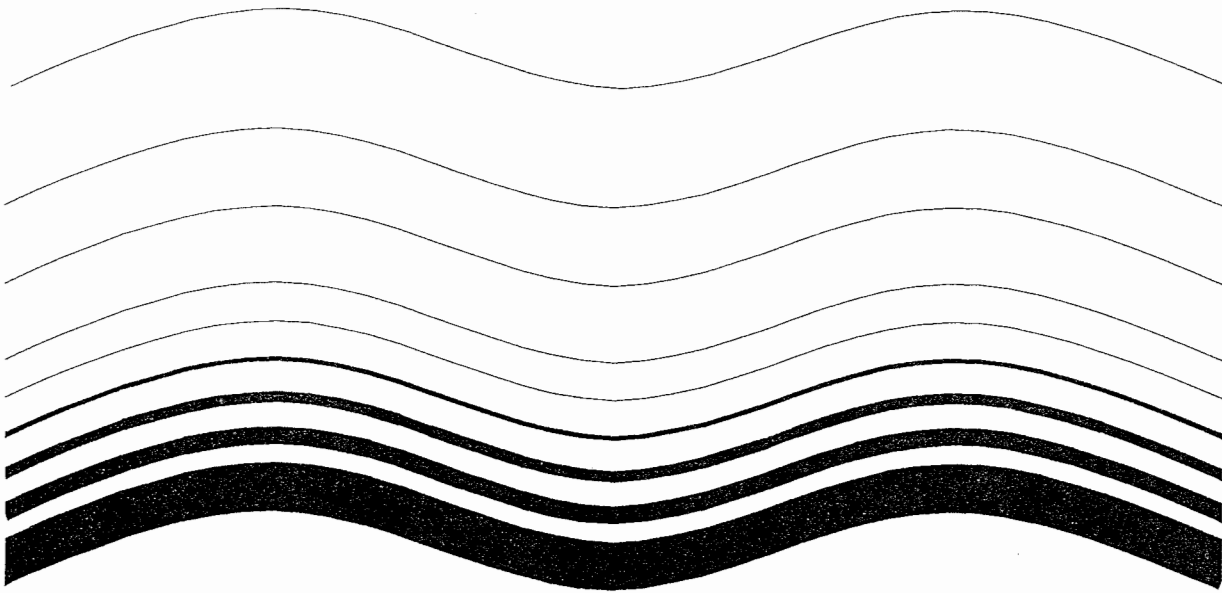


ε-160

Instruction Manual

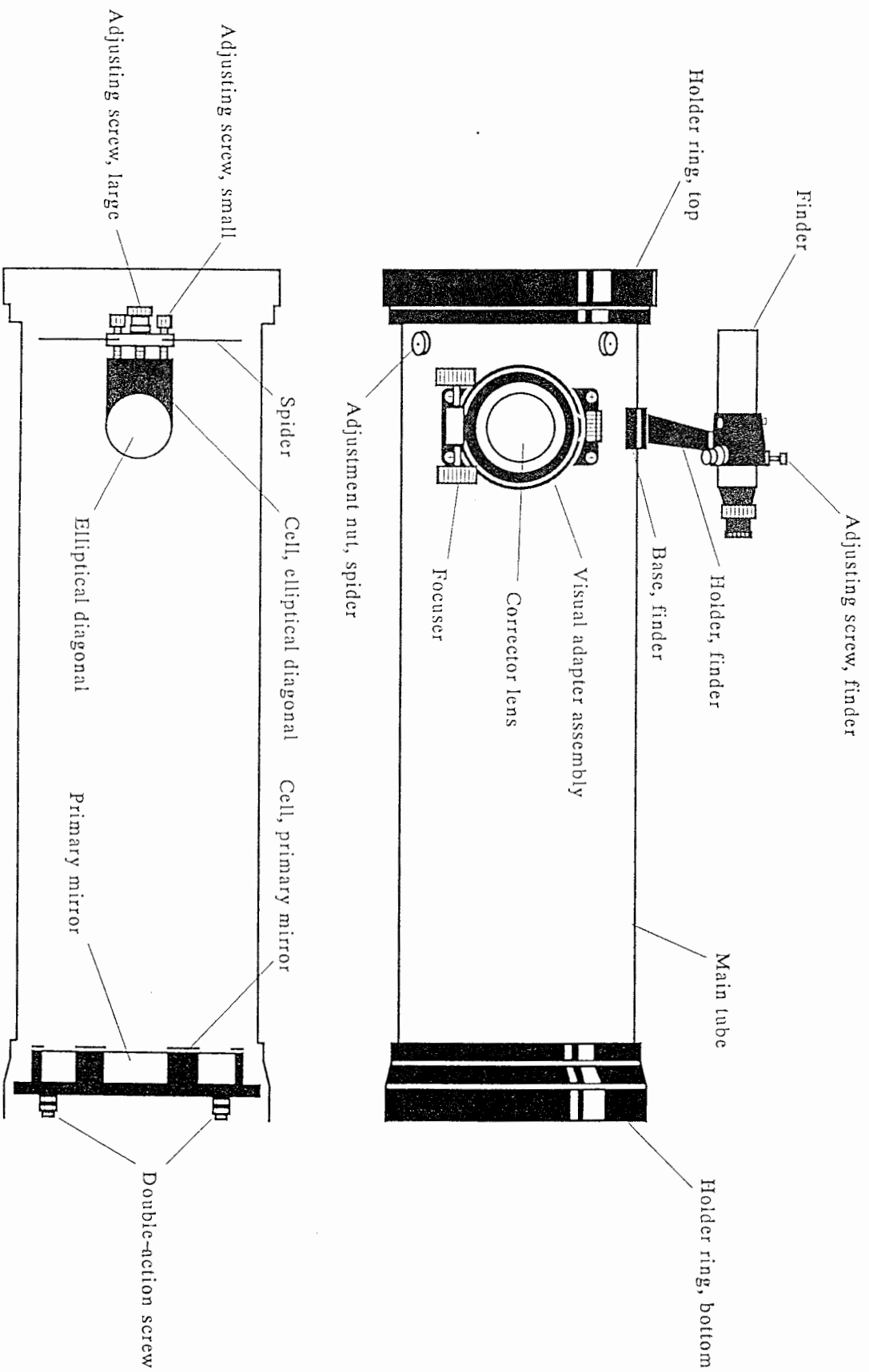


TAKAHASHI

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Epsilon-160: Main Tube



Main Tube Assembly

1. Finder Scope

Mount the finder scope holder on the base with two screws as shown in fig. A. A 7×50 finder scope can be mounted optionally on the base.

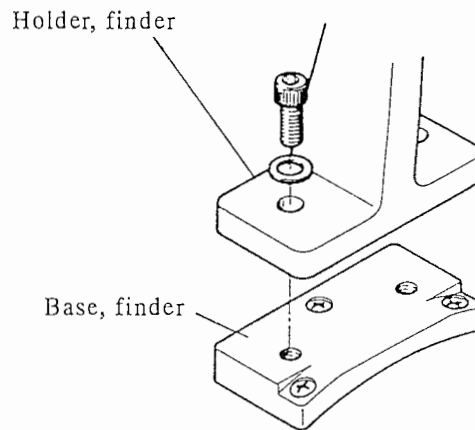


Fig. A

2. Visual Adapter Assembly

Dependent on the specific observation, use the system parts as shown in the system chart. Be sure to remove the corrector lens when optical axis alignment is made.

3. Mounting the tube on the equatorial mount

Mount the main tube with tube holders and M-type mounting plate as shown in Fig. B. The tube holders are connected with a bridge, on which a guiding mount or a panhead can be mounted. An extra space for a guiding mount (optionally available) and two keyways to mount the tube well-balanced are provided on the M-type mounting plate.

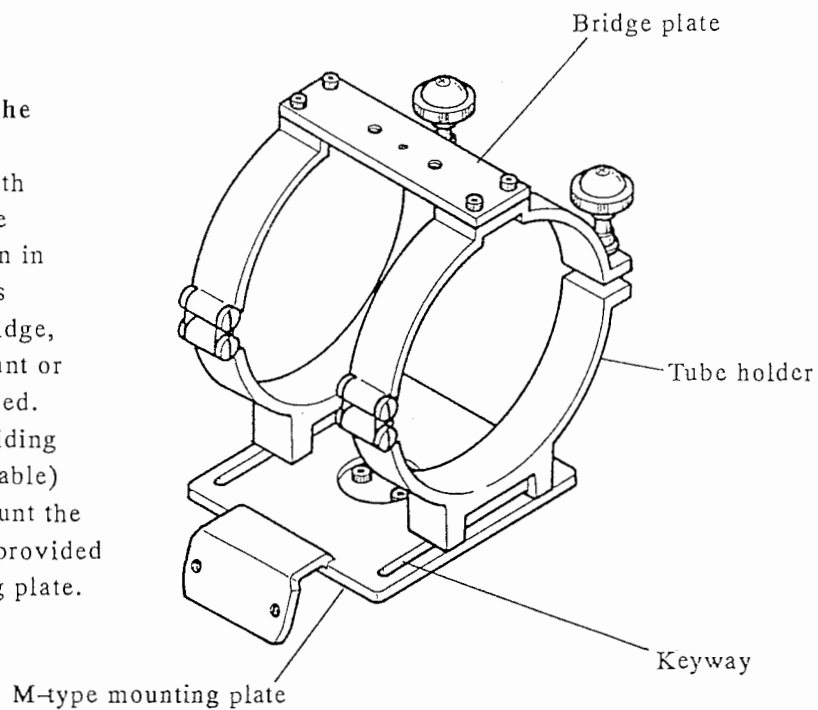


Fig. B

Visual Adapter Assembly

1. Focuser

Precision-machined rack and pinion is used for very smooth focusing. Loosen the focuser clamp and make focusing by turning focusing handle. If focusing is made forcedly by turning the handle without loosening the focuser clamp, it may cause the focusing mechanism out of order.

2. Corrector Lens

In the visual adapter assembly, 4-element corrector lens is attached. This is an essential part of the optical configuration of the Epsilon so that it must be attached when making photo-visual observation. Remove it when making optical axis alignment. Be sure to attach the corrector lens, after alignment, so that it does not come loose while photographing.

3. Revolving Device

Revolving device is built in the visual adapter assembly. It is very convenient to adjust camera angle at any angle desired when making photography. It also does not make defocusing when camera angle is adjusted with it, but to make sure, check focus just before starting exposure. When adjusting camera angle, turn the revolver, holding it firm enough.

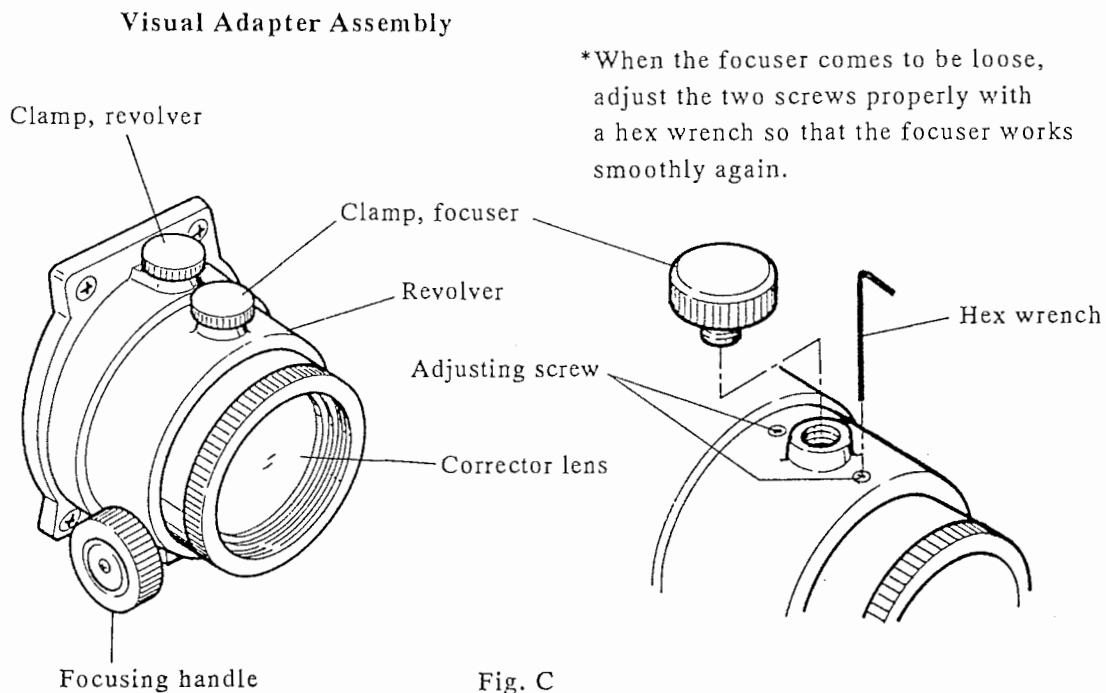


Fig. C

Optical Axis Alignment

In a reflective optics with short focal length, only a slight irregularity of optical axis will affect sensitively the quality of images.

It is, therefore, very important all the time to make the optical axis of the main optics aligned correctly.

In case the cell is taken out for cleaning the mirror, optical axis alignment is required after the cell is set in place again. In order to keep the optics in optimum condition for photo-visual observation, the owner must learn how to make optical axis alignment correctly.

Check if the optical axis of your telescope is in order, whenever you try to do your pleasant photo-visual observation.

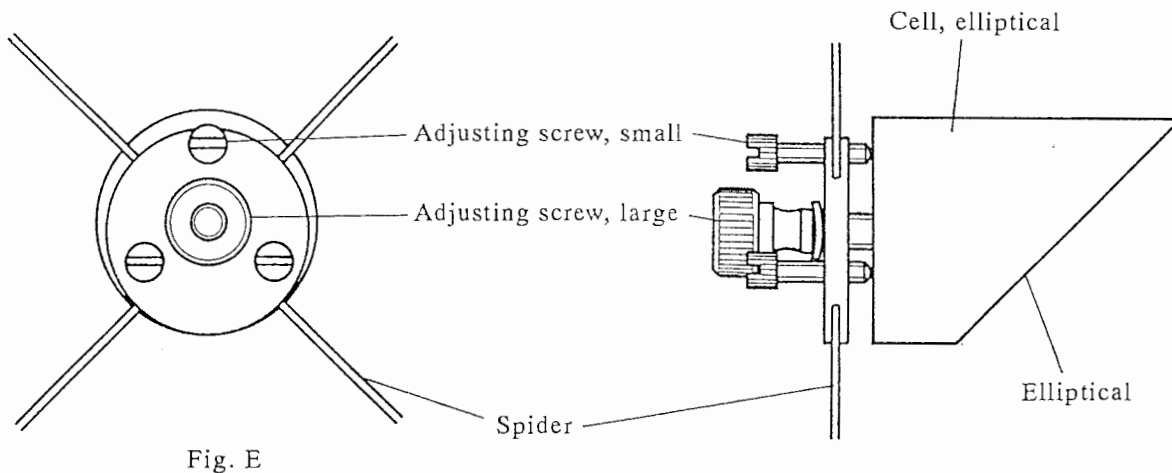


Fig. E

How to adjust the elliptical mirror - Adjust the adjusting screws as shown in Fig. E as instructed in Fig. F, G, and H respectively.

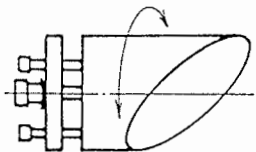


Fig. F

Turning the mirror - Loosen the large screw in the center of the cell by turning it counter-clockwise and the mirror can be turned by hand either clockwise or counter-clockwise. Do not loosen the screw too much.

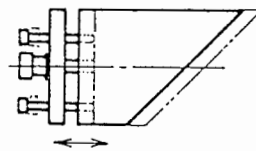


Fig. G

Moving the mirror - Loosen (or tighten) the large screw and turn the three small screws in equal portion clockwise or counter-clockwise to move the mirror forward and backward in parallel to the optical axis.

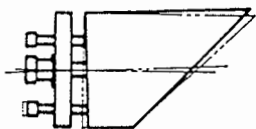
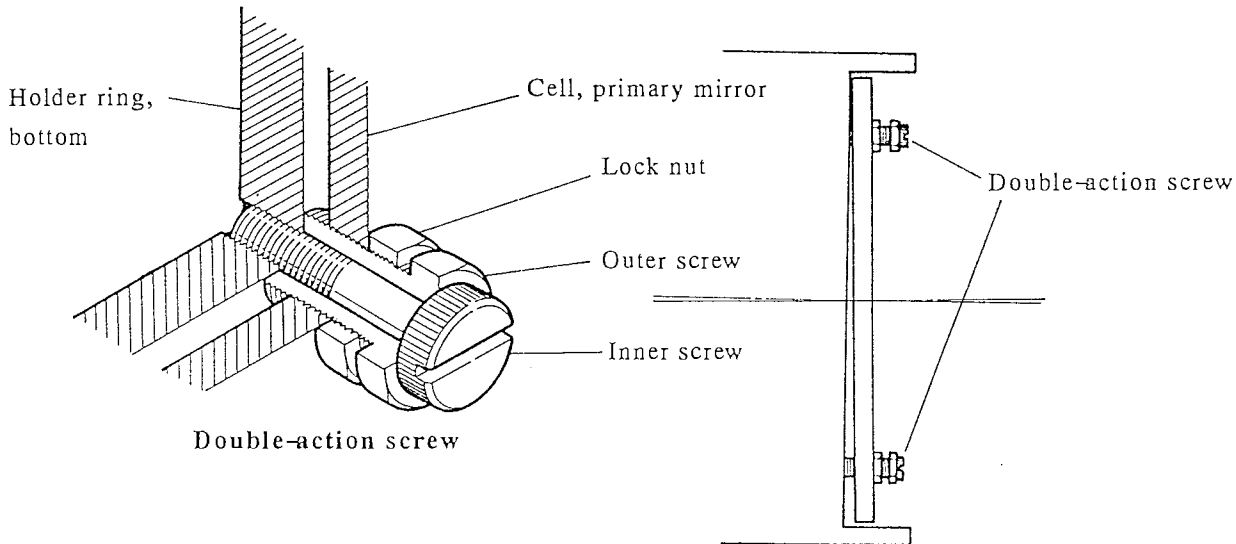


Fig. H

Tilting the mirror - Loosen the large screw and turn the small screws respectively in proper portion to tilt the mirror upward or downward at free position. Do not loosen the center screw too much.

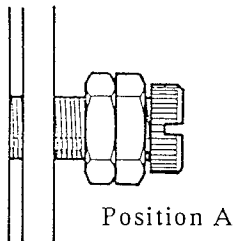
Adjustment for Primary Mirror



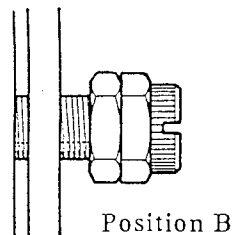
with three sets of the double-action screws, the mirror can be adjusted at any desired angle.

1. Shift the lock nut close to the double-action screw. Loosen the inner screw a little to turn the outer screw. Do not loosen the inner screw too much.

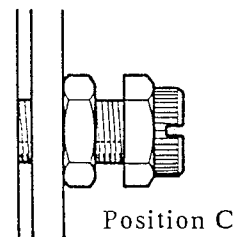
Double-action screw



2. The cell can be moved forward and backward by turning the outer screw clockwise or counter-clockwise. Stay the cell at proper position with the inner screw. The optical axis alignment for the primary mirror can be so made with three parts of the double-action screws, repeating the above procedure.



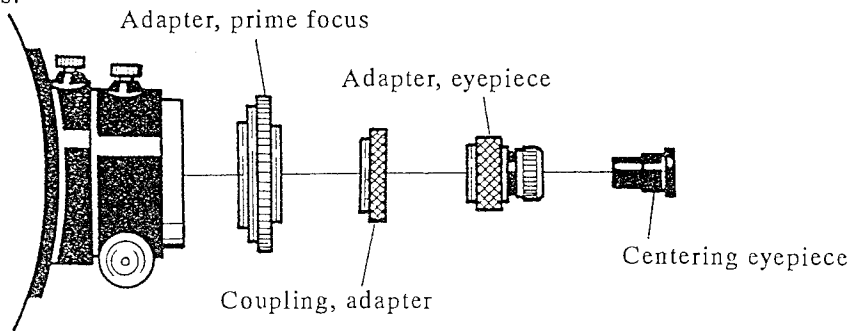
3. After the optical axis is aligned properly, shift back the lock nut to its original position and tighten it firm, with a spanner provided, to the cell. The outer screw is then fixed tightly with the cell.



When the cell is required to be taken out, it is advisable to provide a reference mark in advance both on the cell and the cell holder. This makes the optical axis alignment easier after the cell is reset in place. The cell can be taken out by loosening the inner screw, but keeping the outer screw tightened. In case the primary mirror is taken out from the cell for cleaning or other purpose, the optical axis alignment must be made from the very beginning.

Procedures for Optical Axis Alignment

The Epsilon-160 is specially designed for deep-sky astrophotography. In order to correct uneven distribution of light, the elliptical mirror is so mounted that it is positioned off-center. The owner must learn how to see the related sight of the optics and its parts when the optical axis is correctly aligned. Basic procedures for alignment is of on difference from those for conventional reflectors.



On the dead center of the primary mirror and optical center of the elliptical mirror, a collimating mark is provided respectively for quick optical axis alignment.

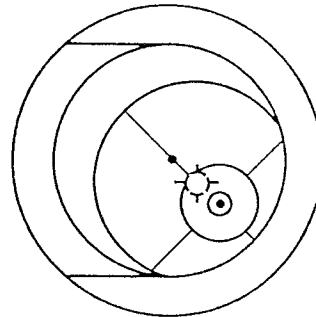


Fig. K

Just insert the collimating eyepiece into the eyepiece adapter and look inside of the main tube. Collimate the markings, adjusting the screws properly. Fig. K shows the optical axis is not aligned yet, while Fig. L and M (collimated markings) show the alignment is correctly made.

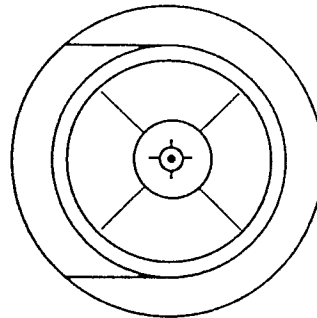


Fig. L

Fig. M shows the collimated markings reflected on the primary mirror.



Fig. M

Optical Axis Alignment With Off-centered Elliptical

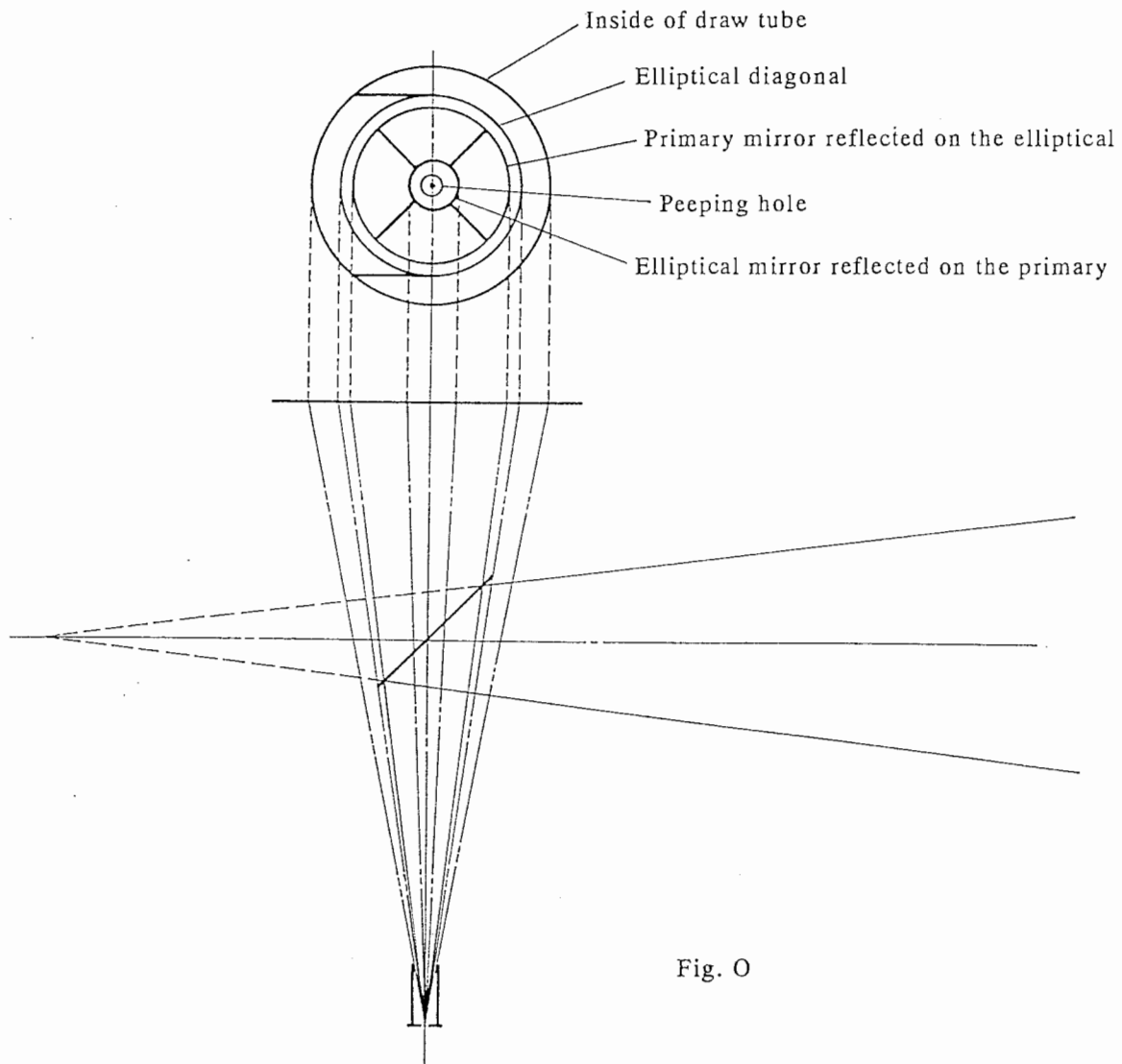
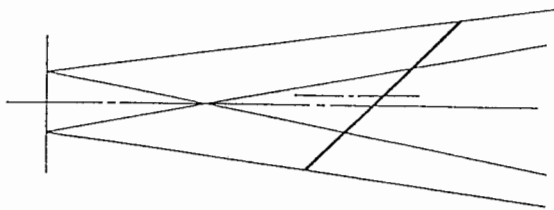
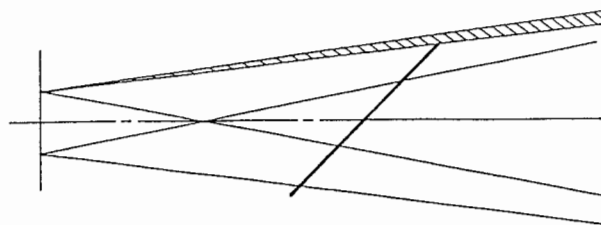


Fig. O

◆ Off-centered elliptical diagonal



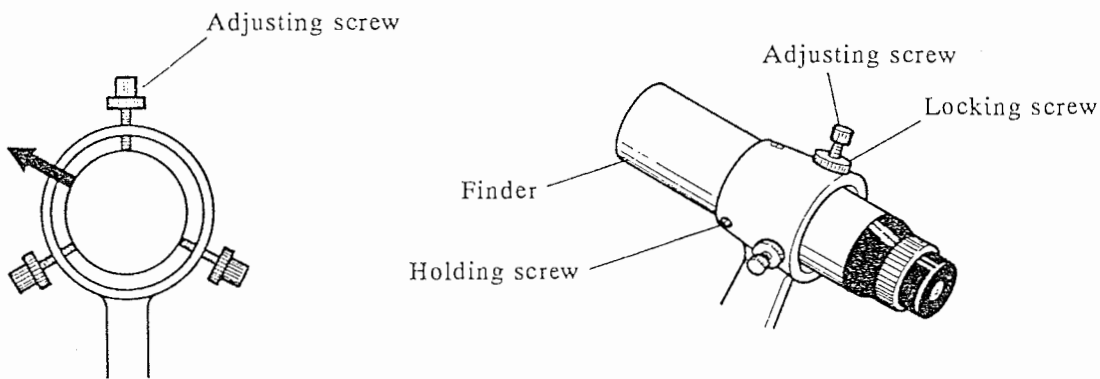
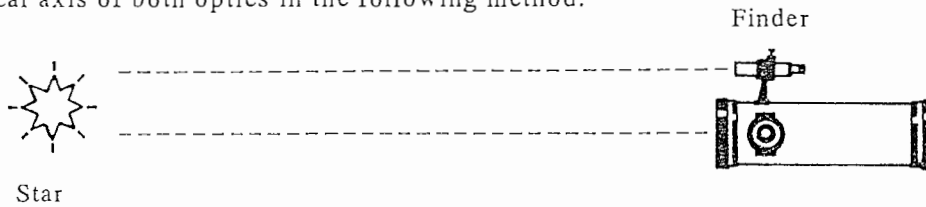
◆ In case the elliptical diagonal is centered at the optical axis of the primary mirror, it gives vignetting to shadowed part.



Well-balanced quantity of light can be distributed, centering the optical axis of the primary mirror.

How To Adjust The Optical Axis Of The Finder Scope

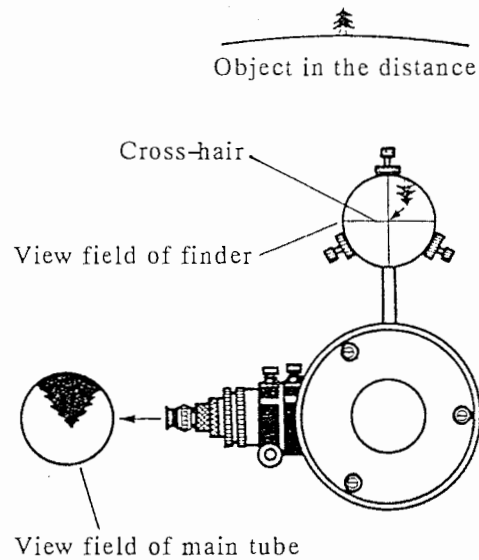
The view field of the main scope is so limited that it is very difficult to catch a deep-sky object with the main scope. also in case astrophotography is taken with a film holder or a 35mm SLR camera, the view field seen through a focusing screen or a finder glass is so dark that a deep-sky object is hardly to be spotted. The finder scope has, on the other hand, wider and lighter view field so that it can catch a deep-sky object easily and quickly. Align the optical axis of both optics in the following method.



1. Set a low-power eyepiece in the main scope and guide a distinct object located far away such as a top of a big tree or a mountain at the center of the view field of the main scope.

2. Adjust the finder fixture properly so that the object guided in the view field of the main scope can be seen at the cross point of the view field of the finder.

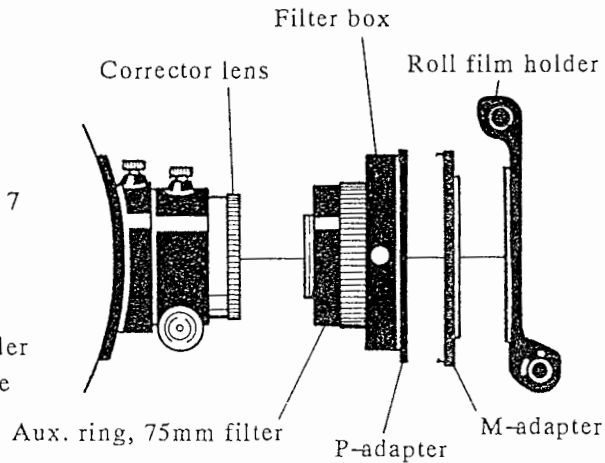
3. Tighten all the fixtures of the finder with lock nuts.



Make the alignment in the daytime and be ready for your exciting observation at night.

Astrophotography

The Epsilon-160 is so designed specially for a deep-sky astrograph that it can accept a 35mm SLR camera, a Mamiya 6×7 roll film holder, and a 70mm film holder for the Mamiya RB67. Therefore, special film such as 103a are usable. And it is highly recommendable to use the film holder for wider photo-field of 5° provided by the Epsilon-160.

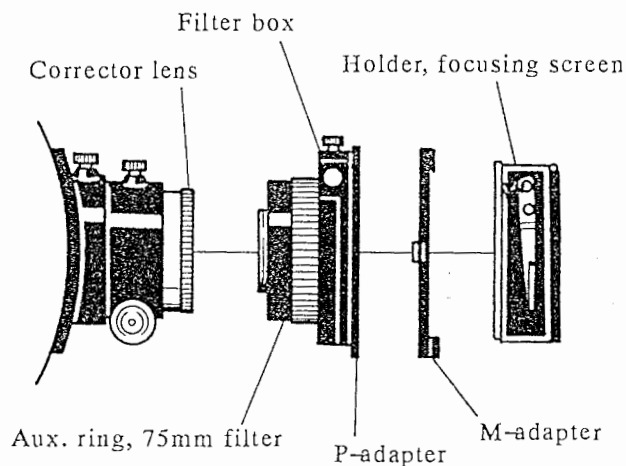


Astrophotography With The Film Holder

Refer to the system chart for Epsilon-160.

1. Setting up the holder

Mount the Mamiya P adapter to the filter box with four screws and set the assembly in the corrector lens by screwing it. The P adapter can accept an M adapter or a G adapter - the former is for the roll film holder and the latter for the RB 70mm holder.

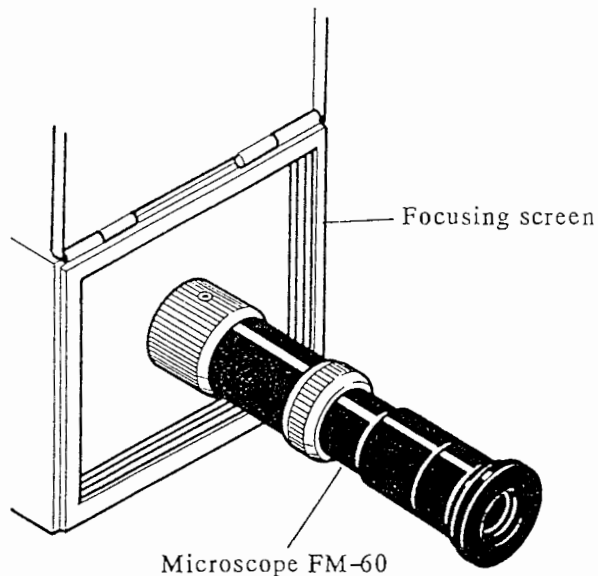


2. Focusing screen

To focus the object as sharply as possible, use a focusing screen. In case the roll film holder is used, mount the focusing screen to the M adapter and check the object is just focused. When the RB film holders are used, mount the holder to the P adapter by means of the G adapter after focusing is done with the M adapter and the screen. Refer to the system chart for Mamiya roll film holders.

3. Focusing

Be sure to place the star used for focusing at the center of the focusing screen. Focus the image of the star as sharp as possible by turning the focuser. Use the microscope specially designed for sharp focusing as an optional instrument.



This FM-60 microscope can change magnification from 40× to 60×.

Photography With A 35mm SLR Camera

Refer to the system chart for the Epsilon-160. Mount a 35mm SLR camera to the cell of the corrector lens by means of a wide mount as shown in Fig. X.

Focusing - In a camera that has an interchangeable finder screen, use the screen with all matt-finish. If the screen is not an interchangeable type, make very careful focusing at the center of matt-finish, using a magnifier.

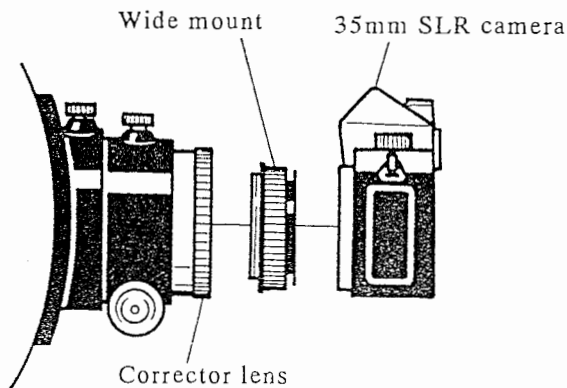


Fig. X

Filter

The filter box can accept a 75mm square sheet filter, which is inserted into the filter box with the filter being held in a paper holder. When a 35mm SLR camera is used, screw-in the filter into wide mount. Refer to Fig. Y.

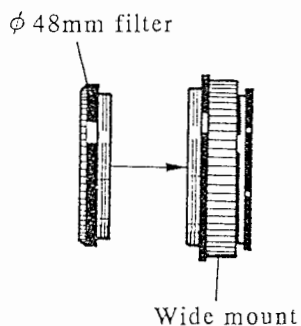
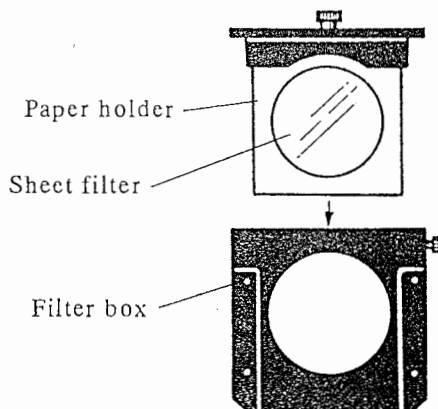


Fig. Y



Visual Use

Basically the Epsilon-160 is designed for astrophotography so that it is not recommendable to use it for planetary observation which requires very high magnification, but it works very well for deep-sky observation in a low magnification of more or less 100 \times . Be careful for selecting eyepieces for visual observation with the Epsilon-160 because the stroke of the focuser is so limited.

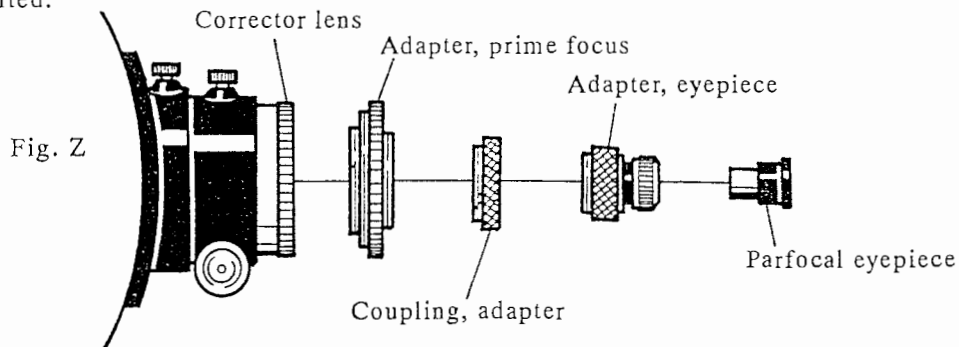
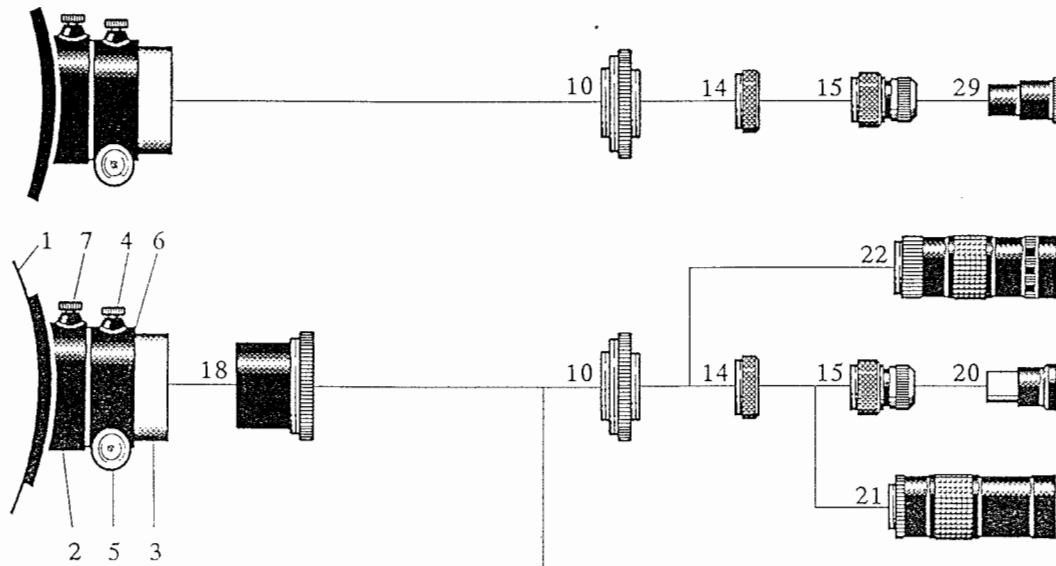
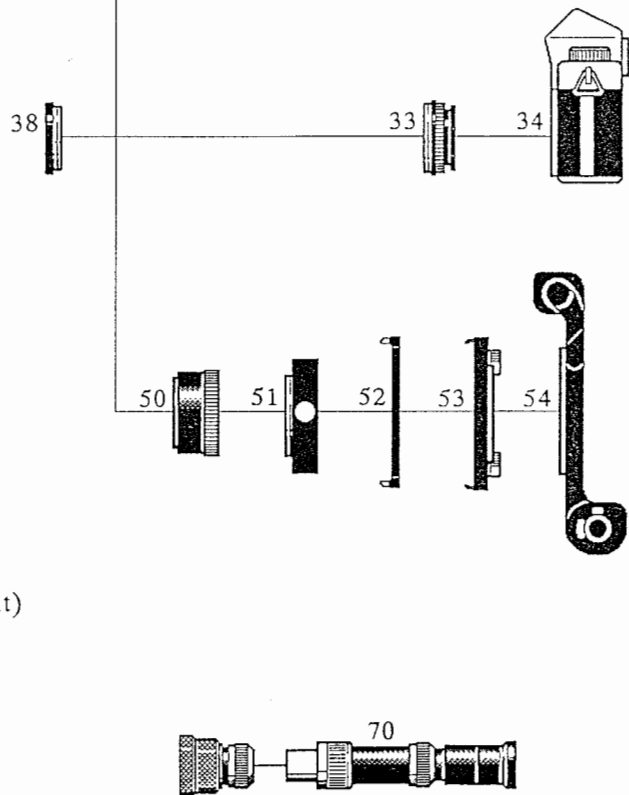


Fig. Z

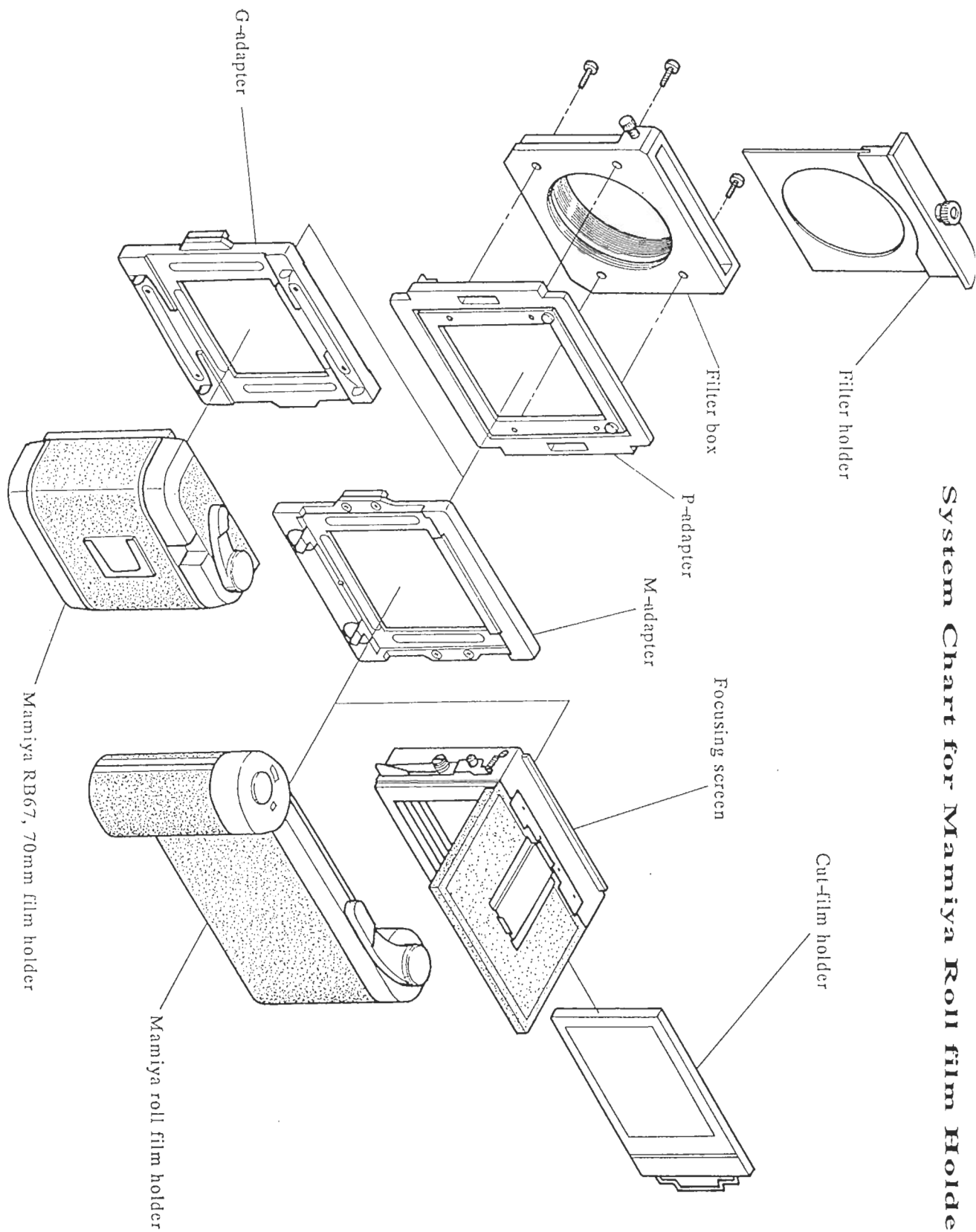
System Chart for ϵ -160



- 1. Main tube
- 2. Focusing unit
- 3. Focuser
- 4. Clamp, focuser
- 5. Knob, focuser
- 6. Revolver
- 7. Clamp, revolver
- 10. Visual adapter
- 14. Ring, visual adapter
- 15. Eyepiece adapter
- 18. Corrector
- 20. Parfocal eyepiece
- 21. Or40mm,Er32mm(58°)
- 22. Er32mm(62°)
- 29. Collimating eyepiece
- 33. Wide mount(Wide ring + T-mount)
- 34. 35mm SLR camera
- 38. ϕ 48mm filter
- 50. Aux. ring, 75mm filter
- 51. Filter box
- 52. P-adapter
- 53. M-adapter
- 54. Mamiya roll film holder
- 70. FM-60 microscope



System Chart for Mamiya Roll film Holders



Cautions In Astrophotography

1. Focusing

Use a fix star as a reference star for focusing. The 3rd or 4th magnitude star is most suitable and brighter and darker ones are not recommendable.

Focusing must be done at the center part of the focusing screen.

If a suitable reference star is not available around the photographic object, use a star that lies as near the object as possible. After careful focusing, the object must be guided in the photo field.

In the warm season, humidity goes up as temperature rises, which may cause the film expanded and sharp images of the objects unobtainable. To keep the film plane as flat as possible, use a film holder with a suction device.

2. Movement of focal point

A change of ambient temperature can make the main tube and the primary mirror expanded or contracted. Due to this, focal point is sentively moved. Careful attention must be taken for a change of temperature with a thermometer. A difference of $\pm 2^{\circ}\text{C}$ may cause defocusing. In order to obtain sharply focused images on the film, try to take two or more shots for a object and then do focusing for another object.

3. Trial photography

For those who go to the expedition to seek an ideal dark sky, it is highly recommendable to take a trial photography first in the backyard of their houses. Even in the adverse light in a city area, 30-second or so of exposure with Try-X can be done for a trial shot. Do careful focusing for every shot and check the image on the film with a magnifier so that operator can always obtain sharply focused images on the film. After a series of practice in this way, try to do much more exciting astrophotography under an ideal dark sky in the field.

Visual Observation

Epsilon series are specially designed for deep-sky astrophotography and it is not so suited for planetary observation which requires a high magnification. In a lower magnification more or less $100\times$, however, it turns a superb visual telescope, producing a breathtaking stellar image over the wider field of view. Do not forget the corrector lens set in place when trying visual observation. TAKAHASHI parfocal eyepieces are recommendable to use for visual observation. Some other oculars may cause defocal due to limited stroke of the focuser of the Epsilon.

Maintenance

Visual adapter assembly: The focuser may come to be loose after a long period of use. It can be fixed by the adjusting screws provided on the focuser as shown in Fig. C. Be careful not to tighten the focuser too much.

Special grease is applied in the focusing mechanism to stand for a long period of use without lubrication. Do not apply any other oil or grease in the focusing mechanism.

Primary and secondary mirrors: When they get dew on their face during observation or when they get moisture on the mirror after the scope is brought into warm room from cold outside, dry it immediately. Dew and moisture may cause the mirror and fixtures get musty and rusty. When the diagonal or the primary mirror gets dust on it, take it out with the cell together and blow out the dust by a blower. When mold or rust covers all the mirror, cleaning or recoating may be required. In such case, ask your dealer what to do.

A slight pressure on the mirror may cause the stellar images distorted. A great care must be taken when the cell is set in place after repairing service. Do not set the screw too tight. Sharp edge of the diagonal can be chipped by a shock on it. Be careful in handling. Do not take the corrector lens out from its cell. It is very difficult for amateur to align the lens to keep its right performance.

Dust on the main tube can be wiped out with a duster and stained dirt on the tube can be cleaned with a car wax.

Specifications

Optical configuration ———— Hyperboloidal catadioptric
Primary mirror ———— Pyrex multi-coating (enhanced aluminum)
Effective aperture ———— 160mm
Effective focal length ———— 530mm
Focal ratio ———— F/3.3
Corrector lens ———— 4-element
Secondary mirror diameter ———— 63mm
Image circle ———— ϕ 49mm 5°
Total length of main tube ———— 570mm
Diameter of main tube ———— ϕ 204mm
Weight of main tube ———— 6.5kg (abt. 14.3lbs)