POLAREX · UNITRON ASTRONOMICAL TELESCOPES

INSTRUCTIONS

POLAREX Equatorial Refractors

PART I: INTRODUCTION

A telescope with an equatorial mounting offers the observer many features not available on the simpler altazimuth models. The advantages of the equatorial mounting result from its ability to be oriented parallel to the earth's axis of rotation. Once the mounting has been oriented, objects can be tracked with one motion only as they revolve about the polar axis; two motions are required for an altazimuth mounting. By using a single control knob, the observer can follow the celestial object in a completely straightforward manner, without danger of "losing" it. Furthermore, since the objects move at a uniform rate, this one motion, the right ascension, can be operated by a clock drive, leaving the operator completely free to concentrate on his observations.

Movements of the mounting correspond to the grid lines normally employed on star charts. These grid lines divide the sky in declination and right ascension in the same manner that latitude and longitude is used on the surface of the earth. Setting circles on the equatorial mounting are provided for both declination and right ascension. Just as the position of a feature on the earth's surface can be specifically located, in terms of latitude and longitude, so can a celestial object be positioned in the sky, in terms of declination and right ascension. This means that objects not familiar to the observer can easily be located by consulting a star chart or ephemeris which will provide the declination and right ascension. This data can then be applied to the setting circles for the time of observation and the telescope pointed toward the object with a considerable degree of accuracy. The advantages of the equatorial mounting render it highly desirable for visual observation and a MUST for astro photography.

In the instructions which follow, detailed information is given on the use of the setting circles and on aligning the telescope with the high degree of precision needed to insure most accurate readings. However, if you are a beginner, do not be misled into thinking that you must understand all of these complexities before enjoying the use of your POLAREX Equatorial Refractor. By making a rough adjustment with respect to the North Star Polaris in the Northern hemisphere or any substitute in the Southern hemisphere, you can enjoy the convenience of single-knob tracking: later, as your interest and skill developes, you can use the setting circles to locate celestial objects which are not readily apparent.

Although there are many variations of equatorial mountings available, they all consist of two axes, positioned at right angles to each other. POLAREX refractors are equipped with the German-style mounting which is the most common type and is noted for its adaptability to portable instruments and ease of operation.

Although the apparent movement of the stars, from east to west, results from the revolution of the earth, it is, perhaps, an easier concept for observers previously unfamiliar with the equatorial mounting to visualize the earth as being a fixed point, and the stars as objects fixed on a celestial sphere which revolves approximately once every 24 hours about the earth's axis. A major portion of these instructions will be devoted to the proper orientation and use of the equatorial mounting.

> CAUTION: As in the case of any precision instrument, certain skills and equipment are employed in the assembly of POLAREX refractors that are generally not available to the amateur observer. We advise the user against attempting any disassembly or adjustment of the objective, eyepieces, or mounting. If, at any time, your instrument requires servicing beyond the maintenance described in these instructions, please communicate with our agent in your country.

PACKING: The major components of all equatorial models are shipped in three separate wooden cabinets as follows: Optics Cabinet - contains the refractor with eyepieces, sun glass, dewcap, dustcap, cradle, sunscreen apparatus, star diagonal and erecting prism system. Mounting cabinet - contains the equatorial mounting with control rods, counterweight rod, counterweight and the flexible cable. Tripod Cabinet - contains the tripod legs. For the Model 128, a 3-piece flat bar assembly is included with the legs for holding the legs in position when the instrument is set up. For 3" and 4" models, a tripod shelf is provided in a separate carton.

NOTE: References to illustrations are in brackets. The Figure number is given first followed by the item number.

PART II: ASSEMBLY

1. ATTACHING THE TRIPOD LEGS: Attach the tripod legs (1-1) to the base of the mounting by using the tripod leg bolts (1-2) packed with the tripod legs. Attach the spreader bar (Model 128) or shelf (3" and 4" models) at the mid-point of the legs to hold the tripod legs in position.

2. INSTALLING THE CONTROL RODS:

A) Declination fast motion clamp rod (1-3): this rod is identified by the 3-pronged handle. It locks the telescope on the declination axis. When loosened, it permits major changes in the position of the telescope tube, in declination. In some models a shipping bolt must be removed to permit insertion of this rod.

B) Declination slow motion control rod (1-4): this rod is identified by the round knob and fine thread. The rod should be screwed into a point where turning the rod causes a movement of the cradle around the declination axis. For this rod to act upon the cradle, the declination fast motion clamp must be tightened. This control permits the fine adjustments to be made in declination, while observing.

C) Right ascension fast motion clamp (1-7): this clamp locks the telescope on the polar axis (1-9). It should be kept tightened except when making major changes in right ascension.

D) Auxiliary right ascension control rod (1-8): screw this rod in until it causes a movement of the mounting around the polar axis. The right ascension fast motion clamp must be tight in order for this control to operate properly. This control is used to make fine adjustment in right ascension when a synchronous motor drive is being used with the telescope. (Ordinarily, the right ascension control knob (1-10) would be used for this purpose, but the installation of a synchronous motor drive eliminates the right ascension control knob as a means of manual control. Manual adjustments can then be accomplished with the auxiliary right ascension control rod.)

E) Flexible cable (1-11): this is provided to extend the right ascension control to a comfortable position for manual tracking while viewing through the telescope. It may be used on either side of the instrument by inserting it into the recessed center of the right ascension control knob (1-10) and tightening the thumbscrew. If a synchronous motor is installed on any of the equatorial mountings, then the flexible cable should be removed as it will create an uneven drag on the motor.

F) For Photo-Equatorial models (refer to Fig. 2): An added feature on these models is the dual clamping system on the polar axis. In addition to the auxiliary right ascension control rod and the fast motion clamp (2-3), a short wing screw (2-2) is provided. The observer will find that the auxiliary control (2-1) is sometimes difficult to reach when the telescope is pointed in certain directions. By loosening both the clamp screws (2-2) and (2-3) simultaneously, the entire clamping collar may be repositioned about the polar axis. Loosening either clamp individually will permit fast motion about the polar axis.

3. COUNTERBALANCE:

A) Counterweight rod (1-12): screw the end of the rod containing the hexagonal stop nut into the recess at the end of the declination shaft until the stop nut seats against the face of the shaft.

B) Counterweight (1-13): for 2.4" and 3" models, the counterweight threads onto the counterweight rod. In 4" models, the counterweight slides onto the shaft and is held in place by two hexagonal nuts which are screwed down against opposite sides of the weight.

4. OPTICS:

A) Install the refractor tube (1-15) on the mounting by removing the cradle nuts (1-14) and inserting the bolts through the holes on the flat bar at the upper end of the declination axis. Replace and tighten these nuts. Hand tightness is sufficient. The use of pliers may damage the nuts.

B) Viewfinder (1-16): on the 2.4" and 3" models, the viewfinder is shipped mounted in the brackets on the main tube. On 4" models, the viewfinder is in a separate cardboard carton in the optics cabinet and must be slid into the brackets after backing out all six collimating screws (1-17) to obtain clearance.

C) Dustcap and Dewcap: the dustcap slides over the end of the dewcap. The dewcap slides over the objective lens on the 2.4" model. On the 3" and 4" models, the dewcap screws onto the outer cell over the objective lens.

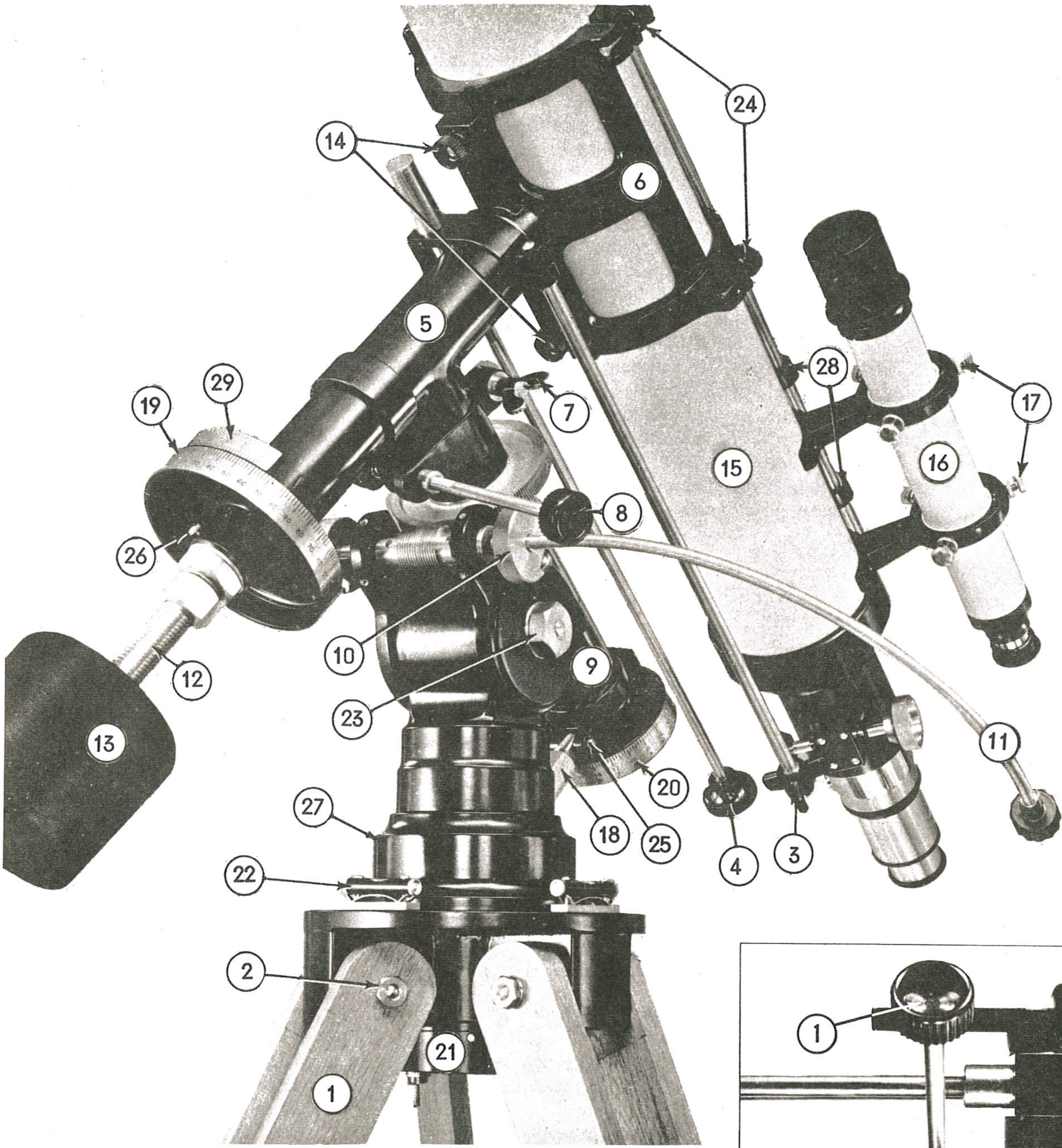


Fig. 1: POLAREX Equatorial Refractor

1. Tripod legs
2. Tripod leg bolt
3. Declination fast motion clamp rod
4. Declination slow motion control rod
5. Declination axis
6. Cradle
7. Right ascension fast motion clamp
8. Auxiliary right ascension control rod
9. Polar axis
10. Right ascension control knob
11. Flexible cable
12. Counterweight rod
13. Counterweight
14. Cradle nuts
15. Refractor tube
16. Viewfinder
17. Viewfinder collimating screws
18. Latitude screw
19. Declination circle
20. Right ascension or hour circle
21. Shelf light (4" models only)
22. Tripod level vials (4" only)
23. Trunnion nuts
24. Cradle clamp nuts
25. Latitude screw retaining bolt
26. Lock screw - declination circle
27. Azimuth locking screw (not visible in Fig.1)
28. Sun screen brackets
29. Vernier for declination circle

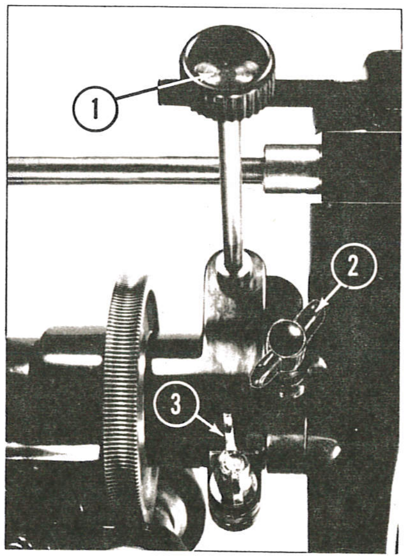
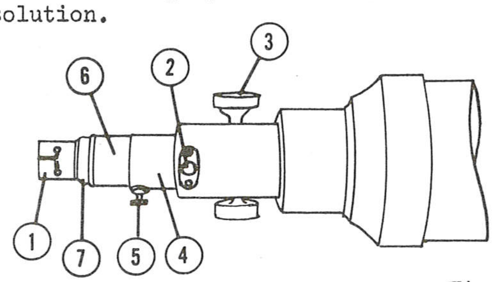


Fig. 2: Right Ascension Controls of Photo-Equatorial Models

1. Auxiliary right ascension slow motion control knob.
2. Right ascension fast motion control (auxiliary)
3. Right ascension fast motion clamp

PART III: OPERATION OF OPTICAL SYSTEM

1.) FOCUSING: The 2.4" and 3" models are equipped with the Standard rack and pinion focusing mechanism, unless the Deluxe rack and pinion was specified in the order. The 4" models are equipped with the Deluxe rack and pinion. Focusing procedures are mostly same, but the Deluxe rack and pinion has locking screws (3-2 and 3-5) which must be loosened during focusing and then may be tightened to prevent accidental movement of the mechanism. If the observer is unfamiliar with high powered telescopes, it is desirable to practice focusing the instrument during daylight on a distant object. Select a low power eyepiece and insert it in the end of the eyepiece holder (3-1). The magnification, or power, will be determined by dividing the focal length of the eyepiece into the focal length of the objective. The focal length of the eyepiece, in millimeters, is shown on the top of each eyepiece. The focal lengths of objectives are as follows: 2.4" refractor - 900mm; 3" refractor - 1200mm; 4" refractor - 1500mm. To obtain an approximate focus, loosen the fine focus locking screw (3-2) and by turning the fine focus knobs (3-3) move the fine focusing sleeve (3-4) until it is approximately at the center of its total travel. Next, loosen the coarse focus locking screw (3-5) and while sighting through the eyepiece, slowly pull out the drawtube (3-6) until the distant object is as close as possible to being in focus. A sharp focus can then be obtained by adjusting the fine focus knobs (3-3) in the appropriate direction. As eyepieces are changed, a minor adjustment in fine focus will be necessary to achieve maximum resolution.

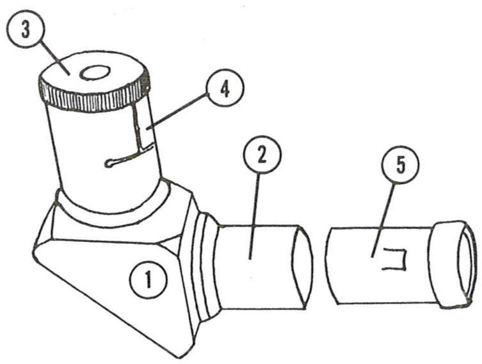


1. Eyepiece holder
2. Fine focus lock (not on standard R & P)
3. Fine focus knob
4. Fine focus sleeve
5. Coarse focus lock (not on standard R & P)
6. Drawtube (coarse focus)
7. Eyepiece holder collar

Fig. 3

The Deluxe model rack and pinion has a drawtube with reversible eyepiece holder. The eyepiece holder collar (3-7) can be unscrewed and reversed 180° to provide a 1-1/4" eyepiece holder. Super rack and pinion available as an extra accessory features a double drawtube. The inner drawtube is the same type used in the Deluxe rack and pinion while the outer drawtube, of approximately 58mm diameter, permits use of the Super rack and pinion and 60mm widefield eyepiece. POLAREX Photo-Equatorial Models are equipped with this Super rack and pinion.

2) STAR DIAGONAL & ACHROMATIC AMPLIFIER (Barlow Lens): (Refer to Fig. 4) The star diagonal (4-1) permits comfortable viewing regardless of the position of the telescope tube. It is for astronomical observation only, as the image viewed when using a star diagonal will be upright, but reversed from right to left. To use the star diagonal, insert the chrome tube without slot (4-2) into the eyepiece holder of the rack and pinion. An eyepiece (4-3) is inserted into the eyepiece holder (4-4) of the star diagonal. The telescope is then focused using the same procedure previously outlined. An Achromatic Amplifier (4-5) is a two-element Barlow-type negative amplifying lens. It is located in the drawtube end of the star diagonal and looks like an eyepiece, but without marking. It will double the magnification of any eyepiece with which it is used. The Amplifier will provide the higher magnifications desired for lunar and planetary observations.

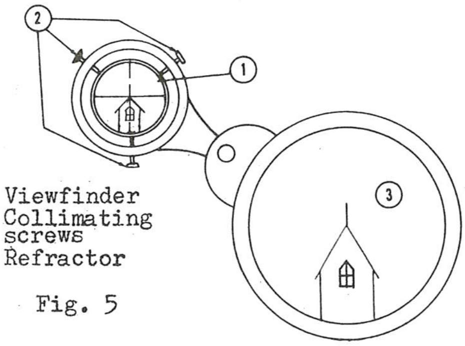


1. Star diagonal
2. Chrome tube without slot
3. Eyepiece
4. Eyepiece holder
5. Achromatic Amplifier

Fig. 4

Use of the Amplifier will, of course, reduce the field and the light passing through the instrument. Consequently, the Amplifier is most useful on bright objects under good "seeing" conditions. The Amplifier has a friction fit in the star diagonal and can be removed or replaced, as desired by the observer.

3) VIEWFINDER: (Refer to Fig. 5) The viewfinder (5-1) is a low power, widefield telescope which aids in locating objects to be viewed with the main telescope. It is focused by moving the eyepiece in or out of the drawtube. The eyepiece has built-in crosshairs which permit an object to be centered in the field of view. Before the viewfinder can be used effectively, its optical axis must be carefully aligned with the optical axis of the main telescope. During daylight hours, select a well defined, distant object, such as a church steeple or flagpole. Using a low power eyepiece center the object in the field of the refractor, as shown in (5-3). By using the collimating screws (5-2) in the viewfinder mounting brackets, move the viewfinder within the brackets until the object is centered in the crosshairs. The optical axes are now close to being parallel. To improve this adjustment, select a well-defined celestial object, such as a prominent star as near as you can find to the North Pole or South Pole and repeat the procedure outlined for daylight alignment. Polaris is an excellent choice for accurate alignment of the viewfinder after the star has been placed in the center of the main refractor field. If you are in the Southern hemisphere it could be α Crucis.



1. Viewfinder
2. Collimating screws
3. Refractor

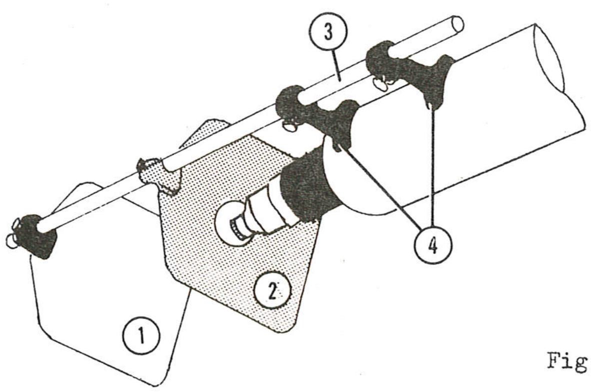
Fig. 5

4) SUNGLASS: A sunglass is included with all POLAREX refractors. It is attached to the top of one of the eyepieces, usually the 12.5mm. It can be removed by loosening the thumbscrew and transferred to the eyepiece of your choice.

CAUTION

Extreme care must be exercised when using the sunglass. The high magnifications employed in astronomical telescopes produce a concentration of heat at the eyepiece sufficient to crack the sunglass if the telescope is pointed at the sun for longer than a brief period of time. SEVERE EYE DAMAGE CAN RESULT IF THIS OCCURS. When viewing, the instrument should be turned away from the sun at frequent intervals. The viewfinder should be covered to prevent accidental exposure of the naked eye to the sun's rays passing through the viewfinder.
When viewing the sun it is recommended that a solar aperture diaphragm be used in front of the objective. If it is not included in your refractor, it can be obtained as an extra accessory. It is similar in appearance to the dustcap but has a small hole located in the center. Use of the aperture diaphragm reduces the amount of light passing through the instrument. Even when using the solar aperture diaphragm, however, the instrument can be pointed directly toward the sun only for brief periods of time if damage to the sunglass is to be prevented. A safer method of direct viewing involves the use of a Herschel Solar Wedge, available as an extra accessory. The Solar Wedge is similar in appearance to a star diagonal but has a small hinged door which, when opened, permits dissipation of most of the sun's heat before it reaches the eyepiece. The Solar Wedge is used in combination with the sunglass.

5) SUNSCREEN: The safest method of viewing the sun requires the use of a sun projecting screen apparatus, which is included with all equatorial models. When sun projection screens are used, the sun's image is projected on a white metal screen, where it may be viewed safely with the naked eye. This method also has the advantage of permitting several persons to view the projected image simultaneously. Attach the brackets (6-4) to the refractor tube, through the use of the thumbscrews provided in the tube. The rod is inserted through the brackets and the screens locked on the rod. The black screen with the hole in the center is used as a shade to prevent the direct rays of the sun from striking the white screen and "washing out" the image of the sun projected through the telescope. The size of the projected image can be regulated by moving the white screen along the rod. The sun's image can be sharply focused by use of the drawtube and rack and pinion mechanism.



1. Sunscreen (White screen)
2. Shade (Black screen)
3. Sunscreen rod
4. Sunscreen brackets

Fig. 6

SEPARATE INSTRUCTIONS: For the following components and accessories refer to Separate Instructions.

* Weight Driven Clock Drive
* Motor Driven Clock Drive
* Astro-Camera
* Guide Telescope
* 60mm Eyepiece
* Rotary Eyepiece Holder
* Double Eyepiece Holder

PART IV: ORIENTATION OF THE MOUNTING

The accuracy with which a good equatorial mounting performs is a reflection of the accuracy with which it was oriented and balanced. If the instrument remains set up in one location, then it will be necessary to orient one time only. If it is taken down between observing periods, then, with the exception of the latitude adjustment, the remaining orienting procedure will have to be repeated each time the instrument is set up. Although the procedure may appear to be involved the first time that it is performed, you will find that orientation requires only a short time once you become familiar with the operation of the mounting. A small inexpensive hand level should be acquired to facilitate leveling and orienting the mounting.

1) LEVELING: Level the mounting by reference to the level vials provided on the 4" models (1-22) or by using the hand level on smaller models, placing it on the flat surface of the tripod head. On soft ground, the tripod legs may be pressed into the ground to achieve a level position. On hard surfaces, shims of plywood, masonite, or cardboard, can be used to raise the tripod in the appropriate direction to obtain a level position.

2) BALANCING:

a) Loosen the right ascension fast motion clamp (1-7) and place the declination axis in a horizontal position. Move the counterweight (1-13) in and out along the counterweight rod (1-12) until the declination axis remains balanced in the horizontal position, unsupported.

b) With the declination axis balanced and locked in the horizontal position loosen the declination locking rod (1-3) and rotate the telescope tube (1-15) to a horizontal position. Loosen the cradle locking screw (1-24) and slide the tube, in the cradle, as necessary to permit balancing. The addition of certain accessories, such as the Astro-Camera, may necessitate the use of auxiliary equipment for balancing the tube. A balance weight assembly is available at an extra cost if your model does not include it as a standard component.

Note: It will be found, while observing, that the telescope may seem to be out of balance in certain viewing positions. This results from a displacement of the center of gravity and minor adjustments of the counterweight and tube position should be made, as necessary. Proper balance is especially important for smooth operation when the synchronous motor drive is used with the mounting. Even for manual operation of the mounting proper balance will reduce gear wear and eliminate "chatter".

3) LATITUDE ADJUSTMENT: The polar axis (1-9) must be inclined to the horizontal plane at an angle equal to the observer's latitude. Your latitude can be determined with sufficient accuracy from any good atlas or topographic map. Cut a triangle out of a piece of cardboard with one angle equal to your latitude. Position the triangle on the polar axis, as shown in Fig. 7 and place the hand level on the upper edge of the cardboard. Turn the latitude screw (1-18) until the hand level bubble is centered. The cardboard triangle can be eliminated if a direct angle reading level is used. Caution: Do not loosen or tighten the trunnion nuts (1-23) during this adjustment as these are adjusted at the factory. Over-tightening these will result in damage to the main gears of the mounting. The latitude adjustment is permanent as long as the observer's location remains the same or the latitude screw is not disturbed.

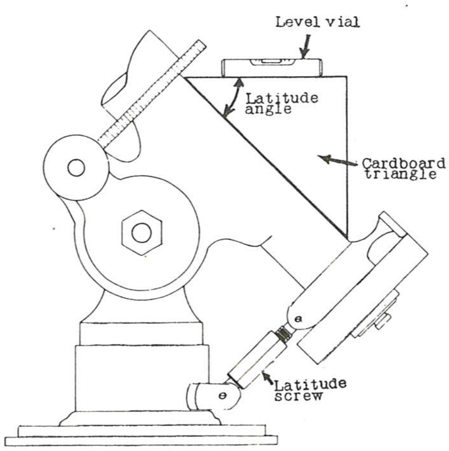


Fig. 7

At the time your instrument is shipped, we check your location and a latitude screw is provided whose range will permit proper setting for your location. If you may find that a latitude screw will not provide as much adjustment in one direction, or the other, as you may desire, return the latitude screw to our agent, indicating the latitude at which you are observing. We will forward through the agent a replacement screw whose mid-range will be approximately equivalent to your latitude. Also, if you move to a new location where the latitude is not within the tolerance of the screw originally provided with your instrument, new latitude screws can be obtained at an extra cost. When ordering, please be sure to include the latitude of your new location and the model number of your instrument.

4) SETTING CIRCLES: Before proceeding further with the orientation of the mounting, it is necessary that you understand how to read and adjust the setting circles. All POLAREX equatorial mountings are provided with setting circles for both declination and right ascension. Since they are graduated differently, we will discuss them separately.

a) Declination Circles: Declination is measured in degrees, minutes, and seconds of arc. Declination corresponds to latitude on earth and is a measure of the angular distance that a celestial body lies north or south of the celestial equator. Declination is measured from 0° at the celestial equator to +90° at the north celestial pole, and from 0° at the celestial equator to a -90° at the south celestial pole. Since most positions on earth permit the observation of some celestial bodies both above and below the equator, the declination circle (1-19) is graduated from 0° to 90° in both directions.

b) Hour Circles: The hour circle is used to set the local hour angle of a celestial body on the telescope mounting. The hour circle is graduated in hours, minutes and seconds of arc since the local hour angle (and right ascension from which it is derived) is measured in these terms. Right ascension for a celestial body is obtained from a star chart or ephemeris. The right ascension is a measurement on the celestial sphere that corresponds to longitude on the earth's surface. By comparing the right ascension of an astronomical body with the observer's longitude the local hour angle may be determined. The local hour angle is the angular distance between the observer's meridian and the body, measured east or west. It is the local hour angle which is actually used in orienting the telescope. This will be discussed, in detail, in a later paragraph.

5) READING THE SETTING CIRCLES: 2.4" Models - On the 2.4" equatorial mounting the setting circles are read through the use of a fixed index. The declination circle is divided into 2° divisions and can be read to an accuracy of approximately 30 minutes with the index, as illustrated in Fig. 8. The hour circle is graduated into ten minute divisions and can be read to approximately 3' with the index as shown in Fig. 8.

Declination = 78°30'

Hour Circle reading
= upper scale 17^h33^m
lower scale 6^h27^m

Fig. 8

3" and 4" Models - The setting circles on the 3" mountings are graduated into 2° increments in declination and 10" increments on the hour circle, just as they are on the 2.4" mountings. They are read, however, to a greater degree of accuracy through the use of verniers. Verniers (1-29) are short, graduated scales which replace the single index used on the 2.4" mounting.

Fig. 9 & 10 show sections of the declination circle with vernier scales. Examining the figures, note that there is only one line on the vernier and one line on the main circle which are in coincidence. Examine the setting circle on your instrument and you will find that for any position of the main circle, only one line will be in coincidence with a graduation on the vernier. The value, in arc, of the entire vernier scale is equal to the value in arc between adjacent graduations on the main scale. Since each graduation of the main scale equals 2°, the total length of the vernier is 120' or 2°. The vernier is numbered in both directions from 0' to 120'. The examples in Fig. 9 & 10 illustrate how to determine which set of numbers should be referred to.

Example 1 (Fig. 9). The leftmost line of the vernier is used to determine the main scale reading. In Fig. 9 it falls between 0° and 2°. Referring to the vernier scale, numbered in the same direction as the main scale, coincidence occurs at 90'. Therefore the total declination reading is 1°30' (0° plus 90' = 1°30').

Example 2 (Fig. 10). The leftmost line of the vernier indicates a reading between 32° and 34°. The vernier is read from right to left (to agree with main scale readings) as 35'. The complete declination reading, then, is 32°35' (32° plus 35').

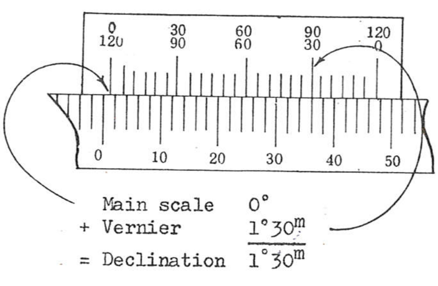


Fig. 9

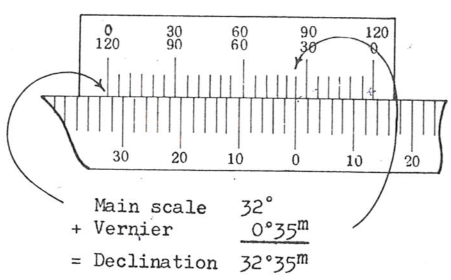
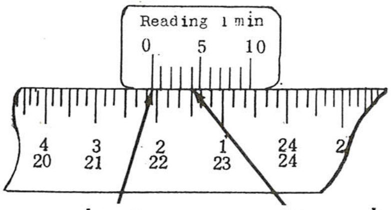


Fig. 10

The Hour Circle (1-20) is graduated in hours and minutes from 0^h to 24^h in two scales, one clockwise and the other counter clockwise. The scale to be used depends upon whether the object observed lies east or west of the observer's meridian. This will be discussed in greater detail later in the instructions. To read the circle, refer to Fig. 11.



Upper 2^h00^m + 06^m = 2^h06^m

Lower 21^h50^m + 04^m = 21^h54^m

Fig. 11

If the lower scale is being used the 0 line of the vernier would indicate a reading between 21^h50^m and 22^h00^m. By examining the lines of the vernier from <u>left</u> to <u>right</u>, the 04^m is coincident with a line of the main scale.

If the upper scale is being used the 0 line of the vernier would indicate a reading between 2^h00^m and 2^h10^m. By examining the lines of the vernier from <u>right</u> to <u>left</u> (the right most graduation would be considered as 0 and the left most line as 10) the 6^m line is coincident with a line on the main scale.

6) <u>ALIGNMENT OF POLAR AXIS AND ORIENTATION OF SETTING CIRCLES:</u> With the latitude adjustment completed, the polar axis can now be aligned with the earth's axis and the setting circles set, as follows:

a) Place the declination axis in the horizontal position precisely, by placing the hand level on the surface of the shaft housing as shown in Fig. 12. Center the bubble of the level by turning the right ascension slow motion control (1-10) in the appropriate direction.

b) Set the hour circle (1-20) by loosening the locking screw (1-25). Turn the circle until a reading of 0 or 24^h appears opposite the index or 0 line of the vernier.

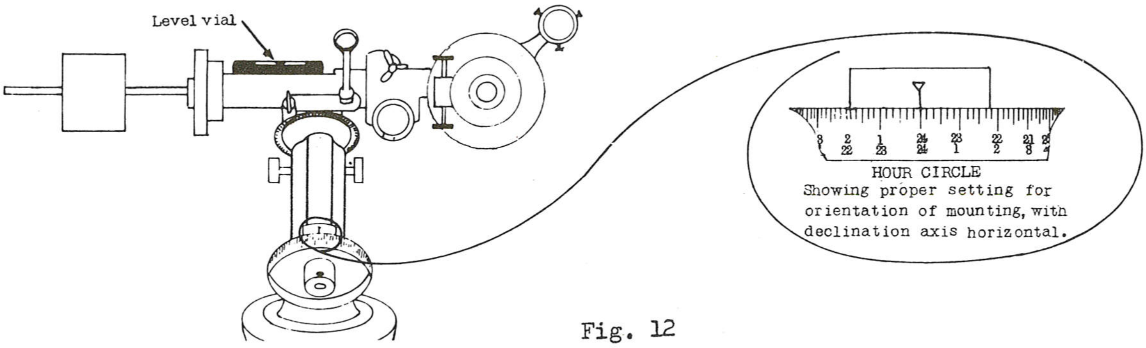


Fig. 12

c) Without disturbing the position of the declination axis, loosen the declination locking rod (1-3) and set the refractor tube approximately horizontal. Place the level on the tube and, using the declination slow motion control (1-4) level the tube precisely. See Fig. 13.

d) Set the declination circle (1-19) by loosening the locking screw (1-26). Set the circle to read the latitude of the observer's location.

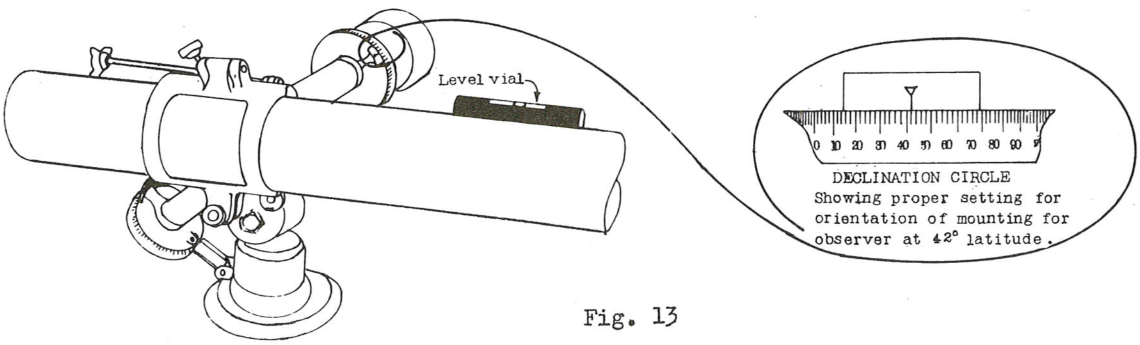


Fig. 13

This completes the orientation of the setting circles. The locking screws on both circles should be tightened and not disturbed again while observing.

e) To complete the orientation of the mounting it is necessary to align the polar axis (1-9) with the earth's axis. If your observing place is in the Northern hemisphere, this is done by sighting the telescope on Polaris, the north star. Since Polaris revolves in an elliptical orbit around the North Celestial Pole, a slight error in orientation may result unless observations are made at preselected times, which will be discussed in a later paragraph. However, since Polaris is never at a greater angular distance from the Pole than approximately $1°15^m$, alignment with Polaris at any instant of time will be sufficiently accurate for most visual observation.

To locate Polaris refer to Fig. 14. The stars forming the forward edge of the Great Bear (Ursa Major) point toward the North Star as shown. They are about 5° apart. Polaris is about 30° beyond the edge of the Bear.
(Familiarity with these distances can be helpful as a "yardstick" for estimating other distances on the celestial sphere). As a further check, an imaginary line drawn from Mizar (the star at the bend of the Great Bear handle) to Ruchbah (the star at the vertex of the widest angle of Cassiopeia, the "Lazy W") will pass through Polaris.

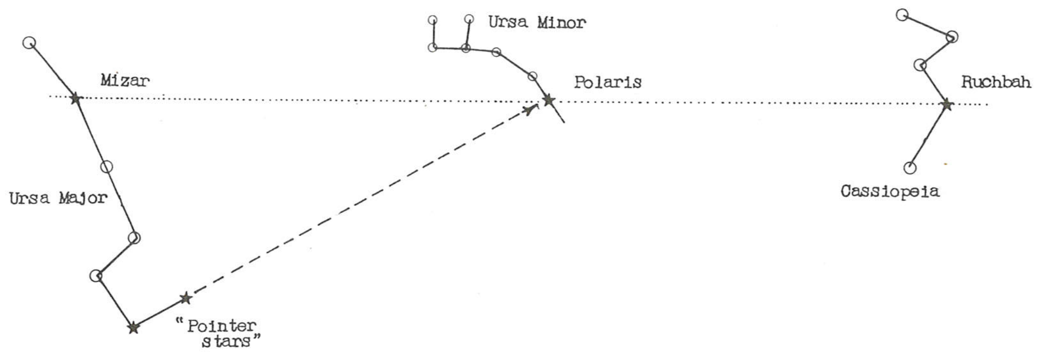


Fig. 14

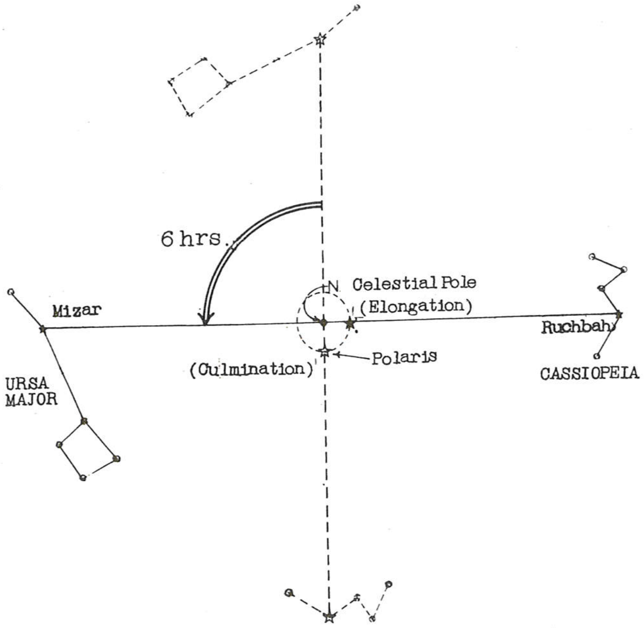
Loosen the declination locking rod (1-3) and the Azimuth locking screw (1-27). Move the telescope tube in azimuth and elevation until Polaris is centered in the field of view. This is best accomplished initially with a low power eyepiece e.g. the 25mm eyepiece. Lock the Azimuth locking screw (1-27) and the orientation of the mounting is completed. After completion of orientation, all subsequent movements of the telescope tube should be done with declination and right ascension controls only. Do not change the orientation of setting circles or loosen the Azimuth locking screw (1-27).

f) For an observer who is in the Southern hemisphere: After having made the adjustment of the Polar axis for latitude and having set the declination circle on the declination axis, proceed as follows.
Chose a prominent star which is West of the Pole and at about the same distance from the Pole as it is from the horizon and for which you can find the declination in your handbook, atlas or ephemeris. Move the refractor tube about the declination axis until you read the declination of the chosen star on the declination circle and block the declination axis. Now loosen the Azimuth locking screw (1-27) and the Right ascension fast motion clamp (1-7) and without altering the declination point the telescope to the chosen star placing it on the crosshair of the finder. Then, lock both the screw and clamp. The telescope Polar axis should be now in the right position pointing at the Pole. (If you find that it points very far off the Pole it means that you have chosen the wrong scale on the declination circle, and the procedure should be started all over again using the other scale.) The star should remain in view all the time by turning the Right ascension control knob (1-10) only. It is advisable to check by repeating the procedure with another star East of the Pole and a third one high in the sky and nearly on the Equator.

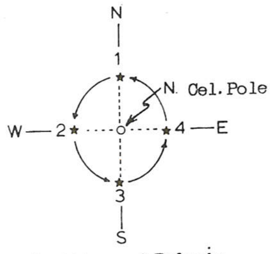
7) PRECISE ORIENTATION: If a more precise alignment of the Polar Axis with the North Celestial Pole is desired for visual observation or especially, for astrophotography, the following procedure should be followed. The imaginary line between Mizar and Ruchbah can be used to determine the position of Polaris with respect to the North Celestial Pole. For accurate setting of the latitude adjustment Polaris should be observed in either eastern or western elongation. For accurate pointing of the Polar Axis in azimuth, Polaris should be observed at upper or lower culmination. Since one revolution of Polaris about the North Celestial Pole occurs approximately every 24 hours, the star is alternately at elongation or culmination every six hours. Reference to Fig. 15 will indicate the relationship of Polaris to the pole with respect to Ursa Major and Casseopeia. The refractor should be equipped with a crosshair eyepiece e.g. the POLAREX 9mm achromatized symmetrical eyepiece with crossline. This eyepiece can be obtained as an extra accessory, but it is equipped in all POLAREX Photo-Equatorial Refractors as a standard one.

Latitude - observe Polaris on the horizontal crossline of the eyepiece at eastern or western elongation, with the declination axis locked in the horizontal position. Loosen the locking screw (1-26) and set the declination circle to read 90°. (The declination of the North Celestial Pole.)

Azimuth - observe Polaris on the vertical crossline of the eyepiece, at upper or lower culmination by loosening the Azimuth locking screw (1-27) and moving the tube horizontally. Relock the screw. Set the Hour Circle to read 0^h or 24^h. The mounting is now precisely oriented.



Determining Position of Polaris



Positions of Polaris

1. Upper culmination
2. Western elongation
3. Lower culmination
4. Eastern elongation

Fig. 15

PART V: USING THE EQUATORIAL MOUNTING

The data necessary to point the telescope at a given celestial object is the declination and right ascension. This information can be obtained from several sources e.g. star charts, ephemerides, and current periodicals.

The declination can be taken directly from the star chart and used on the declination setting circle to orient the instrument in declination. The right ascension is converted to Local Hour Angle which can be used on the Hour Circle of the instrument.

DETERMINATION OF LOCAL HOUR ANGLE: Local Hour Angle (LHA) is the difference between Local Sidereal Time (LST)and the right ascension of the celestial object to be observed. Sidereal Time is based upon the stars but the time which appears on our clocks and watches is based upon the sun. Furthermore, since we are constantly moving with respect to the sun, time based upon the sun, without some modification, would be different for every point on the earth. Our watch time is actually a local mean time (LMT) based on the time zone in which we live. The earth is divided into 24 standard time zones, each approximately 15° of longitude in width.

The first step in determining sidereal time requires us to convert our watch time (LMT) to the standard time for our location. Determine your longitude from an atlas or map to the nearest 1/4° (15^m). If you are located west of your central time meridian, add four minutes for each degree of longitude (1^m per 1/4°). If you are east subtract four minutes per degree.

Example: Observer's location: Boston, U.S.A. longitude $71^{\circ}03^m$

L.M.T. (watch time): 8:00 P.M.

Date: August 14th

Central time meridian = 75°

Difference between longitude and central time meridian:

$75^{\circ} - 71^{\circ} = 4^{\circ}$

Time correction: $4^{\circ} \times 4^m = 16^m$ (to be subtracted from LMT since Boston is east)

8:00 P.M. (LMT) - 16^m = 7^h44^m E.S.T.

The standard time just determined must then be converted to sidereal or star time (ST). This is very easily accomplished by referring to the Table of the next page, which gives the sidereal time equal to 8:00 P.M. Local Mean Time for each day of the year. In actual use we suggest that you reset your wrist watch or clock for the sidereal time. Since the difference between standard time and sidereal time varies only about 4^m per day, this setting will be sufficiently accurate for use throughout an evening of observing.

SIDEREAL TIME equivalent to 8 pm (2000 HRS) Local Mean Time											
Jan.	1	2.45	Apr.	1	8.40	July	1	14.39	Oct.	1	20.42
	11	3.25		11	9.20		11	15.18		11	21.21
	21	4.04		21	9.59		21	15.58		21	22.00
Feb.	1	4.48	May	1	10.38	Aug.	1	16.41	Nov.	1	22.44
	11	5.27		11	11.18		11	17.21		11	23.23
	21	6.06		21	11.57		21	18.00		21	0.03
Mar.	1	6.38	June	1	12.41	Sept.	1	18.43	Dec.	1	0.42
	11	7.17		11	13.20		11	19.23		11	1.22
	21	7.59		21	13.59		21	20.02		21	2.01

for intermediate days			add (minute)
2	12	22	4
3	13	23	8
4	14	24	12
5	15	25	16
6	16	26	20
7	17	27	24
8	18	28	28
9	19	29	32
10	20	30	36
		31	40

Example continued:

Entering the Table for August 14th we find that 8:00 PM LMT = 17^h33^m sidereal time. (Since sidereal time is measured from 0^h to 24^h, 12^h should be subtracted from any reading determined from the Table which exceeds 12^h to permit setting on a standard wrist watch dial). At 7:44 PM (EST), the Boston time equivalent to 8:00 (LMT), the observer's watch should be set to read 5^h33^m (17^h33^m - 12^h00^m). The sidereal time can then be read directly for the balance of the evening by simply taking the watch time plus twelve hours. Hence, at 9:00 PM (EST) the sidereal time would be 18^h49^m (6^h49^m read from the watch plus 12^h).

We stated earlier that the Local Hour Angle which will be set on the Hour Circle of the equatorial mounting is the difference between Sidereal Time and right ascension. If the Boston observer wishes to view the globular cluster, M13, in Hercules, a star chart would indicate the declination as +36°32^m and the right ascension as 16^h40^m.

To point the telescope at this object at 9:00 P.M. (EST) loosen the declination lock rod (1-3) and swing the telescope tube until a reading of +36°32^m (estimated as closely as graduations will permit) appears on the declination circle. Final adjustment should be made with the declination slow motion control rod (1-4). Next, determine the Local Hour Angle (LHA) by taking the difference between the right ascension (RA) and the sidereal time:

$$18^h49^m \text{ (ST)} - 16^h40^m \text{ (RA)} = 2^h09^m \text{ (LHA)}$$

If the RA is <u>greater</u> than ST then the LHA is <u>East</u> of the observer's meridian.

If the RA is <u>less</u> than ST then the LHA is <u>West</u> of the observer's meridian.

In this case the RA being less, M-13 lies 2^h9^m West of the observer's meridian. The Hour Circle would read as shown in Fig. 16.

Loosen the RA clamp (1-7) and swing the objective end of the tube toward the West until the Hour Circle reads 2^h9^m as shown in Fig. 16.

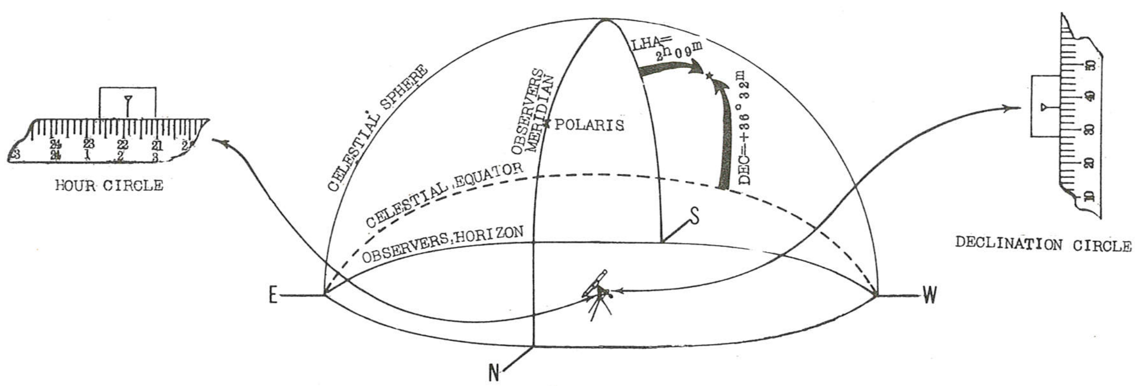


Fig. 16

Once the object has been acquired in the field of view then it may be continuously tracked by turning the RA hand-wheel (1-10) manually or by a synchronous motor or mechanical drive.

This same procedure may be used for locating bright objects during the daytime, such as planets, during certain seasons of the year. If the mounting has been previously oriented, the declination and RA may be determined from an ephemeris and applied to the setting circles to permit location of an object that would be invisible to the naked eye.

PART VI: TERRESTRIAL VIEWING

Astronomical refractors normally present an inverted and reversed image when the eyepieces are inserted directly into the eyepiece holder of the drawtube. As mentioned previously the use of the star diagonal will present an upright image, but it will still be reversed from right to left.

The erecting prism system is recommended for terrestrial viewing. If it is not supplied as a standard component of your telescope, it can be obtained as an extra accessory. The erecting prism system contains a special prism which presents an image oriented correctly both vertically and horizontally. The erecting prism is inserted directly into the eyepiece holder of the telescope drawtube. Any selected eyepiece, from 4mm to 25mm total length, can then be inserted in the eyepiece holder of the erecting prism. Focusing is accomplished in the normal manner.

Although an altazimuth-type mounting is generally preferred for terrestrial observation, the equatorial mounting can be made to function as an altazimuth mounting, for terrestrial use, by locking the declination axis in the horizontal position. Horizontal movements of the tube can be made by loosening the azimuth locking screw. Vertical changes can be made by using the declination controls.

PART VII: CARE OF THE INSTRUMENT

Your POLAREX telescope has been constructed of the finest materials available and, with proper care, will give a lifetime of service. It is a precision instrument and should be handled with care. When not in use, the telescope and accessories are fully protected by the wooden carrying cases.

The objective lens has been treated with a special coating for maximum light transmission and image brilliance. Excessive and incorrect cleaning of the lens and the eyepieces may damage the delicate optical surfaces. Do not rub or polish the lens but, instead, gently remove any dust particles with a camel's hair brush, lens tissue, or hand blower. Frequent cleaning is unnecessary. The objective lens has been assembled at the factory with great care and should never be taken apart. The dustcap should be kept on the telescope except when you are actually observing.

Moving parts of the telescope mounting should be occasionally lubricated to insure smooth operation. A light film of machine oil is preferred. Parts should be wiped free of dust before applying. Tighten the nuts on the bolts which fasten the tripod legs to the mounting whenever necessary to insure proper rigidity.

PART VIII: HINTS ON OBSERVING

1) Use the telescope outdoors. Window glass and the air currents in a heated room will spoil the clarity of the image.

2) As mentioned previously, astronomical telescopes invert and reverse the image as seen with the naked eye. Therefore, star maps must be turned upside down when comparing them with a telescopic view. In addition, the diagonal flips the image, again, from left to right. This corresponds to looking at a star map in a mirror.

3) Use the viewfinder first to locate the general region of the object. Always start out with lower powers in the main telescope. After you have found the object, it is possible to use higher power eyepieces in the main telescope, with their more limited fields of view. The highest power eyepieces will perform to best advantage only under favorable atmospheric conditions and, therefore, it is very often the lower and medium powers which will give the most satisfactory views.

4) A useful adjunct to observing will be an atlas or an almanac.

PART IX: WARRANTY

All POLAREX Refractors and Accessories are fully guaranteed for workmanship and performance. Should any component be found faulty as a result of a manufacturing defect, replacement will be made without charge.