Triplet Ortho Apochromat

TOA-150B

INSTRUCTION MANUAL

TAKAHASHI

Thank you for purchasing the TAKAHASHI TOA-150B Triplet Ortho Apochromat. The optical design is new and is able to produce color-free, high contrast images due to its extremely high color correction. The TOA-150B is corrected in the non-visible near infrared and UV to make CCD imaging easier. The optionally available reducers, which include soon to be released 645Reducer for large chip CCD cameras and flatteners, turn the outstanding visual TOA-150B into a flat field astro camera.

In order to use the TOA-150B to the limit of it capabilities, please read this instruction manual and familiarize yourself with the function of the entire system before using the TOA.

⚠ WARNING



NEVER ATTEMPT TO DIRECTLY OBSERVE THE SUN THROUGH THE TOA-150. NEVER USE ANY SOLR OBSERVING DEVICE THAT DOES NOT HAVE A FULL APERTURE FILTER DESIGNED FOR SOLAR OBSERVING. ANY DEVICE THAT DOES NOT COVER THE OBJECTIVE WILL ALLOW THE INTERIOR OF THE INSTRUMENT TO HEAT AND COULD CAUSE THE OBJECTIVE TO CRACK. FURTHER, THE FINDER SHOULD BE COVERED WITH AN OPAQUE COVER TO PROTECT THE EYE FROM DAMAGE. USE A PIECE OF SOLAR GRADE MYLAR TO COVER THE OBJECTIVE. AN UNCOVERED FINDER CAN CAUSE SERIOUS EYE DAMAGE OR BLINDNESS. KEEP THE INSTRUMENT OUT OF THE REACH OF CHILDREN DURING DAYTIME USE.

⚠ CAUTION

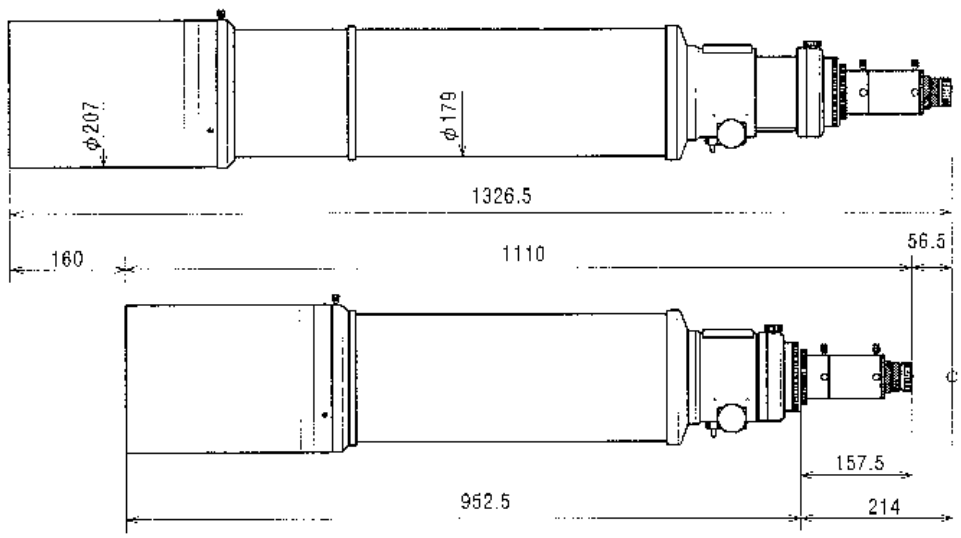
- When the TOA-150B is placed on a surface, make certain that the surface is flat to prevent the OTA from rolling off.
- Keep the tube assembly out of the Sun except when it is being properly used for solar observing. If left in the Sun the air inside could heat up and cause damage to the objective.
- Keep small children away from small objects like oculars to prevent them from accidentally swallowing a part.
- Keep the shipping carton in a safe place away from any flame. It can be used as a temporary travel container since it is triple boxed.

CONTENTS

Warning & Caution 2
CONTENTS 3
Specifications 4
Tube Assembly Layout 5
What is the TOA-150B 6
Attaching Finder & Tube Assembly 7
Focusing 11
Finder Alignment 13
Observation 15-16
Photo/Visual Accessories 17-23
Care & Maintenance 24
Additional Precaution 25
System Chart 26

SPECIFICATIONS

Optical System	Air Spaced Triplet
Effective Aperture	150mm
Focal Length	1100mm
Focal Ratio	1: 7.3
Resoving Power	0.77″
Limiting Magnitude	12.7
Light Gathering Power	459X
Diameter of Main Tube	ϕ 179mm
Length of Main Tube	990mm
Weight of Main tube	20.0kg [42.7lbs] includes 4.8kg tube counter weight
Finder Scope	7x50mm



Tube Assembly Layout

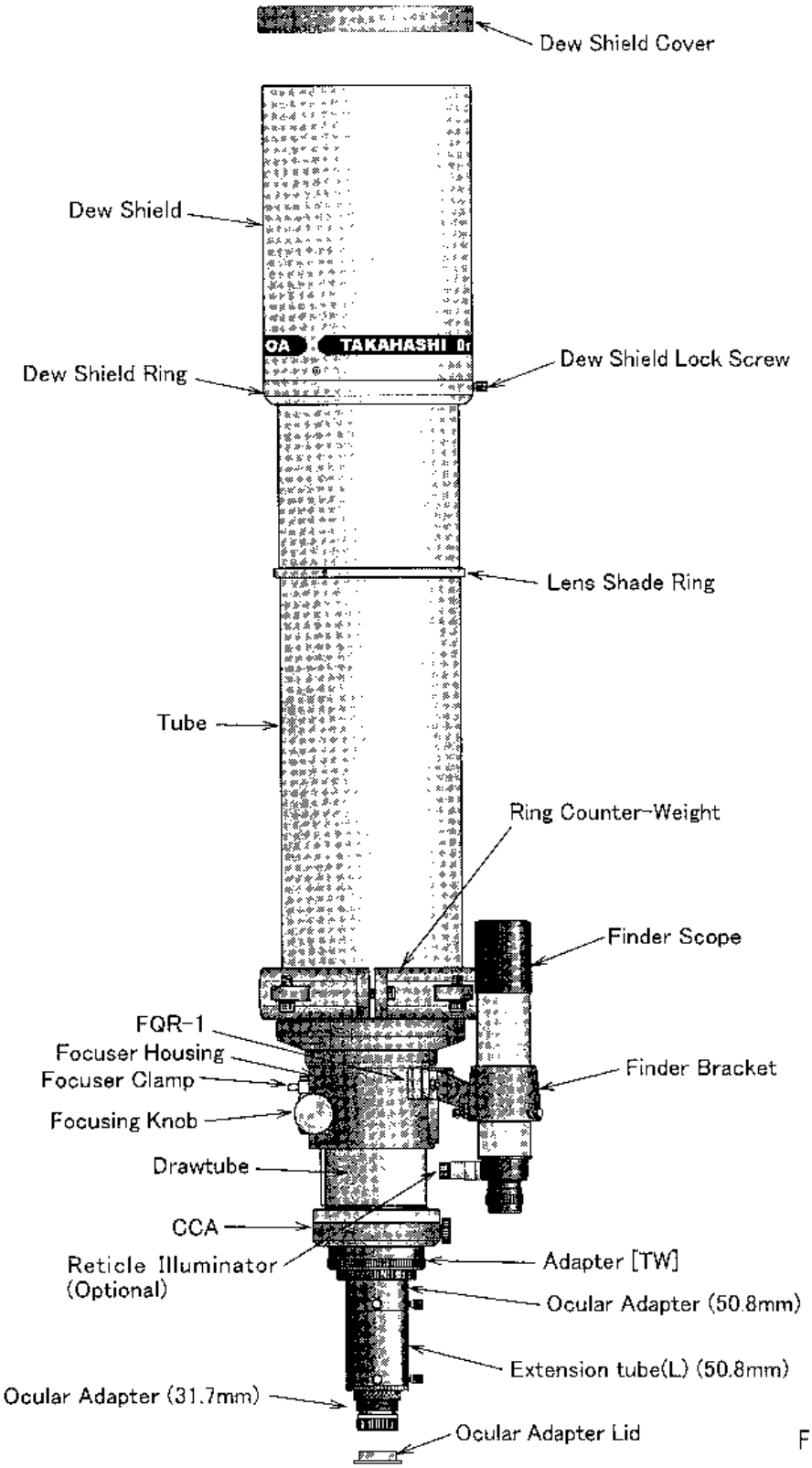


Fig. 1

What is the TOA-150B

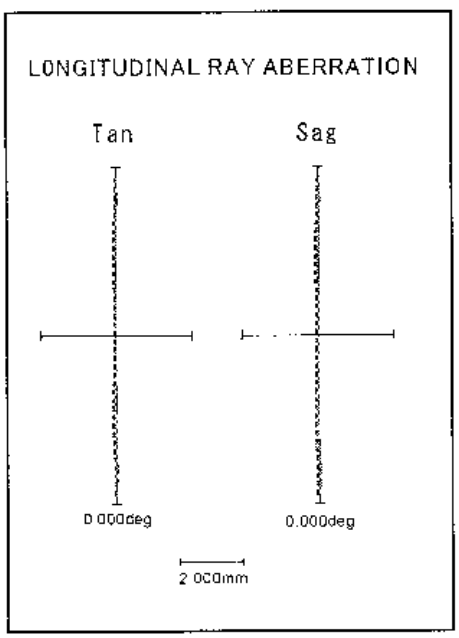
The TOA-150B is a product of Takahashi's research and development over a period of time. Though similar in design to the smaller TOA-130N, its design is different to allow an extremely high order of color correction in a 150mm refractor. This design produces an image absolutely free of any lateral color and is diffraction limited.

The air spaced design of the objective not only corrects that the visible wave lengths, but also corrects in near ultra violet and infra red. This design is a perfect match for CCD cameras.

The TOA-150B with an aperture of 150mm and a focal length of 1100mm can keep the deviation over the focal length to ± 0.01mm in the area of the g line at 4360a wave length to the c line at 6560a. This is an extremely high order of color correction. A design with this correction will show no lateral color in or out of focus. The result is very high contrast image that allows magnifications of over 100x per inch or more.

The TOA-150B can produce an image of I micron in the center in 4 colors, which is far smaller that the diffraction limit of the airy disc.

The TOA-150B has 214mm of back focus which enables the user to attach any combination of diagonal, bino viewer, CCD camera, electronic focuser and bring the image to focus. This enhanced back focus gives great flexibility to the user.



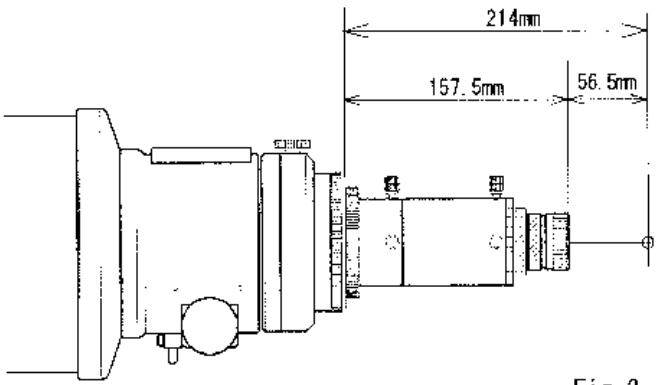


Fig. 2

Attaching The Finder And Tube Assembly

The TOA-150B is shipped with the finder in a separate box to prevent damage during shipping. Use the following instructions to assemble the finder and bracket and mount it.

■ Attaching the Finder Scope

Place the finder bracket over the quick release bracket.

The holes in the base of the finder bracket will match up with the holes in the top plate of the quick release bracket. Attach the bracket with the stainless steel screws provided.

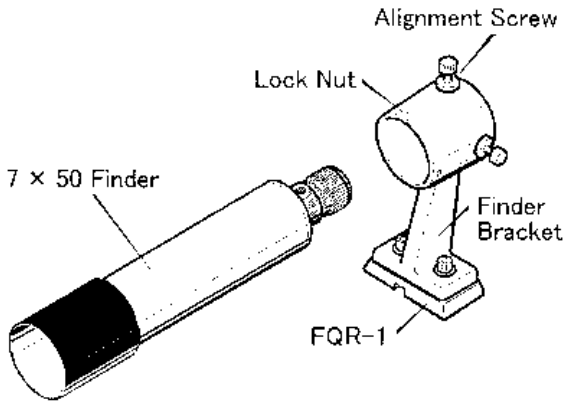


Fig. 3

Align the finder with the main optics and lock the finder bracket set screws. Now loosen the long screws on the left side of the quick release bracket. The finder can be removed and reattached by sliding the finder bracket into the quick release bracket until it stops. You finder will be aligned with the main optics.

The quick release bracket allows the finder to removed and re-attached time and again without loss of alignment.

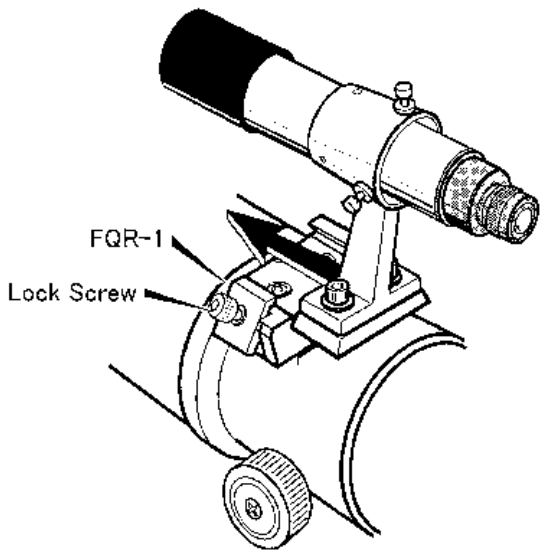


Fig. 4

■ Attaching the Tube Assembly to the Equatorial Mount

Place the tube holder on top of the L-plate and align the holes with the slots in the plate. The insert the four screws provided into the holes in the bottom and hand tighten the screws to the tube rings.

Center the tube rings in the slots in the plate and then tighten the four screws with the Allen wrench provided. See: Figure.5.

The next step is to turn the tube holder so that the bridge is parallel to the ground and the top portion of the holder is away from where you are standing.

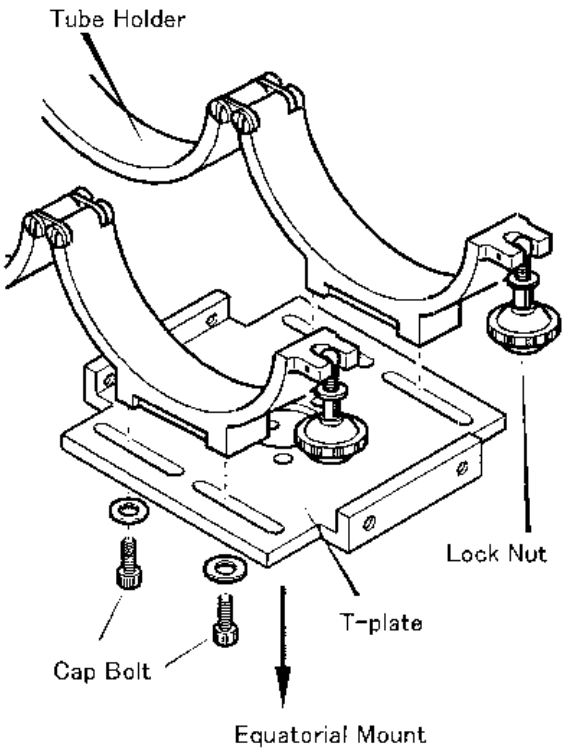


Fig. 5

Lock the Dec. and R.A. axes firmly to prevent the telescope from moving until you have released the clamps axis. Now place the tube assembly into the tube holder, close the holder over the tube and tighten the large set screws. These should be tightened to allow the tube assembly to be moved forward and backwards for balance. See: Figure.6.

Now it will be necessary to balance the TOA-150B in both axes.

Release the Dec. clamp only to allow the telescope to move up or down. Before releasing the Dec. clamp, hold the focuser with one hand in the event that the scope is far out of balance and would move fast and hit you or the mount.

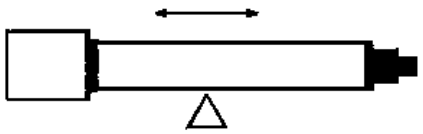


Fig. 6

After releasing the Dec. clamp slowly release your grip on the focuser and watch which way the tube moves.
If it moves objective side down, then return the telescope to a parallel position and move the telescope towards the focuser until it balances.

Then set the Dec counter weight shaft parallel to the ground and move the telescope parallel to the ground.
Release the R.A. clamp and you will note that any imbalance will allow the telescope to move up or down.

Loosen the set screws on the counter weight shaft and move the counter weights until the telescope is balanced.

You are now ready to the final balancing.

Remove the objective cover and attach all of the imaging or optical accessories you will need to accomplish what you wish to do. Repeat the process above with you accessories attached.

Now you are ready to use your TOA-150B. The balancing will allow you mount to operate to the limit of its capabilities.

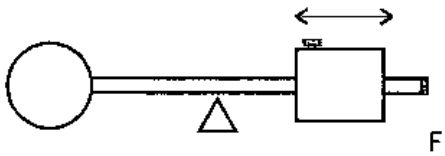


Fig. 7

● How to Use the Tube Counter Weight

The TOA-150B has been designed to be used with a wide variety of imaging and visual accessories. Therefore, a counter tube weight has been provided.

This weight is felt lined to allow it to be easily moved up or down the tube. The weight use 6mm Allen screws. These can be loosened or tightened easily. See Figure.8.

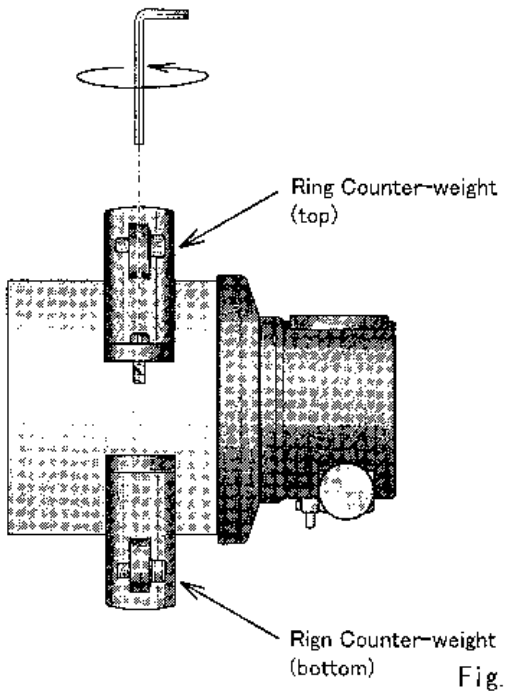


Fig. 8

● How to Retract and Extend the Lens Shade

The TOA-150B has been designed with a retractable lens shade. This allows the TOA to become more compact for easier transportation to remote sites.

The lens shade can be retracted by gently pushing it until it rest upon the ring near the objective end of the telescope. This shade is precisely fitted and slides on felt, so do not place the lens cover over the front to allow the air to be pushed out. If the cover is place on the lens, the air pressure could pop the lens cover off of the front of the lens shade.

When the lens shade has been fully retracted, then place the lens cover over the lens shade.

In order to extend the lens shade, do the following.

1. Remove the lens shade cover from the lens shade.
2. Loosen the two locking screws located at the base of the lens shade.
3. Extend the lens shade by pushing the base forward.
4. Tighten the two clamping screws. Remember to loosen these when retracting the lens shade.

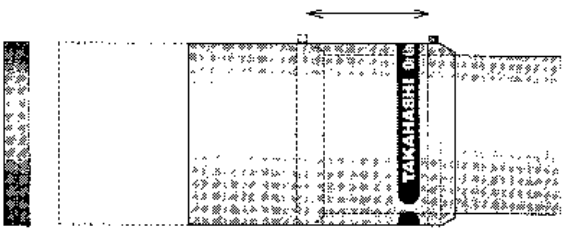


Fig. 9

■ Attaching Oculars & Accessories

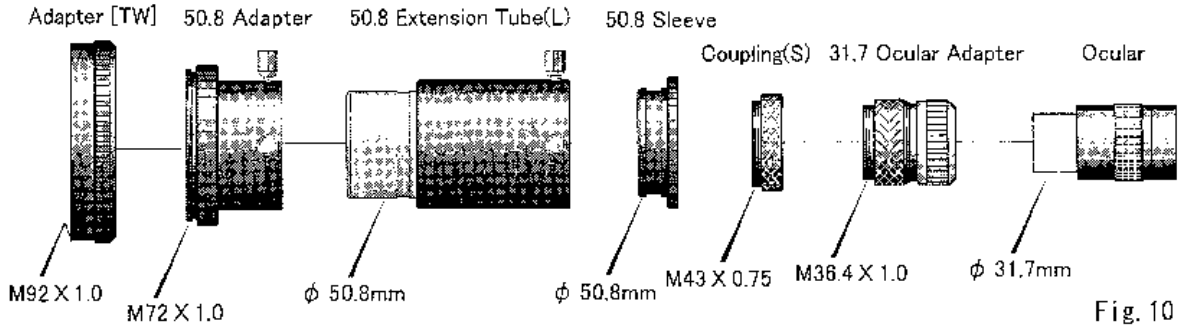


Fig. 10

■ Compression Ring

Remove the ocular cover after loosening the chrome lock ring by turning it counter-clockwise. Then, inset the ocular into the adapter and loosely tighten the chrome lock ring by turning it clockwise.

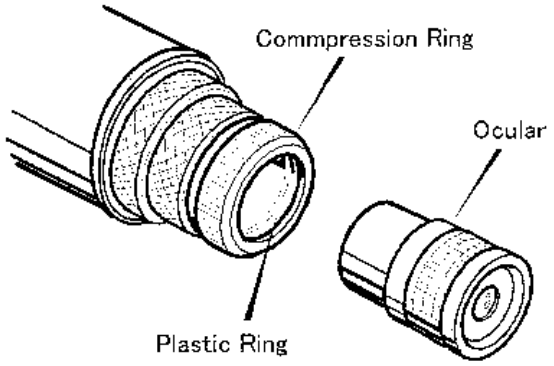


Fig. 11

■ Connecting System Parts

Study the system chart carefully included in this instruction manual before connecting system parts. Incorrectly connecting system parts will not allow the TOA to focus or image will not be as sharp as it can be.

■ Focusing

The best possible focus will insure the highest degree of satisfaction from the TOA. Do not forget that the atmosphere will limit the highest usable magnification.

Start with a low power ocular and then, by using shorter and shorter focal length oculars, increase the magnification until the desired magnification is achieved.

This process also allows the object to be continually centered in the field of view.

Please familiarize yourself with the following procedures.

● Focusing System

The TOA-150B uses a rack-and-pinion focuser. This focuser enables the observer to focus rapidly. Turning the focuser clockwise will move the drawtube out, while turning it counter-clockwise will move the drawtube in. Refer to Fig. 12.

This focuser has Takahashi original 1/7 micro edge focuser built-in. Turning the small knob clockwise or counter-clockwise can achieve very fine focusing at high magnification or for imaging.

Remove the lens shade cover and the aluminum plug from the 31.7mm compression ring adapter. Insert the diagonal prism into the compression ring adapter. Carefully tighten the compression ring until it begins to made contact with the barrel of the diagonal prism. It is not necessary to overtighten the ring to hold the diagonal prims. Then insert the ocular into the compression ring of the diagonal prism, repeating 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 the best focus, move the focuser inside and outside of what you think is the best focus. This will confirm the critical procedure.

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

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

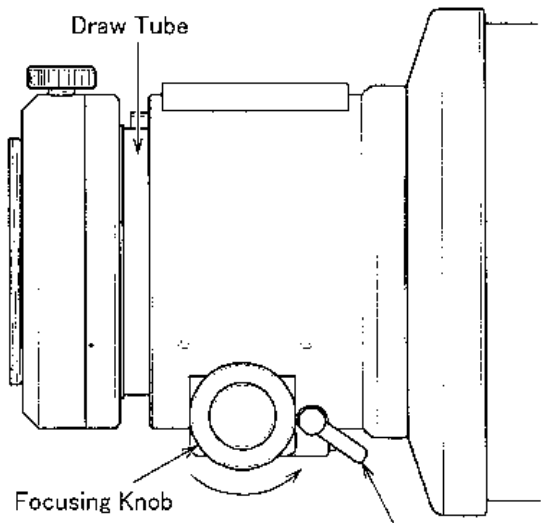


Fig. 12

● Focuser Draw Tube Clamp

The focuser clamp is located on the underside of the focuser. It is the handle as shown in Fig.13. Pulling it toward, the focus knob tightens the clamp and pushing it forward loosens it. It is not necessary to pull the clamp with force since a light pull is sufficient to hold any load. Do not over tighten this clamp.

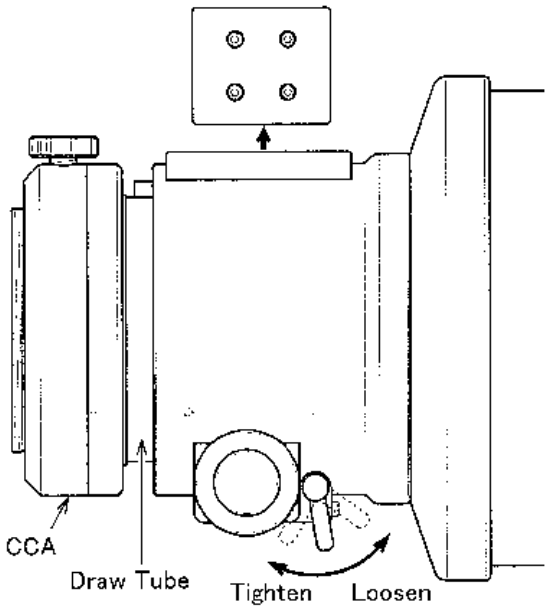


Fig. 13

● Camera Angle Adjuster

The Camera Angle Adjuster was invented by Takahashi in the 1970's and is still being used today. It is a bearing rotator device that allows the ocular to be turned 360° to the most comfortable position without loss of focus or de-centering. There is also a locking knob to hold the ocular and diagonal in position.

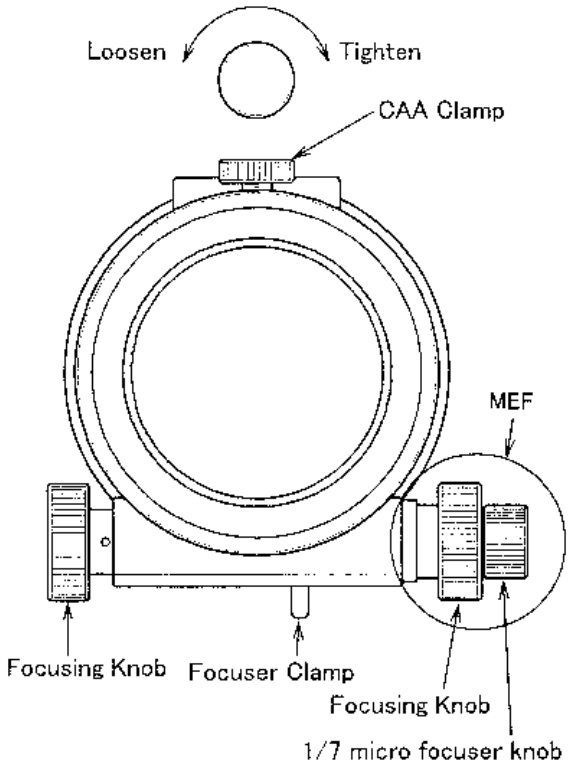


Fig. 14

⚠ Caution

Never loosen the four screws (M3 hexagon hole bolts) under any circmustances because these screws hold the flat bearing. If these screws are loosened the focuser will become loose.

■ Finder Alignment



Before placing the finder into the finder holder, wrap three layers of clear cellophane tape around the tube of the finder where the front set screws make contact with the finder. The rear set screws have a protective nylon cover over the end of the screws to prevent them from scratching the tube.

The 7X50 finder [standard with sets and optional otherwise] has a 6.3° and uses an interrupted crosshair that allows the precise centering of a star in the field of view after the finder has been aligned with the main optics.

An optional illuminator will help the observer to see the crosshairs in a dark site and make finding objects and centering them in the field of view easier.

The finder must be aligned with the main optics of the TOA-150B in order to allow the finder to be as useful as possible.

● Alignment Procedure

1. Remember that the motor drive should be engaged when the finder is aligned with the main optics. It is recommended that this procedure be done at night on a bright star, though it can be done in daylight using a target a few miles away.
2. Place a low power ocular in the TOA and find a bright star which you will center in the field of view. Then looking through the finder, center the star at the center of the interrupted crosshair. By using the thumb screws located at the rear of the finder mounting bracket. You may also adjust the three set screws located at the front of the holder, but exercise caution while doing this. You will need a very small slotted screw driver. It is rare that this is necessary.
3. Next insert a high magnification ocular and repeat the process until you have used a very high magnification ocular to center the star in the field of view and the center of the finder. Since the TOA-150B is supplied with a quick release bracket, it would not have to be done for a long period time.

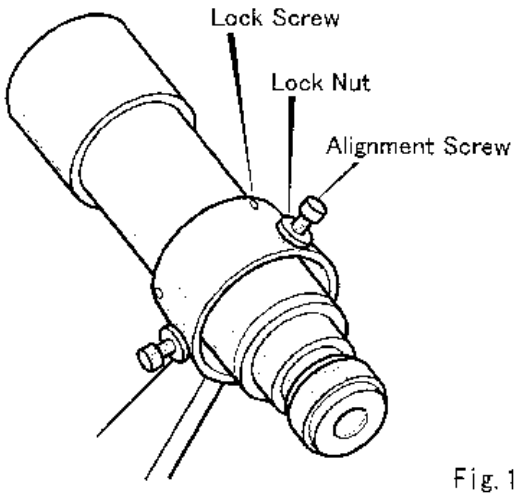


Fig. 13

● Adjusting Screw Procedure

1. Turn all the lock nuts until they reach the head of the alignment screws.
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.12.

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.

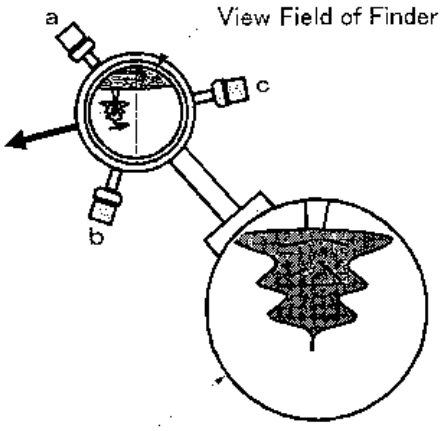


Fig. 13

● Optional Reticle Illuminator

The Takahashi 7X50 and 11X70 finders will accept the optional Reticle Illuminator. This illuminator by illuminating the interrupted crosshair in the finders makes the centering of objects in the field of view easier. The Reticle illuminator is inserted into the hole covered by the slotted screw next to the eyepiece end of the finder. Fig.13.

If you wish to turn the illuminator on, turn the chrome knob clockwise. The knob will click when it is turned on. This will allow the illumination to be changed to suit the sky conditions. Turning the knob counter clockwise will turn the illuminator off. The knob will click once again when it is turned off.

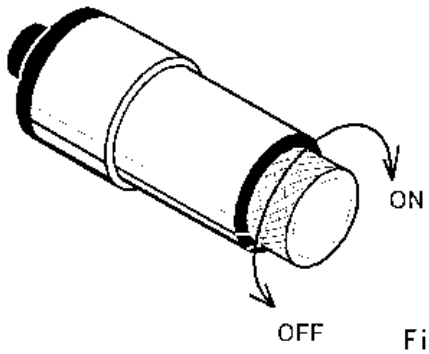


Fig. 14

● Replacing Batteries

Before changing the batteries, make certain that the illuminator has been turned off. Unscrew the battery holder as shown in Fig. 14. Remove the old batteries and replace them with fresh ones that have been wiped off to make certain that they are not contaminated by dirt or grease. Check the polarity and insert the batteries into the holder and screw it together. Then turn the knob clockwise to make certain that the illuminator is working. The batteries you will need are silver V-76 PX or equivalent battery.

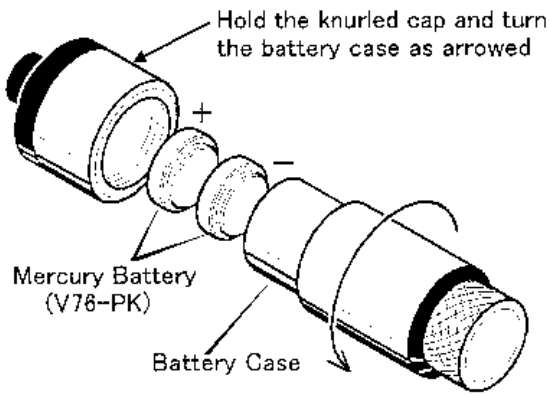


Fig. 15

Observation

■ Visual Observation

◆ Determining Magnification

The magnification of any ocular used with the TOA 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 the night of exceptional seeing, the TOA-150B can be used at a magnification of 130X per inch and on nights of exceptional seeing 160X 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 TOA-150B set [telescope w/mount] with a 90° compression ring 31.7mm 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.

■ 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.

◆ Prime Focus Photography

This is the method to take photo by placing film at the focal point of the telescope. This means the telescope is uses as a telephoto lens. The focal length of a telescope is far longer than that of a camera lens. Even a slight mistake to guide the telescope will make star images deformed. It is advisable to use a heavy duty equatorial mount for astrophotography.

◆ Eyepiece Projection Photography

The TCA-4 has been designed to allow the TOA-150B to be used for high magnification imaging/photography of the Moon and the planets.

It is designed to attach easily and allow the projection magnification with any ocular used to be changed by using the extendable ocular tube.

◆ Seeing

It is important that high magnification images of the Moon and planets require good seeing. The method for determining the quality of seeing on a scale of 1 to 10, with 10 being perfectly steady seeing is to look to the zenith at a bright star. If it is twinkling rapidly, the seeing is between 1 to 4. If the twinkling is moderate this is 5-6. If the star twinkles slowly to no twinkling, we have the 7 to 10 night. The less twinkle the better.

⚠ Cautions

When taking high magnification photographs of the Moon and planets, pay careful attention to balance. Rebalance the telescope when the object is placed in the center of the camera.

If the telescope is moved to another object, then rebalance it in the position in which the photos will be taken. Do not use the camera shutter; use the "hat trick" a black card place over the lens shade before the shutter is set on bulb. After the vibration has stopped, remove the black card for the duration of the photo, which will normally be in seconds.

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 TOA. Then focus and check for pinpoint focus over the field of view.

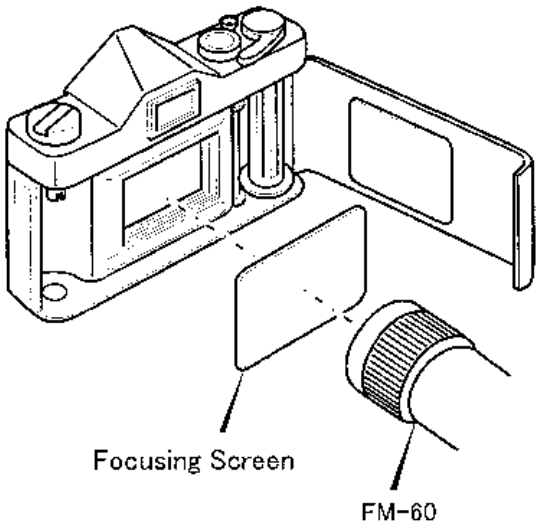


Fig. 16

Accessories for Photo/Visual Application

A wide variety of imaging and visual accessories are available for the TOA-150 including reducers, flatteners and a flat field 1.6x visual extender.

■ 67-Flattener

The 67 Flattener when used with the TOA-150B and 130NFB to produce a ϕ 90mm image circle with 3 micron stars at the center of the image, with 20 micron stars at the edge of the image circle.

● 67-Flattener

· Focal length	1090mm
· Focal ratio	f/7.3
· Image circle	ϕ 90mm

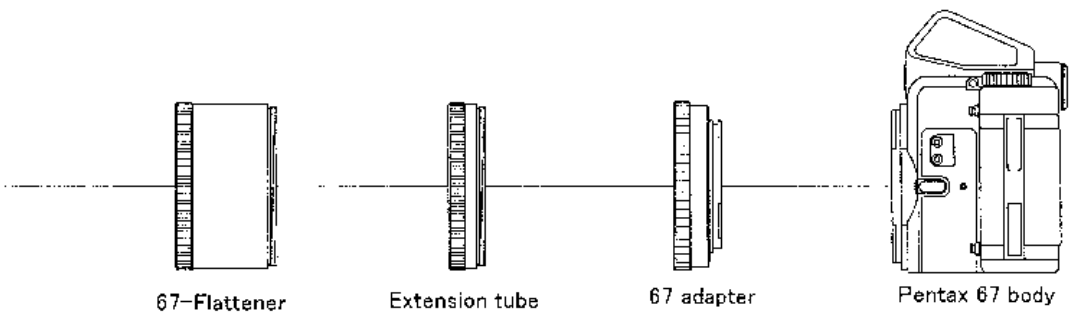


Fig. 17

■ 35-Flattener

This flattener is designed for imaging with a CCD camera, digital SLR, 35mm film camera and visually. The 35-Flattener attaches easily to the TOA-150B by means of its 50.8mm barrel allows imaging and visual equipment to be easily interchanged. The ϕ40mm flat field produces 2-micron stars in the center and 8-micron at the edge, diffraction limited images.

● 35-Flattener

· Focal length	1080mm
· Focal ratio	f/7.2
· Image circle	ϕ 40mm

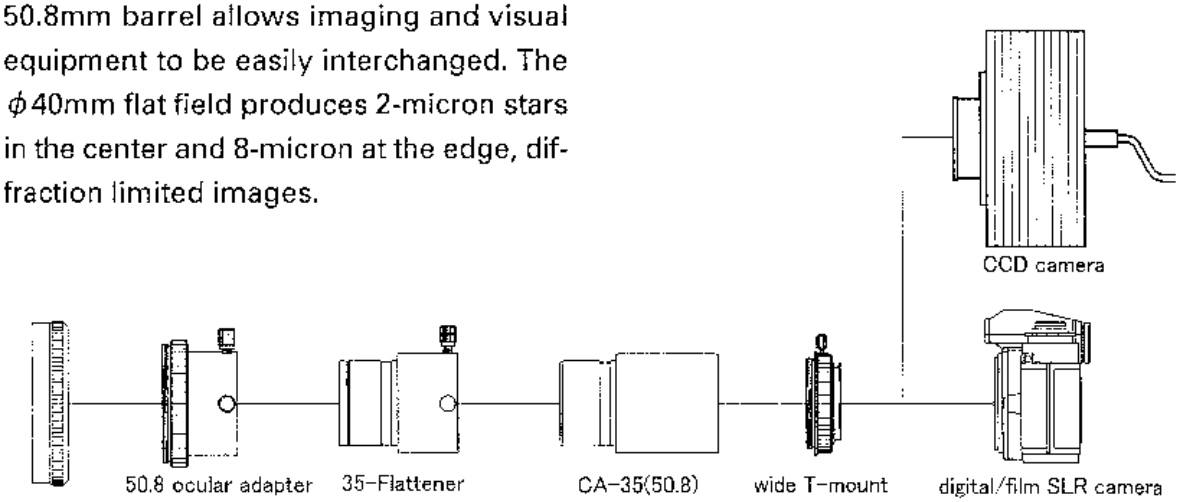


Fig. 18

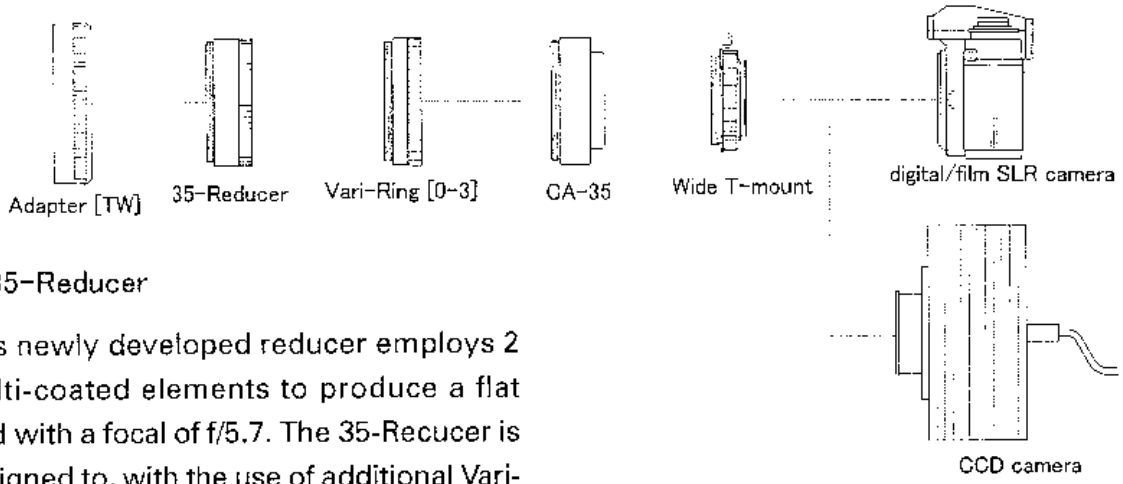


Fig. 19

■ 35-Reducer

This newly developed reducer employs 2 multi-coated elements to produce a flat field with a focal of f/5.7. The 35-Recucer is designed to, with the use of additional Vari-rings; reduces the focal ratio to f/5.1 with a reduced image circle. The stars size remains below 20 microns which makes it useful for CCD cameras and digital SLR imaging.

● 35-Reducer with one Vari-ring
- Focal length 860mm
- Focal ratio f/5.7
- Image circle ϕ 50mm

■ 645-Reducer

The 645-Reducer is specially designed ultra high quality reducer to produce maximum performance of super apochromatic optical system when large sized CCD or full-sized 35mm digital SLR camera is used with the TOA-150B or TOA-130BF model.
In order to achieve maximum color correction near the edge of the field, as a rear converter, a large sized 4-element 4-group system is used. Due to this, image sizes of 10 microns at 40mm circle and 20 microns at 60mm circle can be produced with illumination of 100% at 50mm circle with f/5.6 (TOA-150B) - f/5.8(TOA-130NFB).

● 645 Reducer
- Focal length 840mm
- Focal ratio f/5.6
- Image circle ϕ 65mm(60%)
  ϕ 50mm(100%)

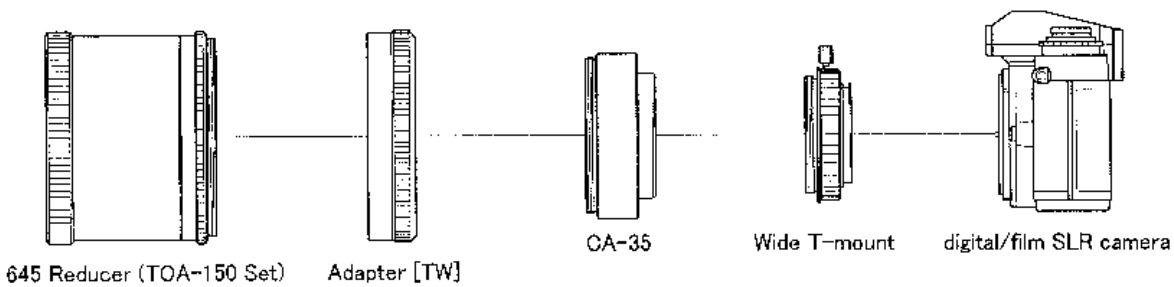


Fig. 20

■ Extender-TOA 1.5X

The Extender-TOA 1.5X is newly designed a two element extender, with an ED glass being used for one of the element, that increases the focal length of the TOA-150B to 1650mm. As its sleeve size is 50.8mm, attaching and detaching is done easily. The longer focal length will produce stunning images of the Moon and planets. A 35mm camera can be attached to the Extender-TOA 1.5X with a 50.8 extension tube and wide T-mount camera adapter. When it is used with the 35-Flattener, it procuces a flat 44mm dia. circle for visual, digital SRL camera CCD applications.

● Extender ED1.5x
- Focal length 1650mm
- Focal ratio f/11.0
- Image circle ϕ 44mm

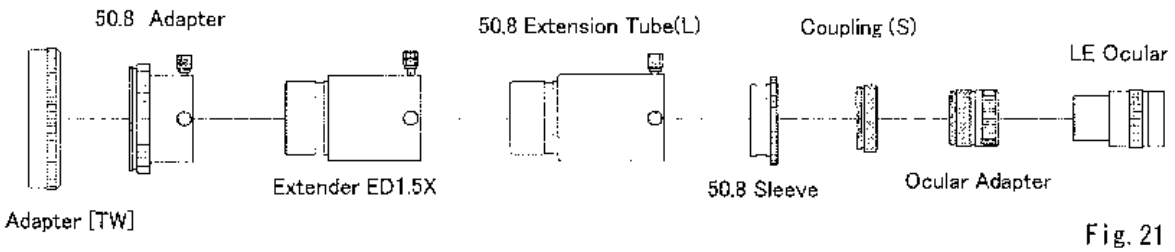


Fig. 21

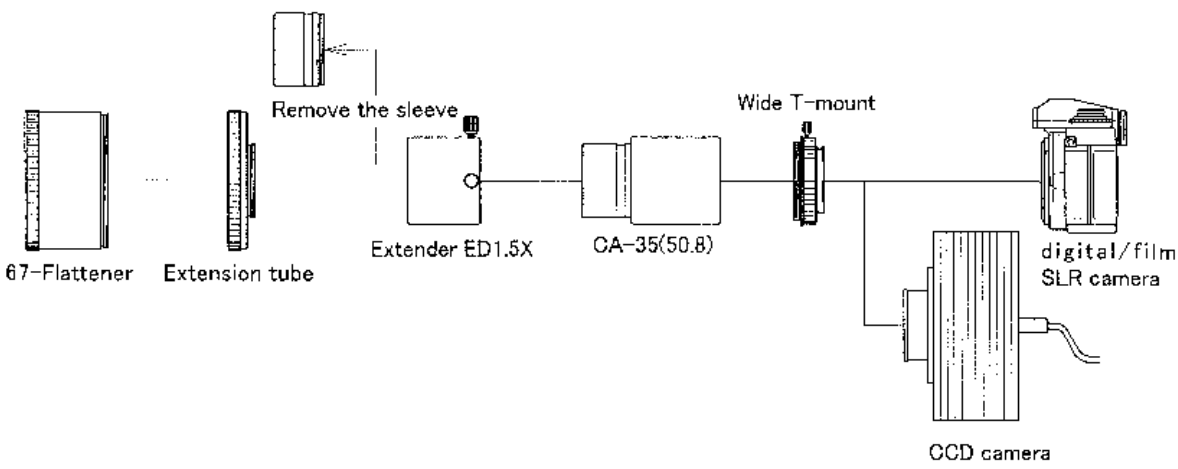


Fig. 22

■ CA-35

The CA-35 has been designed to be used with the TOA flatteners 35 and 67, the Reducer TOA and the Extender TOA 1.6X. One version can be used with the TOA-35 flattener and Extender TOA and the second for the TOA-67 flattener.

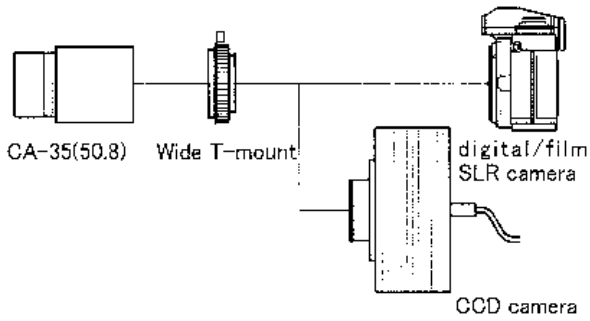


Fig. 23

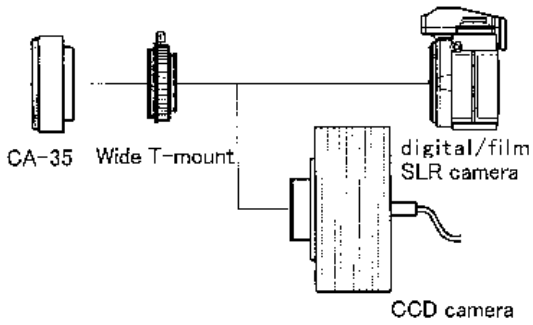


Fig. 24

■ TCA-4

It can be used with a digital or film SLR camera or properly adapter CCD camera.

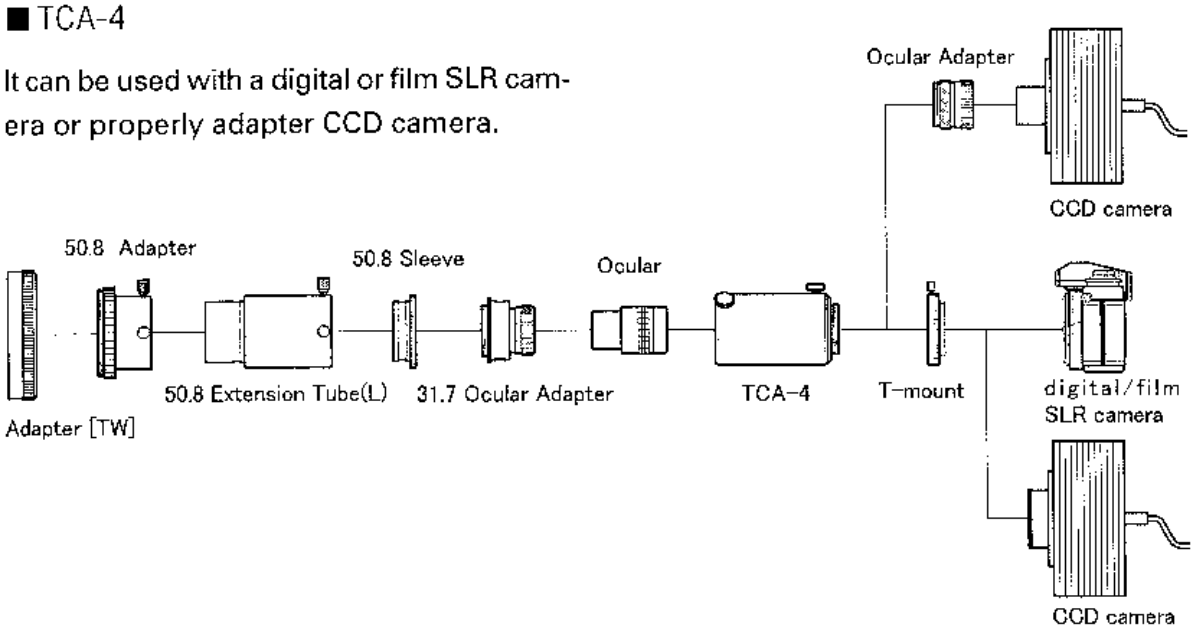


Fig. 25

■ T-Mount & Wide Mount T-Adapters

These adapters, one for the standard T-mount and the second for the Wide T-mount.

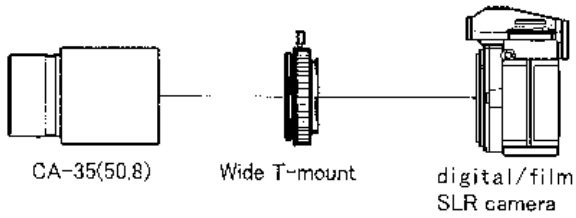


Fig. 26

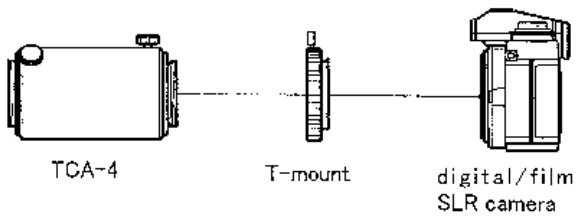


Fig. 27

■ 5-Turret Ocular Holder
W/Large Prism Diagonal

The 5-ocular turret ocular holder with LPD give the visual observer great flexibility in choosing 5 different magnifications for their advanced visual studies.

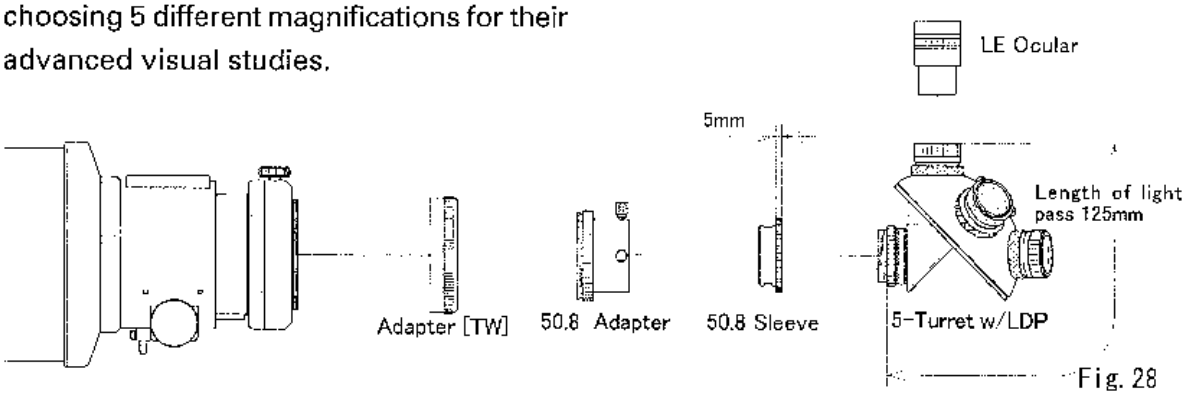


Fig. 28

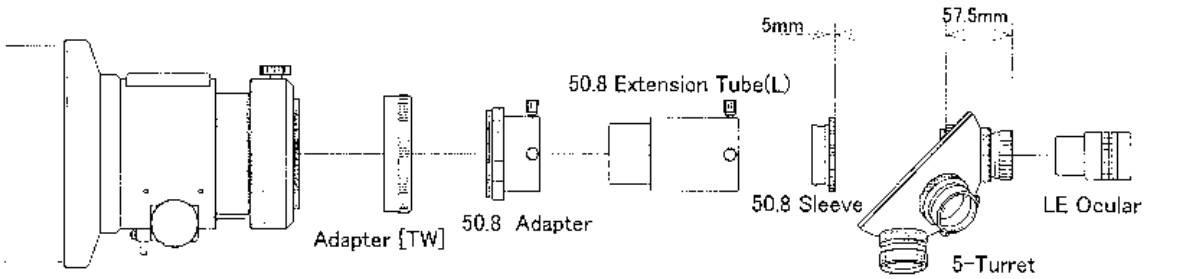
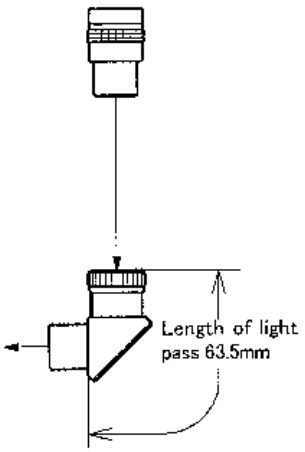


Fig. 29

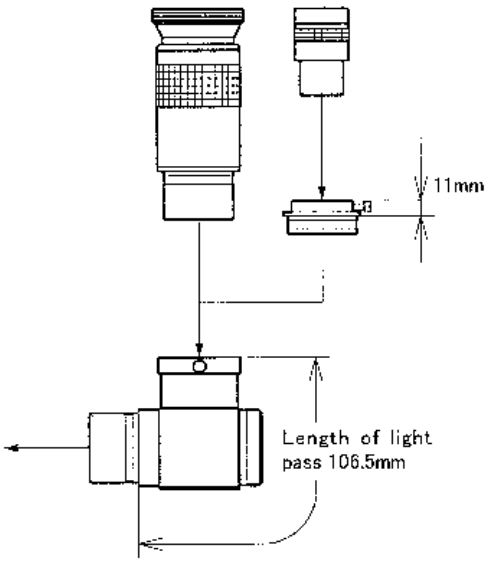
■ 50.8 1/10th Wave Mirror Diagonal and
31.7 Compression Ring Diagonal

Both of these diagonals use a different amount of back focus. In either case the over 200mm of back focus of the TOA-150B will allow these or any bino viewer to focus easily.



31.7 Prism Diagonal

Fig. 30



50.8 Mirror Diagonal

Fig. 31

■ Finder Scope

The 7x50 finder can be attached to the pre-drilled holes on the left side of the focuser. [USA models include a ScopeGuard quick release bracket.]

If an 11x70 finder is used it can be attached directly to the counter weight ring using the single arm holder. The ears are threaded to accept the 11x70 finder bracket.

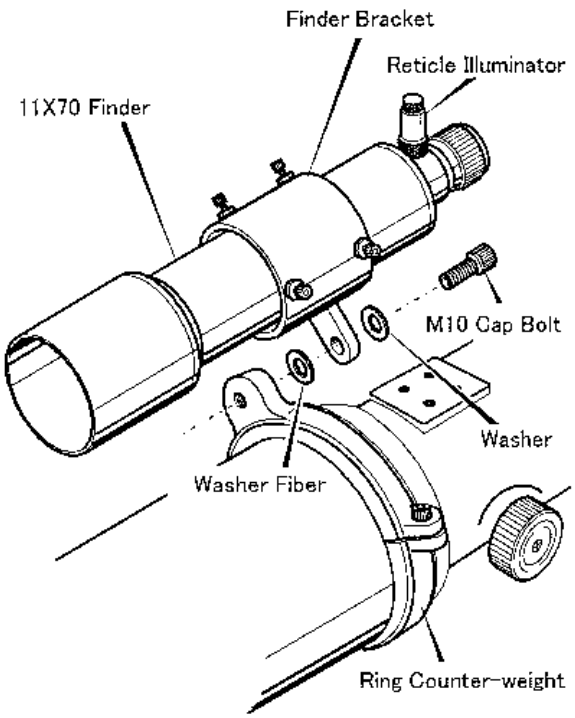
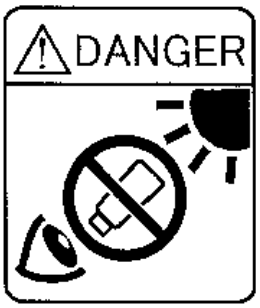


Fig. 32

■ Solar Observing

The high quality optics of the TOA-150B will provide outstanding images of the Sun. It is best to use high quality glass filters or H-alpha filter.

Never observe the sun directly. This will cause instant blindness. Cover your finder with two layers of aluminized Mylar, or an opaque cover finder to allow the observer to center the sun.



Sun Projection Observation System

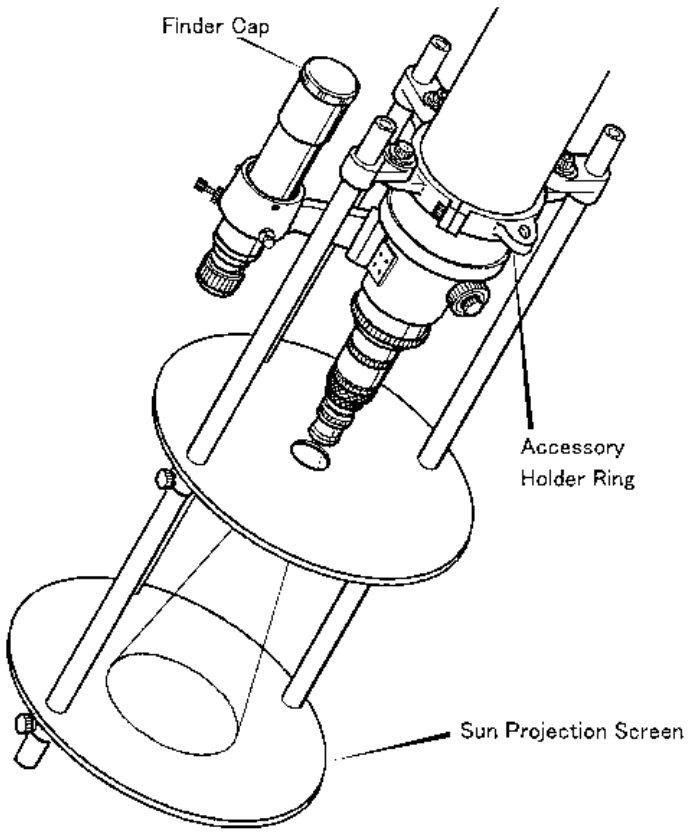


Fig. 33

Care & Maintenance

- Your TOA-150B apochromatic refractor has been precisely collimated at the factory by skilled optical technicians. In the even, 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, retract the dew shield and remove the particles by using large handpower 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 of the front lens be rubbed, as this could cause scratches in the coating.

- Use pure cotton swabs and a non ammonia lens cleaner to dab but never rube the surface until the dirt or grease is removed. Once again: NEVER RUB THE SURFACE OF THE OBJECTIVE WHICH WILL CAUSE THE COATING TO SCRATCH.

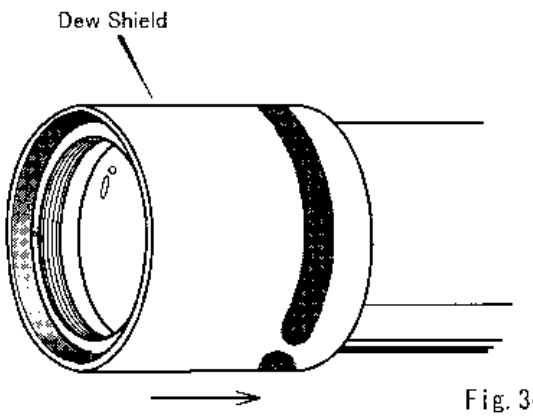


Fig. 34

Additional Precautions

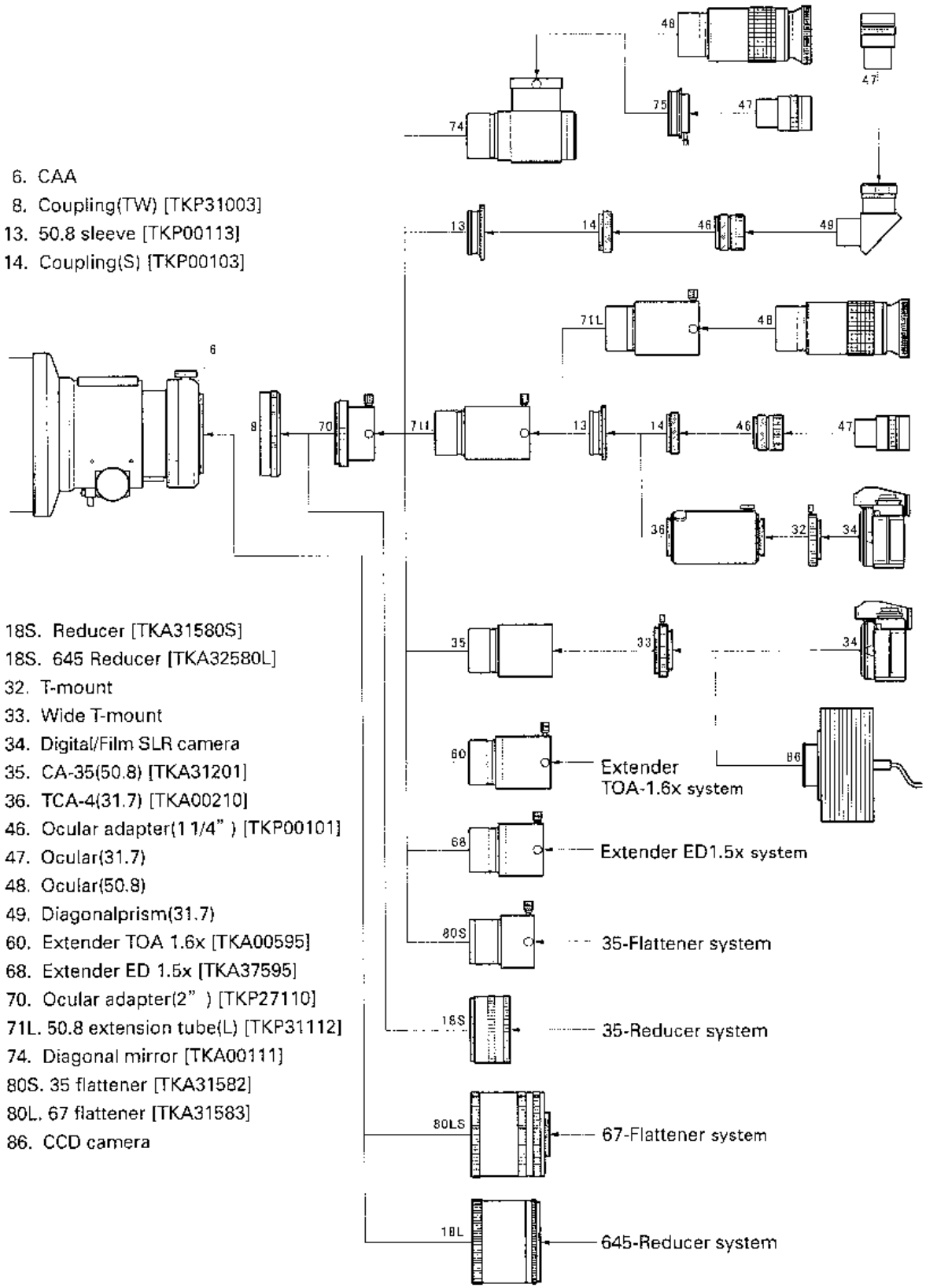
- Keep the telescope away from large fluctuations in temperature. When the instrument is brought our from a warm room to colder air, dew may form.

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

- Under no circumstances should the lenses be disassembled. The lenses have been properly aligned and set in place by skilled optical technician with special tools. Doing so will void any warranty on the tube assembly.

System Chart



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