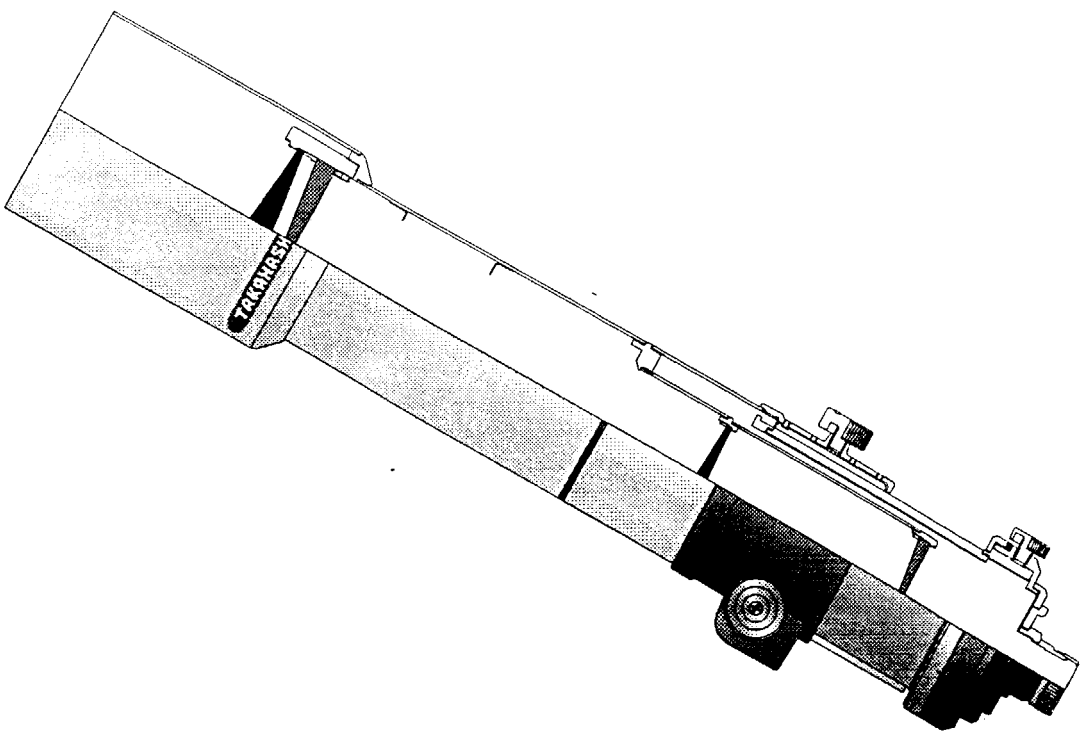
FSQ-106

QUADRUPLET FLUORITE APOCHROMATIC REFRACTOR

INSTRUCTION MANUAL

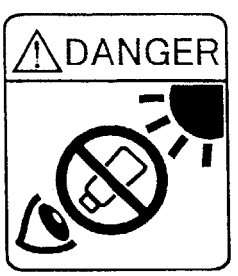


TAKAHASHI

Thank you for purchasing the Takahashi FSQ-106 Quadruplet Fluorite Apochromatic Refractor. This is a state-of-the-art double fluorite astrograph that is capable of wide number of photo/visual applications. In order to use the FSQ-106 to the limit of its capabilities, please read this manual and familiarize yourself with the parts and their functions before using this instrument.

⚠ WARNING

NEVER ATTEMPT TO OBSERVE THE SUN THROUGH THIS TELESCOPE WITHOUT A FULL APERTURE SOLAR FILTER DESIGNED FOR THIS PURPOSE. FAILURE TO DO SO COULD CAUSE INSTANT BLIMDNESS. COVER THE FINDER WITH AN OPAQUE COVER TO PREVENT ANY LIGHT FROM COMING THROUGH. AN UNCOVERED FINDER CAN ALSO CAUSE SERIOUS DAMAGE TO THE EYE. KEEP CHILDREN AWAY FROM THE TELESCOPE DURING DAYTIME.



⚠ CAUTION

- When placing the tube assembly on to an equatorial mount, be care full to balance the tube in the saddle. This will prevent injury to fingers and will prevent it from falling to the ground. When placing the FSQ in the saddle, always hold the tube with one hand to keep it from falling off the saddle on to the ground.
- Always lay the tube assembly on a completely flat surface that totally supports it to protect it from damage.
- Keep the tube assembly out of the Sun. Otherwise, the tube assembly could heat up, causing lens damage.
- Great care should be taken during focusing.

CONTENTS

Specifications

Optical System	Fluorite Apochromat Modified Petzval Quadruplet
Effective Aperture	106mm ϕ
Focal Length [Prime Focus]	530mm
Focal Ratio [Prime Focus]	5.0
Resolving Power	1.09″
Limiting Magnitude	11.9
Light Gathering	229x
Image Circle	88mm ϕ 9.5° for 35mm, 645, or 6x7 medium format 114mm ϕ for 4x5
Effective Focal Length [w/Extender-Q] ..	850mm
Focal Ratio [w/Extender-Q]	8.0
Image Circle [w/Extender-Q]	44mm ϕ 3°
Finder Scope	7x50[will accept illuminator]
Total Length of Main Tube	680mm
Diameter of Main Tube	114mm ϕ
Total Weight of Main Tube	6.0kg [13.2lbs]

Tube Assembly Layout

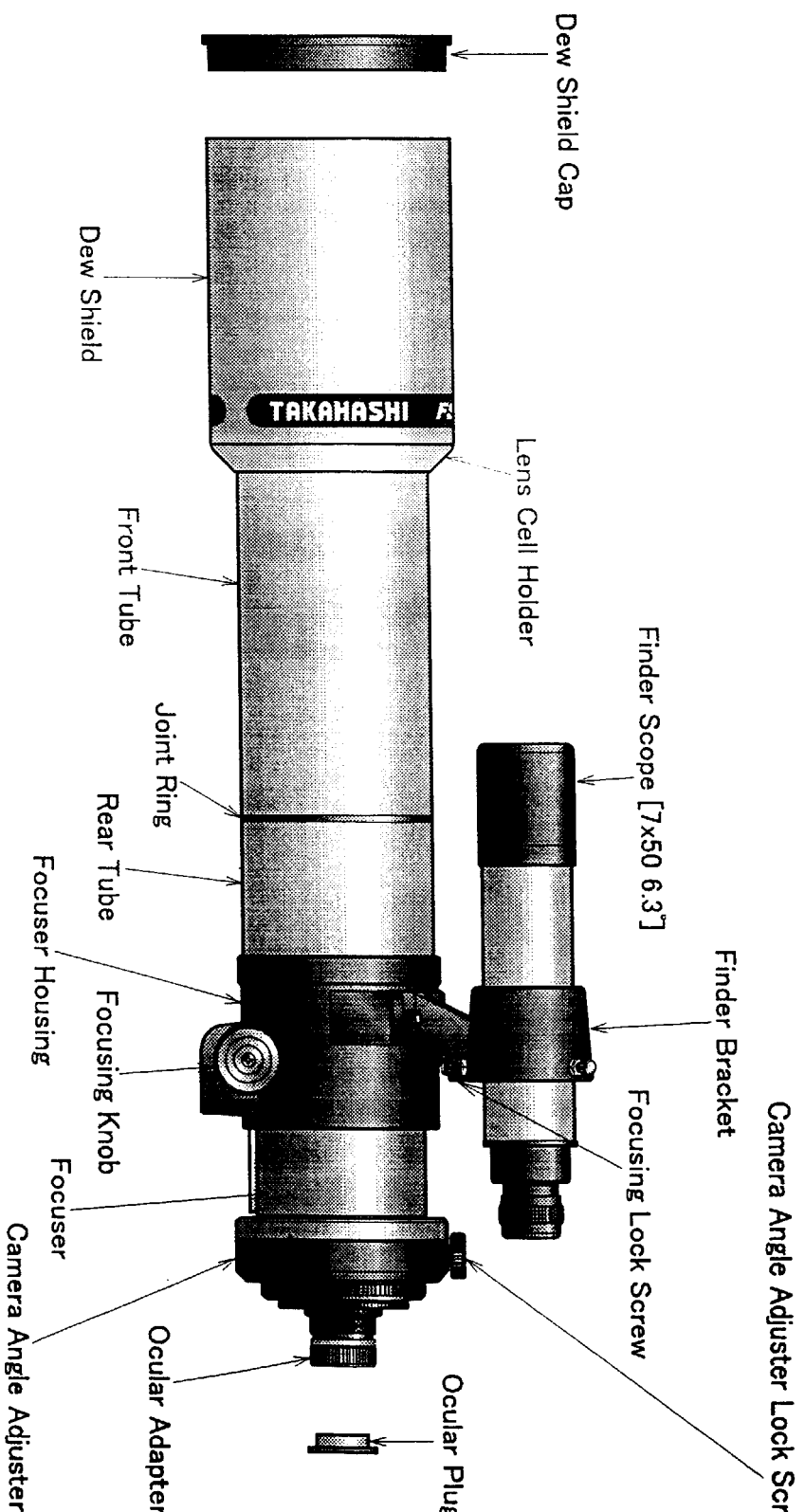


Fig. 1

Optical System Features

The FSQ-106 is a state-of-the-art fluorite apochromatic refractor. It sets a new standard for innovation and color correction.

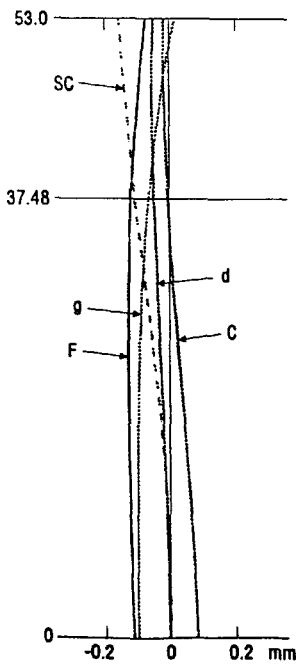
The heart of the FSQ-106 is the unique modified Petzval design that employs two fluorite elements. The original Petzval design, though excellent for astrophotography, exhibited inherent problems with field curvature and astigmatism. Now Takahashi's modified Petzval design employs two widely separated rear elements to correct field curvature and astigmatism to produce a flat field, high contrast image without any hint of astigmatism.

This design produces an amazing 88mm ϕ image circle that will fully illuminate a 35mm, 645 or 6x7 medium format cameras. The 4" O.D. standard focuser; the largest available on any short focus 4" apo refractor, has a built-in camera angle adjuster that permits 360° rotation of the camera, makes the FSQ-106 the perfect astrograph. In fact, this outstanding instrument can be used with a 4x5 vacuum back camera! This exceptionally large image circle will permit the use of any CCD camera.

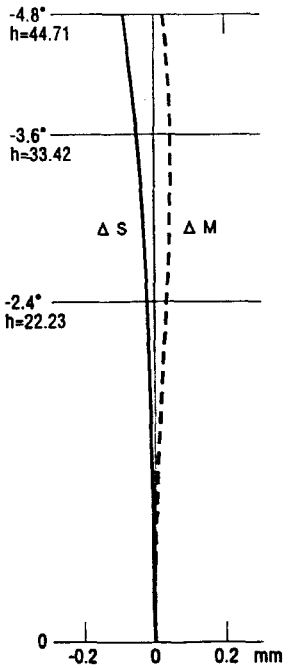
The double fluorite design which forms an image free of any secondary color will produce exceptionally sharp, high contrast views of deep sky objects or total solar eclipses.

When used with the dedicated Extender-Q, a 1.6x multiplier, the FSQ becomes a first class lunar and planetary instrument. The focal length increases to 850mm. In this configuration, the FSQ will produce very sharp and high contrast images of the Moon and planets or it can be used with the TCA-4 eyepiece projection device to produce high quality lunar and planetary photographs.

All of these outstanding features make the FSQ-106 the finest short focus photo/visual instrument available anywhere.



Spherical Aberration



Astigmatism

Fig. 2

Attaching The Finder And Tube Assembly

The FSQ-106 is shipped with the finder unattached to prevent damage. Use the following instructions to assemble and align the finder.

◆Attaching The Finder Scope

Place the finder bracket over the holes in the focuser assembly and attach it with the two cap bolts provided. Make certain that the sides of the bracket are parallel to the sides of the tube assembly. Failure to do so will make finder alignment more difficult. A cap screw covers the illuminator hole. Refer to Fig. 4.

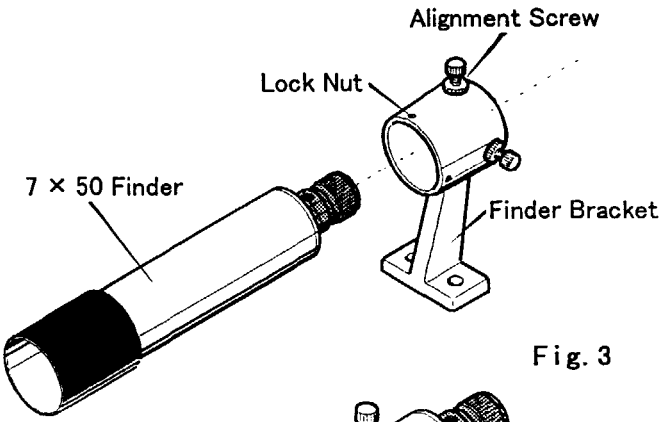


Fig. 3

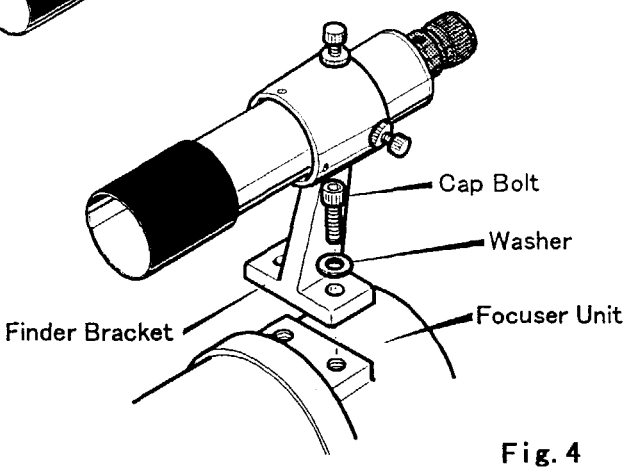


Fig. 4

◆Attaching Tube Assembly To The Equatorial Mount

Place the tube holder onto the top of the Dec. assembly and align the holes in the tube holder with the holes in the Dec. assembly. Attach it with with two cap bolts provided for this purpose. This tube holder can be used with all Takahashi mounts. Refer to Fig. 5.

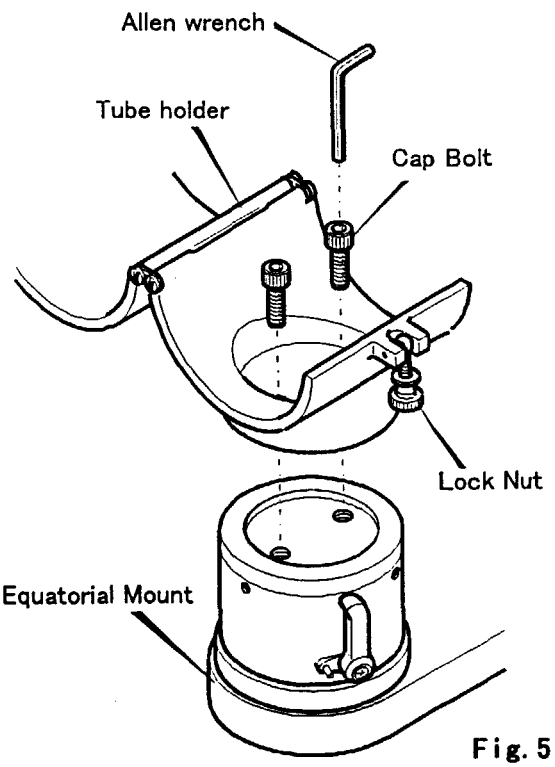


Fig. 5

◆ Attaching Oculars

Remove the ocular adapter cover after the locking ring has been loosened by turning it counter clockwise. Then, insert the desired ocular into the adapter and tighten the ocular ring by turning it clockwise. Refer to Fig. 6.

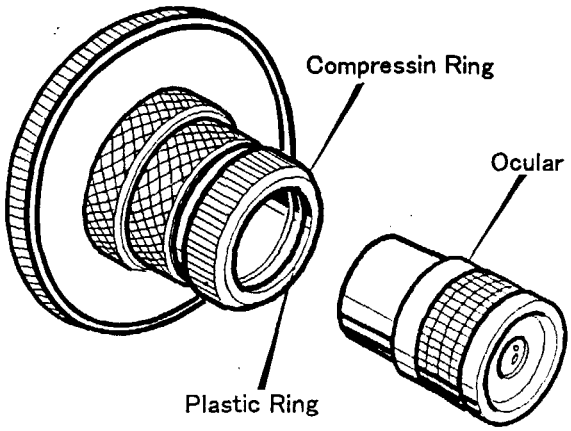


Fig. 6

◆ Connecting The System Parts

Carefully study the system chart in this manual before connecting the system parts. Connecting the parts incorrectly may prevent the FSQ from coming to sharp focus or any focus at all!

Focusing

After inserting the ocular into the telescope, it is necessary to achieve the best possible focus. Remember the atmosphere will limit the highest magnification that can be used on any given night. Using the lowest power ocular; focus the image and then increase the magnification by using shorter and shorter focal length oculars until the desired magnification is reached. This procedure allows the centering of an object at high magnification. Please familiarize yourself with the following.

◆Focusing System

The FSQ uses a rack-and-pinion focusing system. This system permits rapid focusing. By turning the focusing knob clockwise the focuser will move out and by turning the focuser knob counter-clockwise the focuser will move in. Refer to Fig. 7.

Remove the dew shield end cover and eyepiece plug from the telescope. Insert the diagonal into the compression ring and adapter. Carefully tighten the compression ring until it begins to make contact with the barrel of the diagonal. It is not necessary to overtighten the ring to hold the diagonal.

Then insert the ocular into the compression ring of the diagonal, repeating the previous process. Be careful not to overtighten the compression ring.

Begin the focusing process by choosing a bright star in a convenient position. When you think that you have achieved best focus, move the focuser inside and outside of what you think is the best focus position and back to what is best focus. This will confirm the critical procedure.

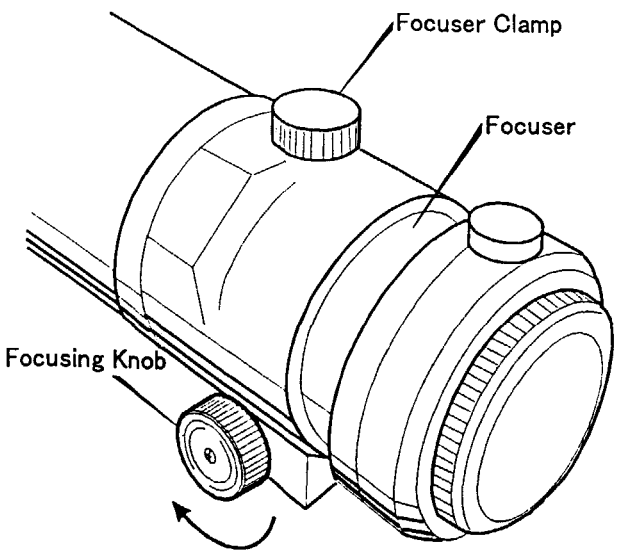
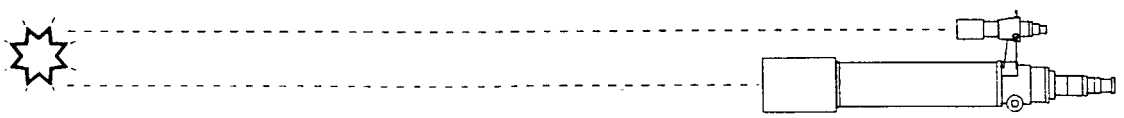


Fig. 7

Begin with a low power ocular and then proceed higher and higher until the desired magnification has been achieved.

When best focus at high magnification has been achieved, you may notice a bright and dim ring around the star. This is not a defect but rather a diffraction pattern which is an indication of diffraction limited optics.

Finder Alignment



A finder is a useful tool. It permits the precise centering of an object in the field of view. The 6.3° field of view allows the easy centering of an object to be viewed or photographed.

The Takahashi finders use an interrupted crosshair which is designed to allow the easy centering of an object to be photographed or observed. The wide field of the finder makes the finding of an object easier, therefore, it is important that the finder and the telescoep be in alignment. The following procedure can be used to align the finder.

◆Alignment Procedure

1. Place a low power eyepiece in the telescope and center a bright star in a convenient part of the sky. Do not forget to engage the motor drive to keep the star centered. If this procedure is done in daylight, use an object that is at least one mile away. Loosen the lock nuts on the finder bracket and slightly move the star to the center of the field using the adjusting alignment screws.

2. Then use a higher magnification eyepiece and repeat the procedure by centering the object in the field of view of the telescope and then the finder. Continue this process until the highest possible magnification has been used.

Finally, tighten the lock nuts and locking screws. If the object moves slightly, adjust alternately tighten and loosen the locking nuts until the object stays in the center.

◆Adjusting Screw Procedure

1. Turn all the lock nuts until they reach the head of the alignment screws.

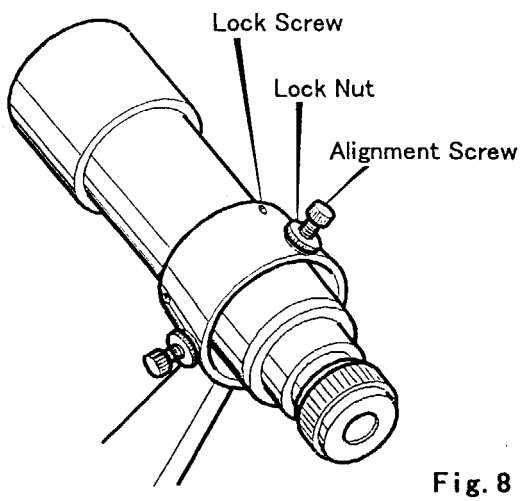


Fig. 8

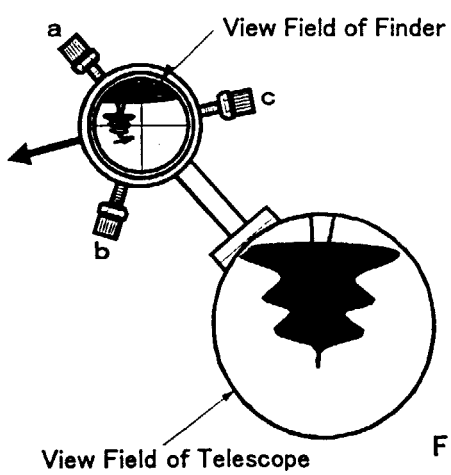


Fig. 9

2. In order to move the crosshair in the direction of the arrow, first loosen screw (a) and tighten (push) the finder with screw (c). This procedure will move the crosshair in the desire direction. The top of the finder will move in the opposite direction and the object will move in the direction of the smaller arrow.
   Refer to Fig. 9.

3. In a similar fashion the direction of the movement of the finder is made by adjusting the three screws.

Learn the relationship between the movement of the three adjusting screws. If the finder cannot be moved in the desired direction, loosen the locking nuts.

◆Reticle Illuminator [Optional]

The 7x50 finder has provision for an optional reticle illuminator.
If an illuminator will be installed, remove the cap screw at the end of the finder and install the reticle illuminator. The illuminator makes the centering of dim objects easier.

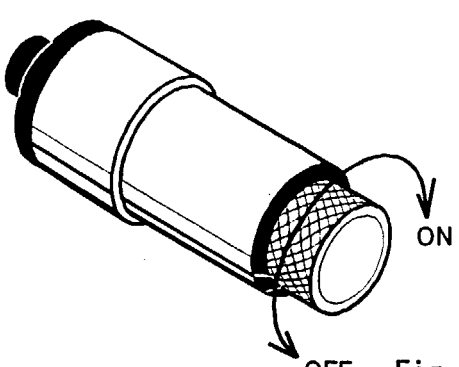


Fig. 10

In order to turn the illuminator on, turn the knob clockwise. The knob will click when the illuminator turns on. As the knob is turned, the reticle will brighten. Adjust the knob to the desired brightness. Turn the knob counterclockwise past the click to turn the illuminator off. Refer to Fig. 10.

◆Replacing The Battery

Before changing the batteries in the illuminator, please be certain to turn it off. Unscrew the battery holder as shown in Fig. 11. Remove the old batteries and insert new one after they have been wiped with a clean dry cloth. Check the polarity of the batteries before inserting them into the holder. Use two silver [V76-PK] or equivalent batteries.

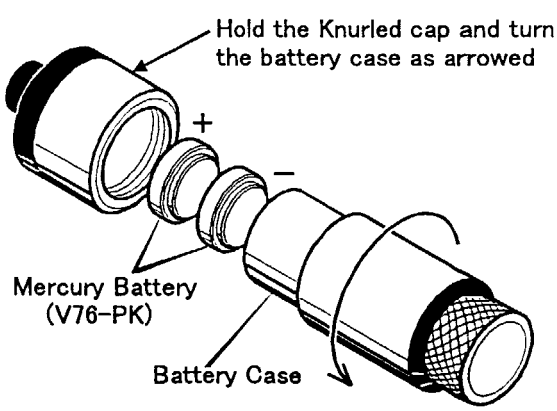


Fig. 11

Visual Observation

◆ Determining Magnification

The magnification of any ocular used with the FSQ can be calculated by using the following formula.

$$\frac{\text{(focal length of a telescope)}}{\text{(focal length of an ocular)}}$$

Therefore, the shorter the focal length of the oculars used, the higher the magnification produced.

During nights of good seeing, the FSQ-106 can be used at a magnification of 100x per inch and on nights of exceptional seeing 120x or more can be used. These rare nights of exceptional seeing will reveal fine planetary filaments and small craterlets on the Moon. At the lower end, using a mignification of 10X per inch will produce breathtaking, ultra high contrast views of galaxies, nebulae and comets.

◆ Compression Ring Star Diagonals

Takahashi supplies each FSQ-106 set [telescope w/mount] with a 90° compression ring 1 1/4″ diagonal. The compression ring centers the ocular and makes the optical axes of the ocular and the telescope coincidental.

Set the ocular into the compression ring and carefully tighten the ring. Do not overtigten the compression ring.

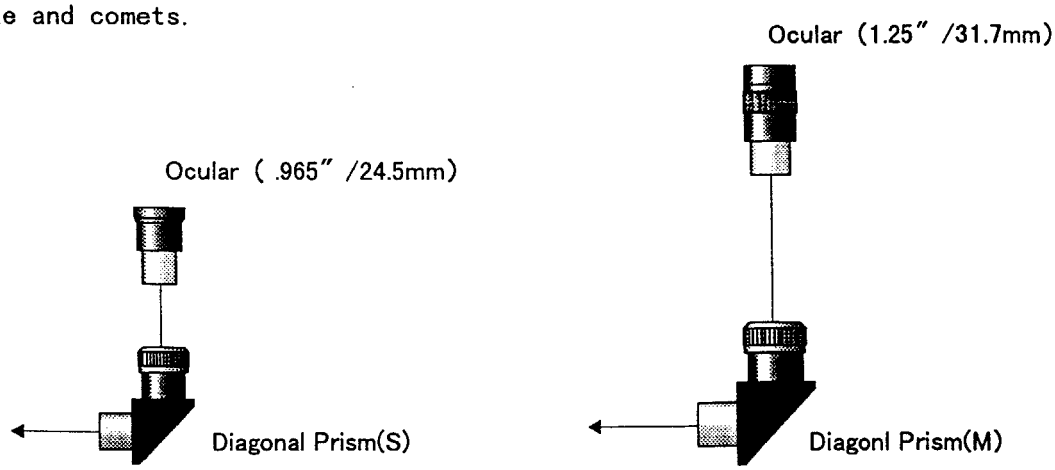


Fig. 12

◆ Extender-Q

The FSQ-106 is a short focus photo/visual astrograph. Nonetheless, due to the very high quality of the optics, the instrument can be used for high magnification lunar and planetary observations.

The Extender-Q is designed to increase the focal length sufficiently to produce the higher magnifications necessary for this type of observing. This dedicated extender increases the focal length by 1.6X to 850mm.

When used with the Takahashi LE-5 ocular it produces 170X or 303X if the 2.8 Takahashi High Eye ocular is used. Refer to the Extender-Q chart below.

FSQ-106 Extender-Q System Chart

8. Multi-Adapter Ring
10. Visual Adapter
46. Ocular Adapter (1.25″)
47. Ocular (1.25″)
48. Ocular (2″)
49. Diagonal Prism (1.25″)
60. Extender-Q
61-A. Vari-Tube (L)
61-B. Vari-Tube (S)
62. Visual adapter (Extener-Q)
66. Adapter-Q (2″) (Extender-Q)
74. Diagonal Mirror (2″)

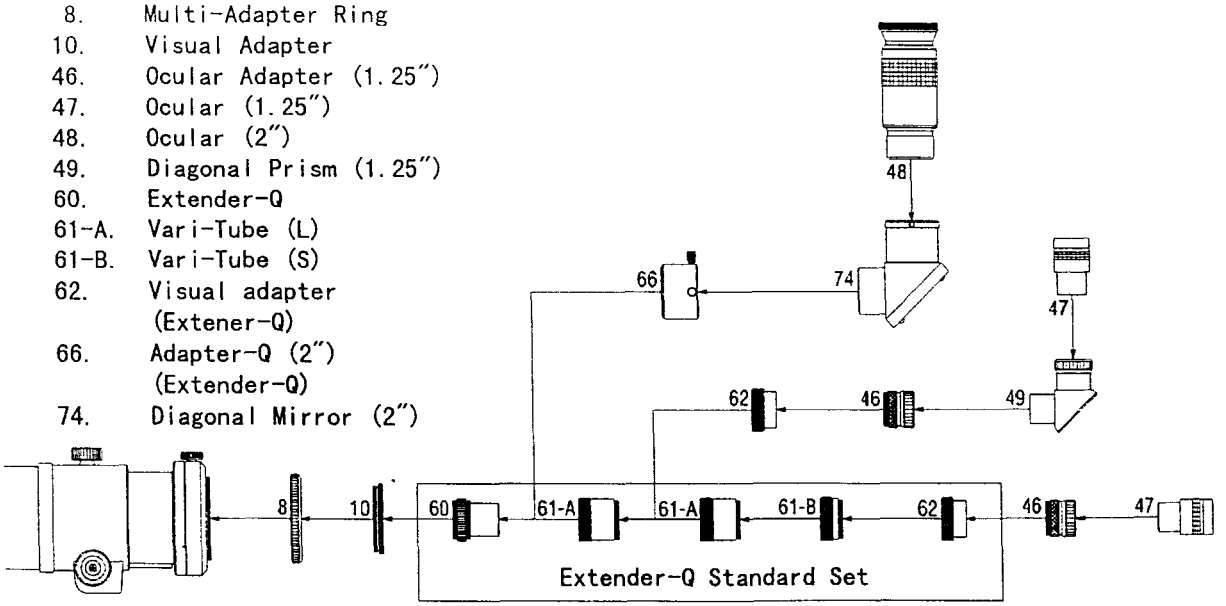


Fig. 13

◆ Lunar Observation

The Moon is an excellent object for beginners as well as advanced amateur astronomers. The entire Moon can be viewed at 50X. If the Moon is full, it is best to use an ND96, 58 green, 3N5 filters or variable density polarizer.

Good lunar observing requires some patience. Since the seeing varies from moment to moment, each object should be observed for a period of time to familiarize oneself with the area. Familiarization will allow the observer to see more detail and in the moments when seeing greatly improves, see amazingly detailed views of the lunar surface. Using higher magnification will allow the observer to see smaller details, ray structures, and rilles. Due to the diminished image brightness, filters are not necessary.

◆ Planetary Observing

When used with the dedicated Extender-Q, the FSQ-106 becomes an outstanding planetary telescope. The ultra sharp, very high contrast images are tailormade for viewing intricate filamentary planetary detail.

High magnification planetary observing requires the best of steady seeing conditions. In order to determine the quality of seeing at the beginning of an observing session, visually observe a bright star at the zenith. If the star is twinkling rapidly, the seeing is poor. It is on those when the star does not twinkle or twinkles very slowly that high magnification planetary viewing can be done. When the seeing is this steady, magnification up to 100x per inch can be used.

Additionally, high quality photos can be made using Fuji Velvia film.

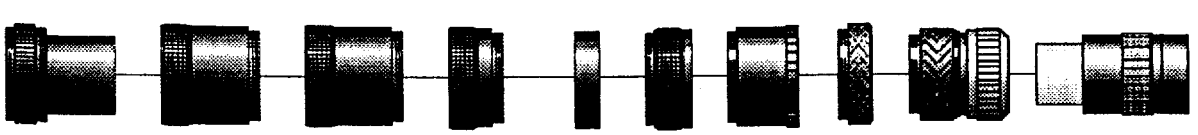
The TCA-4 can be used to achieve the effective focal length of up to f/150 to produce very high quality lunar and planetary photos.

◆ Deep Sky Observing

In general, observing nebulae and star clusters requires a low power, wide field eyepiece which can take full advantage of the FSQ's light gathering capabilities.

On the other hand, observing globular clusters and small nebulae requires higher magnification. This is particularly true in cities with high sky brightness. High magnification will help reduce the background sky brightness and increase the contrast necessary to view these objects.

A good source for beginners for observing deep sky objects is the Messier list. All of these objects can be observed with FSQ-106.



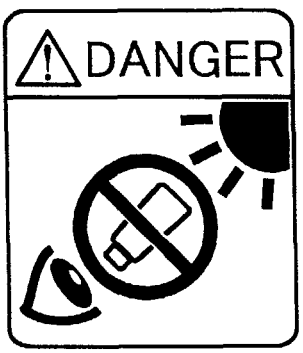
◆ Solar Observation

The FSQ-106 can be used for solar observation when used with a properly designed glass, high quality solar filter that rejects 99.9% of the heat and light. There are three types of these filters which implies how they are used.

The photographic type transmits more light and hence should not be viewed through directly. The image is focused by looking through the finder of the camera for very brief period to achieve focus and for framing purposes.

The second and most used are the visual kind. These filters produce a yellow disk close to the color of the Sun. It is absolutely imperative that the filter be firmly attached over the objective. Additionally, the finder must be covered to prevent any light which could damage the eye, from being transmitted.

Lastly, sub-angstrom hydrogen alpha filters can also be used with great success. These filters operate at focal ratios of over f/30 and require a rejection filter to operate properly. Though their cost is high, they produce spectacular images of solar prominences.



Sun Projection Observation System

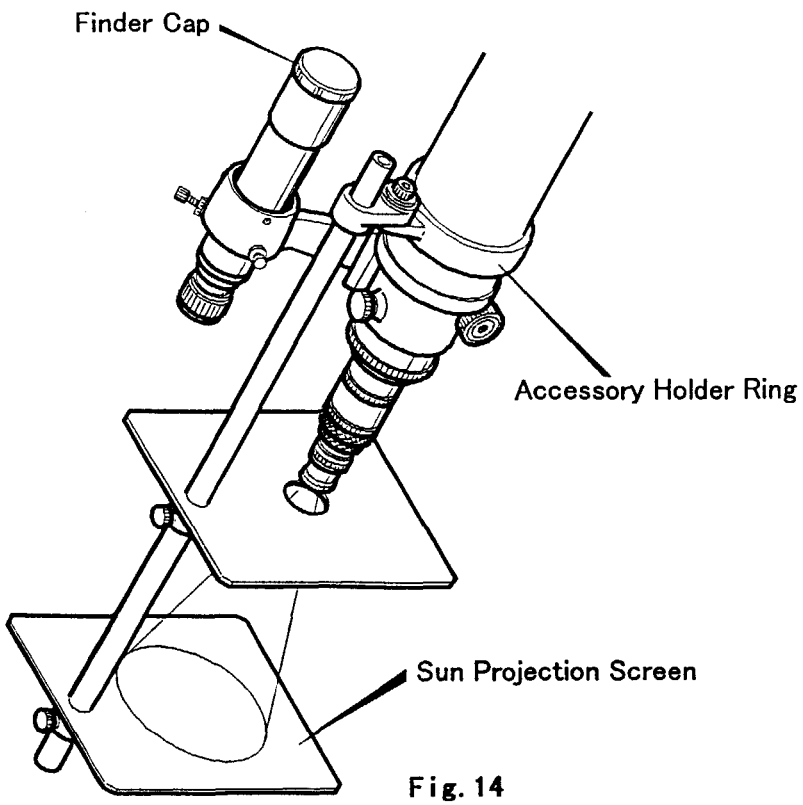


Fig. 14

Astrophotography

Focus is the most critical part of a fine astrophoto. Once critical focus is achieved, photos can be made. If possible recheck focus to make certain that nothing has changed.

FSQ-106 is very high quality F/5 astrograph with a large image circle of 88mmϕ an amazing 9.5° across. This large image circle will fully illuminate a 35mm, 645 and 6x7 medium format cameras as well as any CCD camera. Additionally, a special 4x5 vacuum back camera can also be used to produce outstandingly sharp photos illuminated by a 114mm ϕ image circle.

The ultra sharp stellar images produced by the FSQ-106 make it necessary for each photo to be precisely guided. Guiding error will make the pinpoint stellar images become egg shaped. Therefore, a heavy-duty highly accurate mount is needed to prperly guide the astrophotos. The Takahashi EM-200 is the perfect choice for this task.

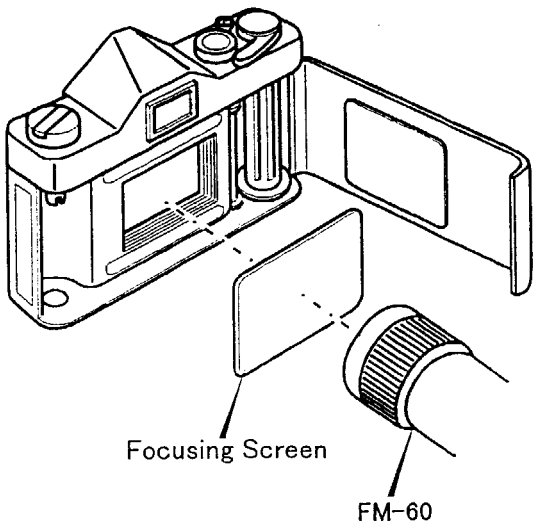


Fig. 16

Focusing with the FM-60 focusing microscope and ground glass is shown in Fig. 16. Set the ground glass in place with the mat side facing the objective of the FSQ. Then focus and check for pinpoint focus over the field of view.

❶Photographing With A 35mm Camera

As shown in Fig. 15 a 35mm camera can be attached as show with the CA35 camera adapter and a wide mount T-ring.

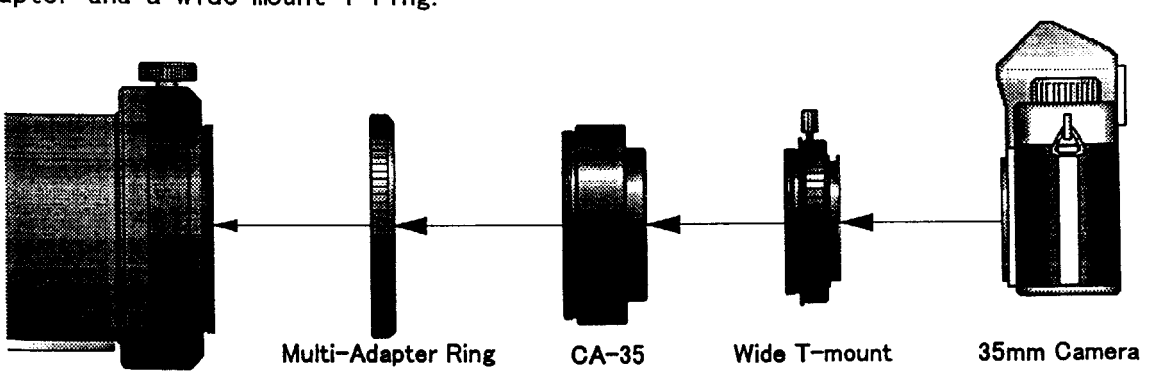


Fig. 15

❷Photographing With A Pentax6x7

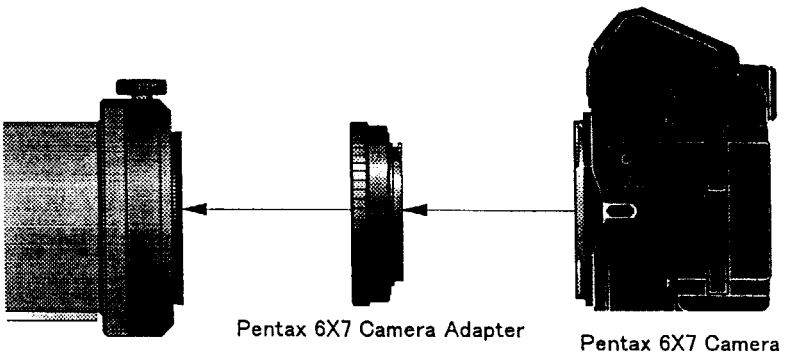


Fig. 17

Change the finder screen to one with a mat finish. This will allow pinpoint focus when used with the FM-60 focusing microscope. The focusing procedure is the same as the one shown in Fig. 17 for a 35mm camera.

❸Photographing with 6x7, 6x9, and 4x5 astro camera

Attach the camera onto the camera angle adjuster with the dedicated adapter as shown in the fig. 18, 19.

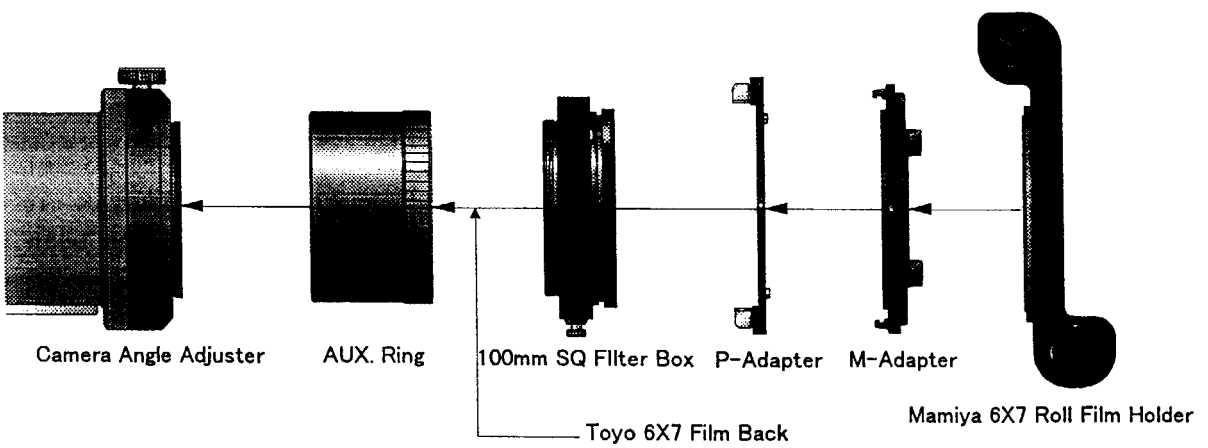


Fig. 18

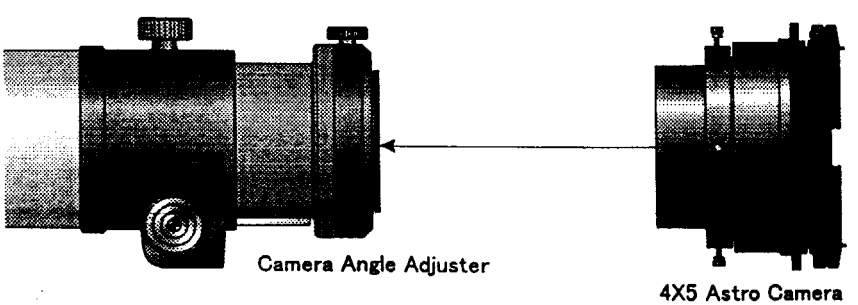


Fig. 19

❹Imagining with a cooled CCD camera

The FSQ-106 can produce very small stellar images into the very far infrared that is very suitable for CCD cameras. Attach a cooled CCD onto the camera angle adjuster with a wide T-mount, a CA35 adapter, and multi-adapter ring as shown in Fig. 20.

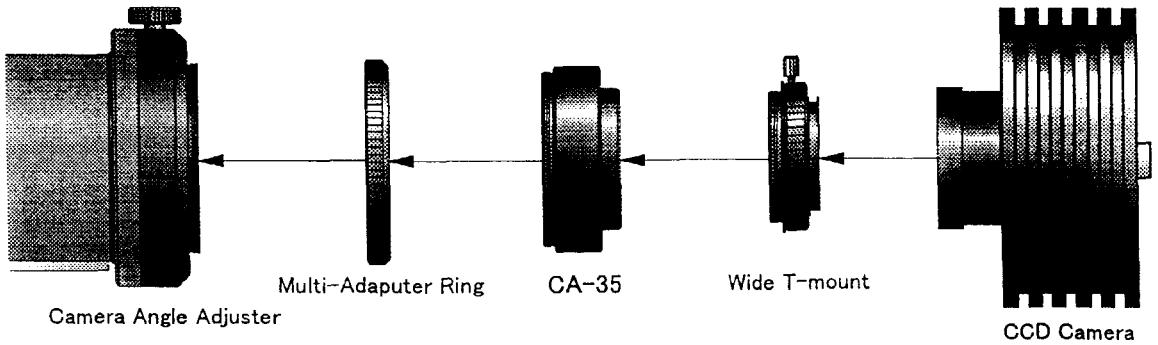


Fig. 20

❺Attaching A Filter

● 48mm φ

When a 35mm camera is used a 48mmφ can be attached to the wide T-ring. It is most important that the focuser be rack out about 1" to keep the filter or fingers from touching the top surface of the rear lens assembly in the FSQ. When the focuser is racked all the way in, the top of the lens is near the end of the tube. So racking the focuser out some distance will prevent any damage from a filter hitting the rear lens.

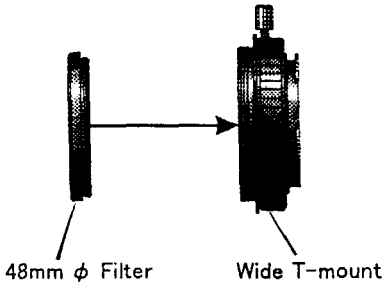


Fig. 21

● 72mm φ

A 72mm φ can be attached to the FSQ. Remove the multi-adapter ring before threading the filter. The filter threads into the rear lens cell inside the tube. This filter should be attached with the greatest care. When the filter is screws in, pay great attention to the finger tips to keep them from touching the surface of the rear lens.

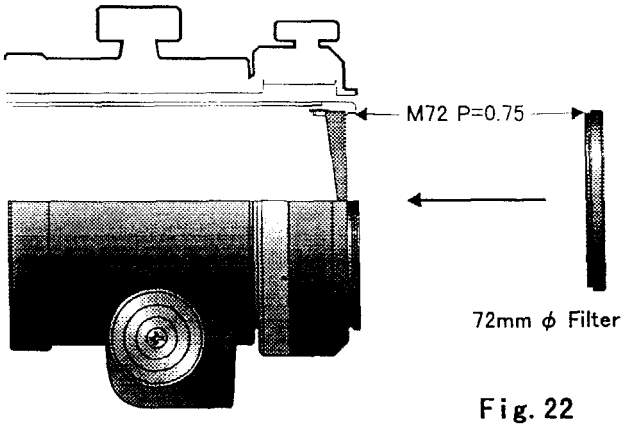


Fig. 22

When a filter is attached, do not rack in the focuser, since the multi-purpose adapter could hit the filter. It is always a good idea to keep the focuser racked some distance to prevent damage.

❻Precautions

● Achieving Sharpest Focus

Use a 3rd or 4th magnitude star for focusing. The focusing system of the FSQ-106 is very sensitive, so great care should be taken during the focusing process to insure the best possible focus. When photos are taken in the summer the air may be very humid. This humidity will cause film to buckle, thereby making some of the photo not sharp because the film has moved away from the film plane.

● The situation can be remidied by the following.

1. 35mm camera: Carefully turn the rewind knob to place tension on the film and place a rubber band over the crank to hold the very slight tension. Remember to remove the rubber band when the film is advanced to the next frame.
2. 6x7, 6x9 or 4x5 cameras: Use a vacuum back to hold film flat for the sharpest possible photo.

● Trial photographing

It is a good idea to make trial photographs with the FSQ-106 before taking it out to remote sites. These photos will aqcuaint the user with the procedure necessary to make excellent astrophotos. Usually a 5 minute photo will be sufficient to record stars for this purpos.

◆High Magnification Photography

The following products can be used to make high quality Lunar and planetary photos.

❶Extender-Q

The Extender-Q [optionally available] can be used to increase the focal length of the FSQ by 1.6X.

The Moon can be photographed either at prime focus or with eyepiece projection. The image brightness of the Moon will tend to keep exposures shorter.

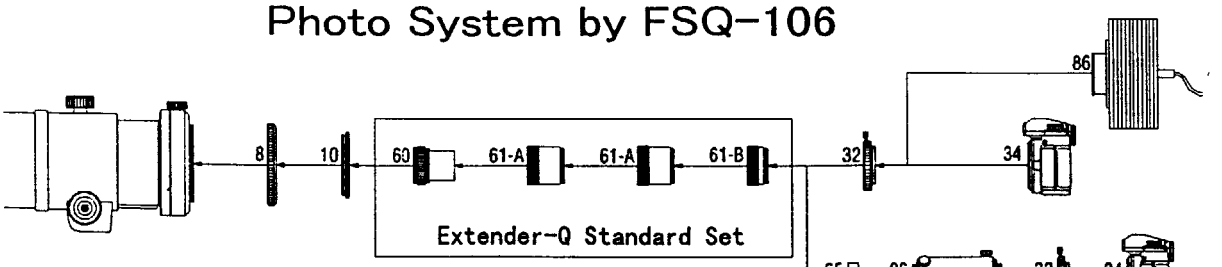
On the other hand, high magnification planetary or lunar crater photography, due to the image being dimmer, will require considerably longer exposures of up to 5 seconds or more. On nights of exceptional seeing, when stars at the zenith do not twinkle, exposures can be made up to 10 seconds in duration.

The importance of steady seeing cannot be over emphasized. It is advisable to make the photos when the twinkling is very slow or at best totally steady.

❷TCA-4 Photography

Using a specially designed ocular holder, 1 1/4″ oculars can be used to make projected highly enlarged images. The integral slide tube can be moved to increase the overall focal length. This is accomplished by loosing the set screw and moving the assembly.

Photo System by FSQ-106



8. Multi-adapter Ring
10. Visual Adapter
60. Extender-Q
61-A. Vari-tube (L)
61-B. Vari-tube (S)
32. T-mount
34. 35mm SLR Camera
36. TCA-4 Camera Adaputer
65. EC Ring
86. CCD Camera

Fig. 23

Care & Maintenance

◆ Your FSQ-106 apochromatic refractor has been precisely collimated at the factory by skilled optical technicians. In the event, as a result of a heavy blow, collimation is lost, please contact your local distributor. They will collimate the instrument and return it to you.

◆ If dust particles collect on the front element, carefully remove the dew shield, then the particles can be removed by using a large handpowered blower. Under no circumstances should canned air be used to remove these particles. Canned air contains a refrigerant that is very cold and could cause damage to the front element.

◆ Under no circumstances should the surface be rubbed, as this could cause scratches in the coating.

◆ Use pure cotton swabs slightly moistened with lens cleaner and gently remove any dirt.

◆ The lens cell has been threaded to accept a 112mmϕ filter. If one is used to protect the objective, there may be some image ghosting. If there is any ghosting, it will disappear when the filter is removed.

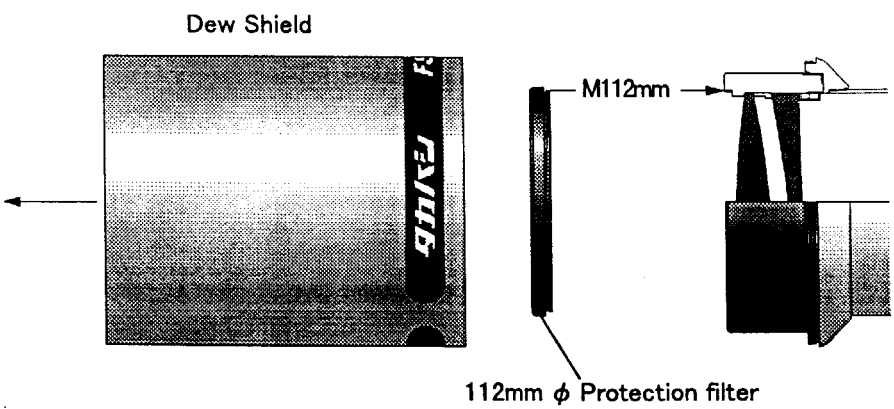


Fig. 24

Additional Precautions

◆ Keep the telescope away from large fluctuations in temperature. When the instrument is brought out from a warm room to colder air, dew may form.

◆ Store the telescope in a cool dry environment. Any dew should be removed by blowing it with a hair dryer with the heating element turned off, which means the air will be at room temperature. This flow of cool, room temperature air, will dry the dew and not leave a residue. Additionally, it is a good idea to store the telescope with a desicant [drying agent] near the objective to keep any moisture away from the objective.

◆ As mentioned previously, never use canned air due to the fact that the propellant is a refrigerant which could cause damage to the front element. If the front element must be cleaned, make certain that it is done in a cool room.

◆ If you want to extend the focal length of the FSQ, use the dedicated Extender-Q. As illustrated the use of any Barlow lens which extends out could hit the rear lens of the telescope and cause it to crack.

◆ The Extender-Q is designed for the FSQ and will produce the maximum performance for lunar and planetary observations and is the only extender that should be used with the FSQ-106.

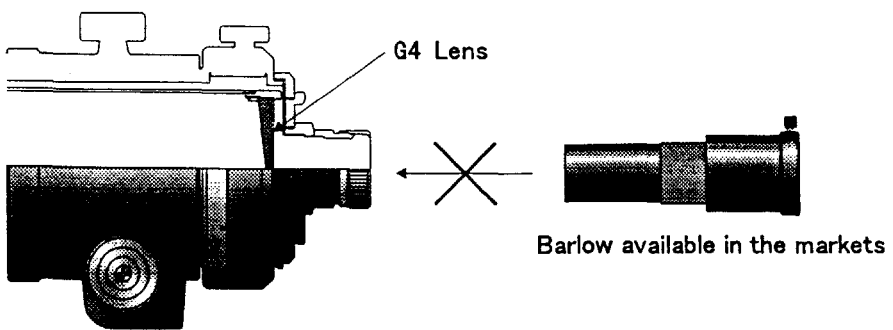


Fig. 25

What is Fluorite?

Calcium fluorite (CaF2) is a naturally occurring crystal. Its very low refractive index makes it the best of materials to use in the manufacture of apochromatic telescopes. Unfortunately, the natural crystal contains impurities and as a result, displays some properties that make it unsuited for use in a telescope.

Comparative Diagrame(non-coated)

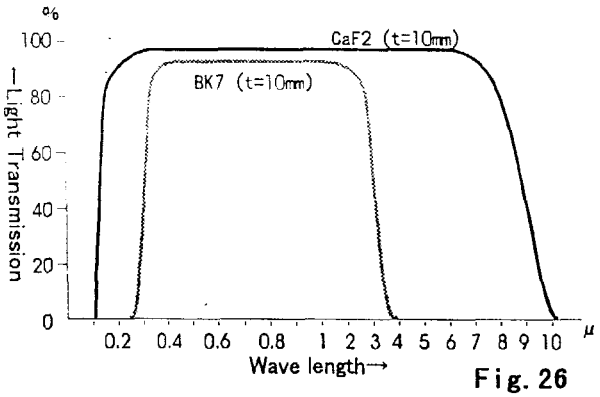


Fig. 26

Now thanks to modern technology, fluorite crystals are be grown in an oven. This process produces a totally pure mono crystal structre that does not display any of the unsuitable properties of the natural crystal and has the same very low refractive index. Now, calcium fluorite crystal can be hard multi-coated for maximum light transmission and durability.

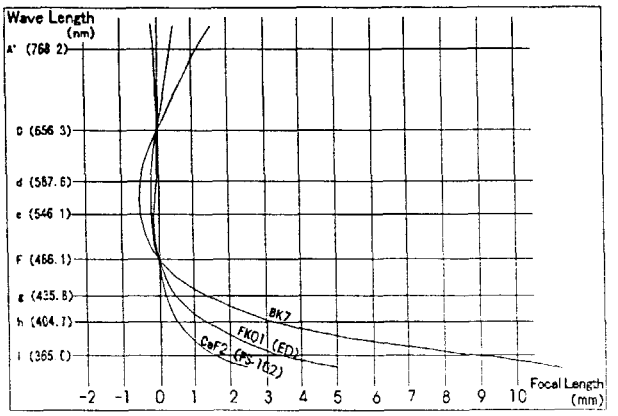


Fig. 27

As the diagram shows, the band pass of fluorite of 1000 to over 100,000 angstroms eclipses by many magnitudes that of any optical glass. Additionally, the use of multicoatings further increases light transmission over any ED glass. These features make the fluorite objective the premier photo/visual instruments for deep sky or lunar and planetary applications in their size class.

When the fluorite instrument is taken out for an observing session, it will take about 30 minutes for the objective to temperature equalize for maximum performance. This fact is also true for any optical system used.

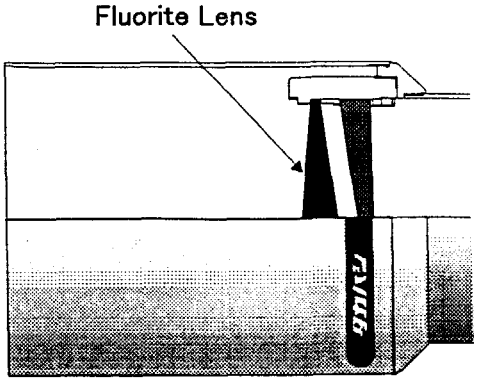
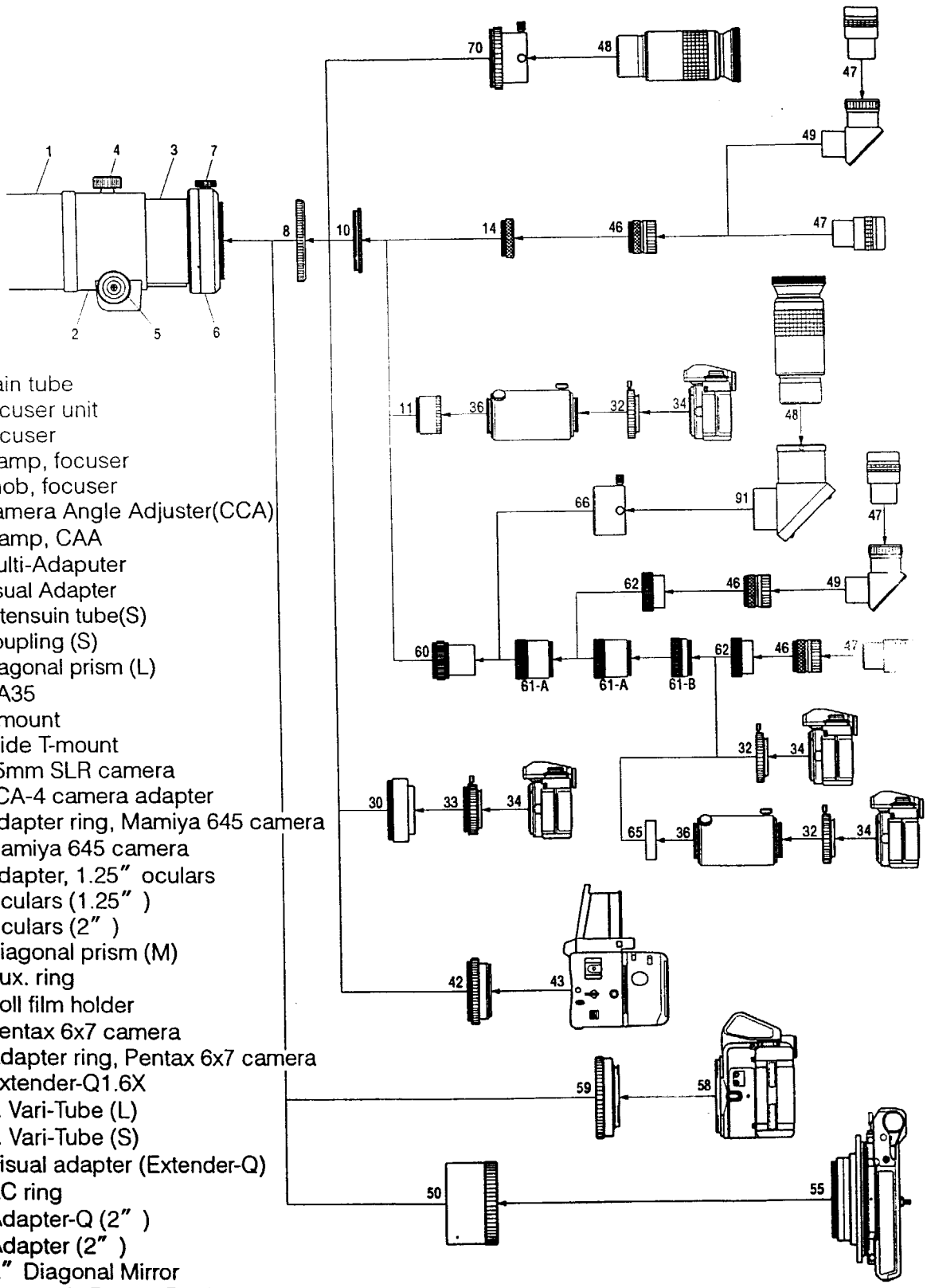


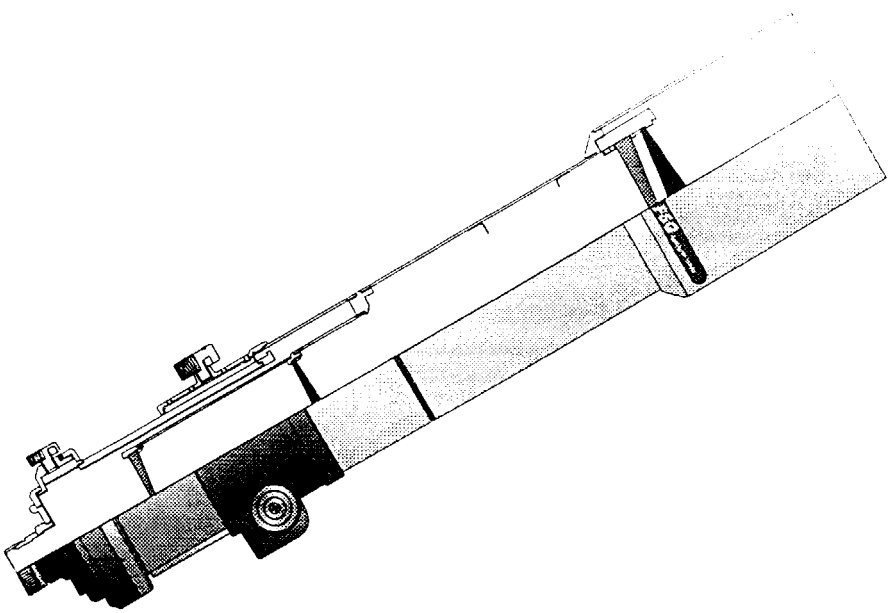
Fig. 28

System Chart



1. Main tube
2. Focuser unit
3. Focuser
4. Clamp, focuser
5. Knob, focuser
6. Camera Angle Adjuster(CCA)
7. Clamp, CAA
8. Multi-Adaputer
10. Visual Adapter
11. Extensuin tube(S)
14. Coupling (S)
24. Diagonal prism (L)
30. CA35
32. T-mount
33. Wide T-mount
34. 35mm SLR camera
36. TCA-4 camera adapter
42. Adapter ring, Mamiya 645 camera
43. Mamiya 645 camera
46. Adapter, 1.25″ oculars
47. Oculars (1.25″)
48. Oculars (2″)
49. Diagonal prism (M)
50. Aux. ring
55. Roll film holder
58. Pentax 6x7 camera
59. Adapter ring, Pentax 6x7 camera
60. Extender-Q1.6X
61-A. Vari-Tube (L)
61-B. Vari-Tube (S)
62. Visual adapter (Extender-Q)
65. EC ring
66. Adapter-Q (2″)
70. Adapter (2″)
91. 2″ Diagonal Mirror

* No. 58 is Pentax Product



TAKAHASHI SEISAKUSHO Ltd.

41-7 Oharacyo Itabashi Tokyo 174-0061, JAPAN

PHONE:+81-3-3966-9491 FAX:+81-3-3966-9524