more stars and deep-sky objects are visible in a dark sky!

### “Seeing” and Transparency

Atmospheric conditions vary significantly from night to night. “Seeing” refers to the steadiness of the Earth's atmosphere at a given time. In conditions of poor seeing, atmospheric turbulence causes objects viewed through the telescope to “boil.” If you look up at the sky and stars are twinkling noticeably, the seeing is poor and you will be limited to viewing at lower magnifications. At higher magnifications, images will not focus clearly. Fine details on the planets and Moon will likely not be visible.

In conditions of good seeing, star twinkling is minimal and images appear steady in the eyepiece. Seeing is best overhead, worst at the horizon. Also, seeing generally gets better after midnight, when much of the heat absorbed by the Earth during the day has radiated off into space.

Especially important for observing faint objects is good “transparency”—air free of moisture, smoke, and dust. All tend to scatter light, which reduces an object's brightness. Transparency is judged by the magnitude of the faintest stars you can see with the unaided eye (5th or 6th magnitude is desirable).

### Cooling the Telescope

All optical instruments need time to reach “thermal equilibrium.” The bigger the instrument and the larger the temperature change, the more time is needed. Allow at least 30 minutes for your telescope to acclimate to the temperature outdoors before you start observing with it.

### Let Your Eyes Dark-Adapt

Don't expect to go from a lighted house into the darkness of the outdoors at night and immediately see faint nebulas, galaxies, and star clusters—or even very many stars, for that matter. Your eyes take about 30 minutes to reach perhaps 80% of their full dark-adapted sensitivity. As your eyes become dark-

adapted, more stars will glimmer into view and you'll be able to see fainter details in objects you view in your telescope.

To see what you're doing in the darkness, use a red-filtered flashlight rather than a white light. Red light does not spoil your eyes' dark adaptation like white light does. A flashlight with a red LED light is ideal. Beware, too, that nearby porch, streetlights, and car headlights will ruin your night vision.

### Eyepiece Selection

Magnification, or power, is determined by the focal length of the telescope and the focal length of the eyepiece being used. Therefore, by using eyepieces of different focal lengths, the resultant magnification can be varied. It is quite common for an observer to own five or more eyepieces to access a wide range of magnifications. This allows the observer to choose the best eyepiece to use depending on the object being viewed and viewing conditions. Your Observer EQ telescope comes with 25mm (M) and 10mm (N) Plossl eyepieces, which will suffice nicely to begin with. You can purchase additional eyepieces later if you wish to have more magnification options.

Magnification is calculated as follows:

Telescope Focal Length (mm) / Eyepiece Focal Length (mm) = Magnification

For example, the Observer 90mm EQ Refractor has a focal length of 900mm, which when used with the supplied 25mm eyepiece yields:

$$900\text{mm} / 25\text{mm} = 36\text{x}$$

The magnification provided by the 10mm eyepiece is:

$$900\text{mm} / 10\text{mm} = 90\text{x}$$

The maximum attainable magnification for a telescope is directly related to how much light it can gather. The larger the aperture, the more magnification is possible. In general, a figure of 50x per inch of aperture is the maximum attainable for most telescopes. Going beyond that will yield simply blurry, unsatisfactory views. The Observer 134mm EQ has an aperture of 134mm, or 5.3 inches, so the maximum magnification would be about 265x (5.3 x 50). This level of magnification assumes you have ideal atmospheric conditions for observing (which is seldom the case).

Keep in mind that as you increase magnification, the brightness of the object viewed will decrease; this is an inherent principle of the laws of physics and cannot be avoided. If magnification is doubled, an image appears four times dimmer. If magnification is tripled, image brightness is reduced by a factor of nine!

Start by centering the object you wish to see in the 25mm eyepiece. Then you may want to increase the magnification to get a closer view, by switching to the 10mm eyepiece. If the object is off-center (i.e., it is near the edge of the field of view) you will lose it when you increase magnification, since the field of view will be narrower with the higher-powered eyepiece. So make sure it is centered in the 25mm eyepiece before switching to the 10mm eyepiece.



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## Focusing the Telescope

To focus the telescope, turn the focus wheels (**Figures 14 and 15**) forward or back until you see your target object (e.g., stars, the Moon, etc.) in the eyepiece. Then make finer adjustments until the image is sharp. If you're having trouble achieving initial focus, rack the focuser drawtube all the way in using the focus wheels, then while looking into the eyepiece slowly turn the focus wheels so that the drawtube extends outward. Keep going until you see your target object come into focus. Note that when you change eyepieces you may have to adjust the focus a bit to get a sharp image with the newly inserted eyepiece.

## What to Expect

So what will you see with your telescope? You should be able to see bands on Jupiter, the rings of Saturn, craters on the Moon, the waxing and waning of Venus, and many bright deep-sky objects. Do not expect to see color as you do in NASA photos, since those are taken with long-exposure cameras and have "false color" added. Our eyes are not sensitive enough to see color in deep-sky objects except in a few of the brightest ones.

## Objects to Observe

Now that you are all set up and ready to go, what is there to look at in the night sky?

### A. The Moon

With its rocky surface, the Moon is one of the easiest and most interesting objects to view with your telescope. Lunar craters, maria, and even mountain ranges can all be clearly seen from a distance of 238,000 miles away! With its ever-changing phases, you'll get a new view of the Moon every night. The best time to observe our one and only natural satellite is during a partial phase, that is, when the Moon is not full. During partial phases, shadows are cast on the surface, which reveal more detail, especially right along the border between the dark and light portions of the disk (called the "terminator"). A full Moon is too bright and devoid of surface shadows to yield a pleasing view. Make sure to observe the Moon when it is well above the horizon to get the sharpest images.

Use an optional Moon filter to dim the Moon when it is very bright. It simply threads onto the bottom of the eyepieces (you must first remove the eyepiece from the focuser to attach a filter). You'll find that the Moon filter improves viewing comfort, and helps to bring out subtle features on the lunar surface.

### B. The Planets

The planets don't stay put like the stars, so to find them you should refer to the monthly star charts at [OrionTelescopes.com](http://OrionTelescopes.com), or to charts published monthly in *Astronomy*, *Sky & Telescope*, or other astronomy magazines. Venus, Mars, Jupiter, and Saturn are the brightest objects in the sky after the Sun and the Moon. Other planets may be visible but will likely appear star-like. Because planets are quite small in apparent size, optional higher-power eyepieces or a Barlow lens are recommended and often needed for detailed observations.

### B. The Sun

You can change your nighttime telescope into a daytime Sun viewer by installing an optional full-aperture solar filter over the front opening of the telescope. The primary attraction is sunspots, which change shape, appearance, and location daily. Sunspots are directly related to magnetic activity in the Sun. Many observers like to make drawings of sunspots to monitor how the Sun is changing from day to day.

**Important Note:** Do not look at the Sun with any optical instrument without a professionally made solar filter placed over the front aperture of your telescope, or permanent eye damage could result.

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### D. The Stars

Stars will appear like twinkling points of light. Even powerful telescopes cannot magnify stars to appear as more than a point of light. You can, however, enjoy the different colors of the stars and locate many pretty double and multiple stars. The famous "Double-Double" in the constellation Lyra and the gorgeous two-color double star Albireo in Cygnus are favorites. Defocusing a star slightly can help bring out its color.

### E. Deep-Sky Objects

Under dark skies, you can observe a wealth of fascinating deep-sky objects, including gaseous nebulas, open and globular star clusters, and different types of galaxies. Most deep-sky objects are very faint, so it is important you find an observing site well away from light pollution.

To find deep-sky objects with your telescope, you first need to become reasonably familiar with the night sky. Unless you know how to recognize the constellation Orion, for instance, you won't have much luck locating the Orion Nebula. A simple planisphere, or star wheel, can be a valuable tool for learning the constellations and seeing which ones are visible in the sky on a given night. Once you have identified a few constellations, a good star chart, atlas, or astronomy app will come in handy for helping locate interesting deep-sky objects to view within the constellations.

Do not expect these objects to appear like the photographs you see in books and on the internet; most will look like dim gray smudges. Our eyes are not sensitive enough to see color in deep-sky objects except in a few of the brightest ones. But as you become more experienced and your observing skills get sharper, you will be able to ferret out more and more subtle details and structure.

## VI. Collimation of Your Telescope's Optics

Collimation is the process of adjusting the optics of a telescope so they are precisely aligned with one another and with the telescope tube. Accurate collimation is important to ensure the peak performance of your telescope, so it should

be checked occasionally. With practice, collimating is relatively easy to do and can be done in daylight.

If you purchased the Observer 90mm EQ Refractor, your telescope's lens optics were collimated at the factory and will not need further adjustment. Reflector telescopes, on the other hand, need occasional optical collimation as the mirrors can come out of alignment.

It helps to perform the collimation procedure in a brightly lit room with the telescope pointed toward a bright surface, such as a light-colored wall. Placing a piece of white paper inside the telescope tube opposite the focuser (i.e., on the other side of the secondary mirror from the focuser) will also be helpful (**Figure 21**). You will need a Phillips screwdriver to adjust the mirrors.

To check your telescope's collimation, remove the eyepiece and look down the focuser. You should see the secondary mirror centered in the focuser, as well as the reflection of the primary mirror centered in the secondary mirror, and the reflection of the secondary mirror (and your eye) centered in the reflection of the primary mirror, as in **Figure 22A**. Got all that? Review it again carefully, and compare what you see to **Figure 22A**. If anything is off-center, proceed with the following collimation procedure.

**NOTE:** *Precise collimation is best achieved by using an optional collimating tool, such as a quick-collimation cap, a Cheshire eyepiece, or a laser collimator. Check our website for available collimating tools. Figures 22B through 22D assume that you have an optional Cheshire eyepiece or collimation cap in the focuser.*

### Primary Mirror Center Mark

You may have noticed that your Observer 114mm or 134mm Reflector has a small ring (sticker) in the exact center of the primary mirror. This "center mark" allows you to achieve a very precise collimation of the primary mirror; you don't have to guess where the center of the mirror is, which is important in the collimation process.

**NOTE:** *The center ring sticker should not be removed from the primary mirror. Because it lies directly in the shadow of the secondary mirror, its presence in no way adversely affects the optical performance of the telescope or the image quality. That might seem counter-intuitive, but it's true! Leave it in place.*

### Aligning the Secondary Mirror

Align the secondary mirror first. Look down the focuser at the secondary (diagonal) mirror. If the entire primary mirror reflection is not visible in the secondary mirror, as in **Figure 22B**, you will need to adjust the tilt of the secondary mirror. This is done by alternately loosening one of the three

secondary mirror alignment screws with a Phillips screwdriver then tightening the other two (**Figure 21**). The goal is to center the primary mirror reflection in the secondary mirror, as in **Figure 22C**. Don't worry that the reflection of the secondary mirror (the smallest circle) is off-center. You will fix that in the next step. It will take some trial and error to determine which screws to loosen and tighten to move the reflection of

the primary mirror to the center of the secondary mirror. But be patient and you'll get it.

### Aligning the Primary Mirror

The final adjustment is made to the primary mirror. It will need adjustment if, as in **Figure 22C**, the reflection of the primary mirror is centered in the secondary mirror, but the small reflection of the secondary mirror is off-center. The tilt of the primary mirror is adjusted using the three pairs of collimation knobs and lock screws on the back end of the optical tube (**Figure 23**). Each pair consists of a collimation knob and a small Phillips head lock screw.

First use the screwdriver to loosen the three lock screws a turn or so. Then tighten one of the collimation knobs about a quarter turn, then look down the focuser to see if the secondary mirror reflection has moved closer to the center of the primary. If it moved farther away then try loosening the same collimation knob a bit. Repeat this process on the other two sets of collimation screws, if necessary, adjusting them one way or the other and seeing if the secondary mirror reflection moves closer to the center of the primary mirror reflection. It will take a little trial and error to get a feel for how to tilt the mirror in this way. When the center hole in your collimating tool is centered as much as possible on the reflection of the adhesive dot on the primary mirror, your primary mirror is collimated. The view through the collimation cap should resemble **Figure 22D**. Then, very lightly tighten the three lock screws so that the primary mirror stays in that position. A simple star test will tell you whether the optics are accurately collimated.

### Star-Testing the Telescope

When it is dark, point the telescope at a bright star and accurately center it in the eyepiece's field of view. Slowly de-focus the image with the focusing knob. If the telescope is correctly collimated, the expanding disk should be a perfect circle (**Figure 24**). If the image is unsymmetrical, the scope is out

of collimation. The dark shadow cast by the secondary mirror should appear in the very center of the out-of-focus circle, like the hole in a donut. If the "hole" appears off-center, the telescope is out of collimation. If you try the star test and the bright star you have selected is not accurately centered in the eyepiece, the optics will always appear out of collimation, even though they may be perfectly aligned. It is critical to keep the star centered, so over time you will need to make slight corrections to the telescope's position in order to account for the sky's apparent motion.

## VII. Telescope Care and Maintenance

If you give your telescope reasonable care, it will last a lifetime. Store it in a clean, dry, dust free place, safe from rapid changes in temperature and humidity. Do not store the telescope outdoors, although storage in a garage or shed is OK. Small components like eyepieces and other accessories should be kept in a protective box or storage case. Keep the caps on the front of the telescope and on the focuser draw-tube when not in use.



## Cleaning the Telescope's Optics

### 1. Observer 90mm EQ Refractor

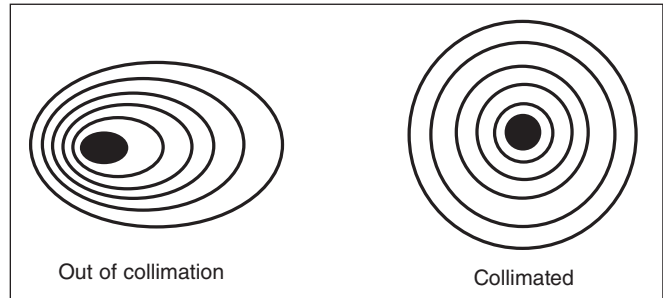
Any quality optical lens cleaning tissue and optical lens cleaning fluid specifically designed for coated optics can be used to clean the lenses of your telescope and eyepieces. Never use regular glass cleaner or cleaning fluid designed for eyeglasses. Before cleaning, remove any loose particles or dust from the lens with a blower bulb or soft brush. Then apply some cleaning fluid to a tissue, never directly on the optics. Wipe the lens gently in a circular motion, then remove any excess fluid with a fresh lens tissue. Oily fingerprints and smudges may be removed using this method. Use caution; rubbing too hard may scratch the lens. On larger lenses, clean only a small area at a time, using a fresh lens tissue on each area. Never reuse tissues.

### 2. Observer 114mm and 134mm EQ Reflectors

You really should not have to clean the telescope's mirrors. Covering the telescope with the dust cap when it is not in use will help prevent dust from accumulating on the mirrors. Even a little dust on the mirror surfaces will not affect the optical performance in any way. If you feel the mirrors need to be cleaned, please contact Orion Customer Service at 800-676-1343 for guidance.



**Figure 23.** The tilt of the primary mirror is adjusted using the three pairs of collimation knobs and lock screws on the back end of the optical tube.



**Figure 24.** A star test will determine if the telescope's optics are properly collimated.

## VIII. Useful Optional Accessories

- **Moon Filter** – A 1.25" Moon filter will cut down the strong glare of sunlight reflected from the Moon, making Moon viewing more comfortable and revealing more surface detail. The filter threads into the bottom of the eyepieces that came with your telescope.
- **Motor Drive** – A motor drive, which attaches to the right ascension axis of an equatorial telescope mount, enables your telescope to “track” the motion of stars and other celestial objects as they drift slowly from east to west in the night sky. This keeps them in the eyepiece field of view indefinitely, instead of drifting out of sight.
- **Barlow Lens** – A 2x Barlow lens doubles the magnifying power of any eyepiece it's used with, giving you a big power boost to get in closer to your target object. You just insert it between the diagonal and the eyepiece. An Orion Shorty Barlow lens is included with the Observer 90mm EQ Refractor.
- **Planisphere** – A nifty “star wheel” that shows what stars and constellations are visible in the sky at any time of any night. Just set the date and time see a mini representation of your local night sky. Great for identifying what you see and planning an evening's observing session.
- **Star Map** – More detailed than a planisphere, a star map is essential for locating interesting celestial objects to observe with your telescope. Nowadays many mobile astronomy apps feature customizable star maps that you can access on your smartphone or tablet while you're at the telescope.

When bringing the telescope inside after an evening's viewing it is normal for moisture to accumulate on the lenses and mirrors due to the change in temperature. We suggest leaving the telescope and eyepieces uncovered overnight to allow the condensation to evaporate.

## IX. Specifications

### Observer 90mm EQ Refractor

<b>Lens aperture:</b>	90mm (3.5")
<b>Lens assembly:</b>	Achromatic doublet
<b>Lens coating:</b>	Fully MgF2 coated
<b>Focal length:</b>	900mm
<b>Focal ratio:</b>	f/10
<b>Focuser:</b>	Rack-and-pinion, accepts 1.25" accessories
<b>Eyepieces:</b>	25mm and 10mm Plossl, fully coated, 1.25" barrel diameter, threaded for Orion filters
<b>Eyepiece magnification:</b>	36x (25mm eyepiece) and 90x (10mm eyepiece)
<b>Barlow lens:</b>	Shorty 2x, 1.25"
<b>Finder scope:</b>	6x30 achromatic
<b>Diagonal:</b>	90-degree mirror star diagonal
<b>Mount:</b>	German equatorial
<b>Tripod:</b>	Aluminum
<b>Total instrument weight:</b>	16 lbs., 12.2 oz.

### Observer 114mm EQ Reflector

<b>Primary mirror diameter:</b>	114mm (4.5")
<b>Primary mirror coating:</b>	Aluminum with silicon dioxide (SiO <sub>2</sub> ) overcoat
<b>Secondary mirror minor axis dia.:</b>	35.2mm
<b>Central obstruction</b>	37.4mm
<b>Focal length:</b>	500mm
<b>Focal ratio:</b>	f/4.4
<b>Focuser:</b>	Rack-and-pinion, accepts 1.25" accessories
<b>Eyepieces:</b>	25mm and 10mm Plossl, fully coated, 1.25" barrel diameter, threaded for Orion filters
<b>Eyepiece magnification:</b>	20x (25mm eyepiece) and 50x (10mm eyepiece)
<b>Finder scope:</b>	Red dot finder scope
<b>Mount:</b>	German equatorial
<b>Tripod:</b>	Aluminum
<b>Total instrument weight:</b>	16 lbs., 1.5 oz.

### Observer 134mm EQ Reflector

<b>Primary mirror diameter:</b>	134mm (5.3")
<b>Primary mirror coating:</b>	Aluminum with silicon dioxide (SiO <sub>2</sub> ) overcoat
<b>Secondary mirror minor axis dia.:</b>	43mm
<b>Central obstruction</b>	39.8mm
<b>Focal length:</b>	650mm
<b>Focal ratio:</b>	f/4.8
<b>Focuser:</b>	Rack-and-pinion, accepts 1.25" accessories
<b>Eyepieces:</b>	25mm and 10mm Plossl, fully coated, 1.25" barrel diameter, threaded for Orion filters
<b>Eyepiece magnification:</b>	26x (25mm eyepiece) and 65x (10mm eyepiece)
<b>Finder scope:</b>	6x30 achromatic
<b>Mount:</b>	German equatorial
<b>Tripod:</b>	Aluminum
<b>Total instrument weight:</b>	18 lbs., 4.3 oz.

## One-Year Limited Warranty

This Orion product is warranted against defects in materials or workmanship for a period of one year from the date of purchase. This warranty is for the benefit of the original retail purchaser only. During this warranty period Orion Telescopes & Binoculars will repair or replace, at Orion's option, any warranted instrument that proves to be defective, provided it is returned postage paid. Proof of purchase (such as a copy of the original receipt) is required. This warranty is only valid in the country of purchase.

This warranty does not apply if, in Orion's judgment, the instrument has been abused, mishandled, or modified, nor does it apply to normal wear and tear. This warranty gives you specific legal rights. It is not intended to remove or restrict your other legal rights under applicable local consumer law; your state or national statutory consumer rights governing the sale of consumer goods remain fully applicable.

For further warranty information, please visit [www.OrionTelescopes.com/warranty](http://www.OrionTelescopes.com/warranty).



**Corporate Offices:** 89 Hangar Way, Watsonville CA 95076 - USA  
**Toll Free USA & Canada:** (800) 447-1001  
**International:** +1(831) 763-7000  
**Customer Support:** [support@telescope.com](mailto:support@telescope.com)

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