Leitz Trinocular Head FS/20 - Maintenance Notes

Leitz microscope head FS/20, art. no. 512 923 (or even 512 923/20), is a basic trinocular microscope head for microscopes from the 160 mm mechanical tube length era and designed for eyepieces with 23.2 mm outer barrel diameter (Figure 1.) Unlike some of the more advanced Leitz heads it doesn't have any automatic mechanism for maintaining the designated mechanical tube length (160 mm) when the interpupillary distance is changed. Instead, after setting the desired interpupillary distance the changed tube length must be manually compensated by adjusting both binocular eyepiece tubes (Figure 2.) These adjustable eyepiece tubes are also used for adaptation to the user's individual eye diopters. Furthermore, the head doesn't have any way to change how the optical path is split between the eyes and the photo tube – the eyes/phototube ratio is fixed at 20/80 %. The head is attached to the microscope via a circular 42 mm dovetail mount (Figure 3.) The inner diameter of the phototube is 38 mm. The head's field of view number is 20 mm (as hinted by the "/20" part of the model designation.)

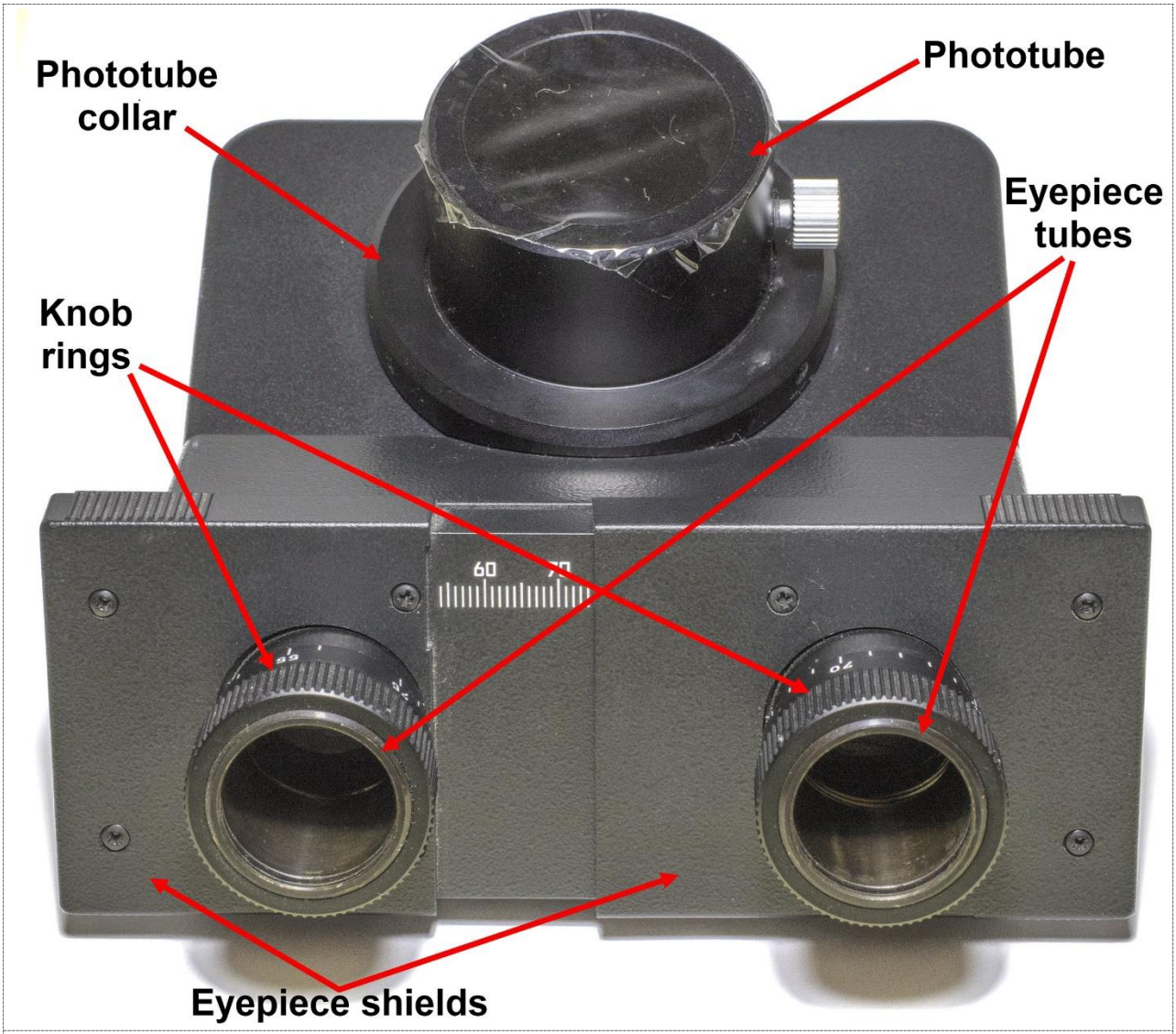

Figure 1: View of Leitz microscope head FS/20 after the eyepieces have been removed. The phototube has been temporarily covered with clear tape to protect the internal optics from dust during the maintenance work.

Scope

These maintenance notes describe the disassembly, cleaning, greasing and reassembly of the Leitz trinocular head FS/20. Basically, there are three maintenance tasks that we as microscopy amateurs can manage:

1. Cleaning and greasing the mechanism for the interpupillary distance adjustment,
2. cleaning and greasing the dioptric adjustment of the eyepiece tubes, and
3. collimation of the head's eyepiece tubes.

Adjustments and realignments of the head's prisms are not included (apologies, if this is disappointing…) because these are difficult tasks that require special equipment and training. Such work should therefore be left to professional microscope service technicians.

So, exactly when does one need to clean and regrease the above-mentioned mechanisms? Seriously seized parts will certainly need cleaning and regreasing to ensure reliable and comfortable function. But otherwise, it is largely a matter of taste, or user priorities. One could even argue that somewhat sluggish interpupillary and diopter adjustments are desirable to prevent inadvertent changes.

After any work requiring that the eyepiece tubes are removed from the head, the eyepiece tubes need to be checked and adjusted for collimation. Eyepiece collimation is described in separate maintenance notes ("Eyepiece Collimation of Leitz 160 mm TL Microscopes".)

Some parts of these maintenance notes may also be applicable for other similar contemporary Leitz microscope heads.

Grease

The head's closeness to the delicate optical surfaces (lenses, prisms) makes it important to select greases that don't emit semi-volatile components that could condense as a hazy film on the glass surfaces. The grease should also stay in place, i.e., it should not migrate along surfaces or fall off as droplets or particles. Having only superficial insights about this topic I have chosen to use Mobilgrease 28 and the somewhat thicker Super Lube Multi-Purpose Synthetic Grease with Syncolon, NLGI grade 2. Feel free to use other greases of your preference. For tips about alternative microscope greases one can find many recommendations on the Internet.

Maintenance Notes

1. Simplified cleaning and regreasing of the diopter adjustments

This procedure can be used for the diopter adjustments (Figure 2) if 1) they turn sluggishly but without being stuck or "frozen", and if 2) the interpupillary distance adjustment doesn't need any maintenance at this time. The procedure is designated as "simplified" because the work can be done without removing the eyepiece tubes from the head and therefore one could omit the otherwise necessary collimation of the eyepiece tubes.

However, if the diopter adjustments indeed are completely frozen and one still insists on using this simplified procedure there is a possible solution. A frozen diopter adjustment tube can often be released

after careful heating of the eyepiece tube with an electric heat gun. Blow the warm air only on the outside of the eyepiece tube and avoid getting hot air on or into the head. Don't overdo the heating. And of course, remove the eyepieces before the heating.

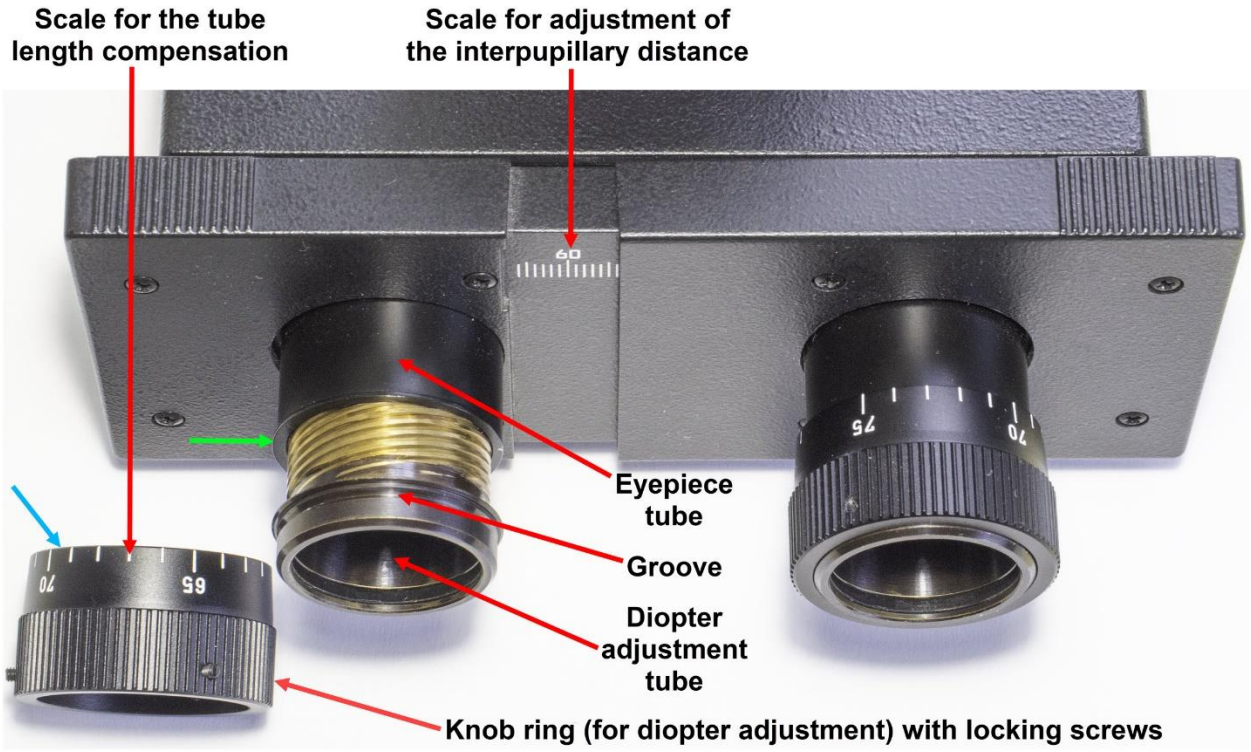

Figure 2: The knob ring of the diopter adjustment mechanism disassembled on the left side. Note that the eyepiece tube remains attached to the head.
The green arrow points to a small outward facing ledge on the rim of the eyepiece tube.
The blue arrow points to a small inward facing ledge on the backside of the knob ring.

1. Remove the head from the microscope.

Remove all eyepieces from the head. Cover the phototube opening (Figure 1) to protect the optics on the inside of the head during the work.

The head is attached to the microscope by a circular dovetail mount (Figure 3.) Release the head by pushing back the lever next to the mount on the microscope stand and lift off the head.

2. Clean the head's dovetail mount.

The head's dovetail mount (Figure 3) has probably accumulated some old grease and dust.

Use cotton swabs and solvent to clean the mount. Be careful not to splash solvent on the glass window in the mount. Also clean the mount in the microscope stand.

Figure 3: The dovetail mount on the head's underside.

3. Remove the diopter adjustment knob rings

The outsides of the knob rings have scales that are used to compensate for the changed mechanical tube length after the interpupillary distance has been changed.

The back end of the knob ring has a barely distinguishable inward facing ledge (blue arrow in Figure 2.) This ledge catches another outward facing ledge on the rim of the eyepiece tube (green arrow in Figure 2) thus setting the limit for how far the diopter adjustment tube can be extended during routine use. The knob ring is secured with three small locking screws (M2x2, headless, with pointed tips) along its periphery (Figure 2.) The knob ring can only be removed from the eyepiece tube after loosening of these screws.

Use a narrow 1.5 mm screwdriver (not wider to avoid damaging the screw threads in the knob rings) to unscrew the three small locking screws and then wiggle the knob rings to release and remove them from the eyepiece tubes. Notice that the knob rings are not identical! It's a good idea to label them now in some way to be able to distinguish the left eyepiece knob from the right eyepiece knob. They can however be distinguished by the location of the peripheral screw holes as follows:

Left side knob ring: Screw holes adjacent to the 55, 63, and 71 mm marks on the scale.

Right side knob ring: Screw holes adjacent to the 59, 67 and 75 mm marks on the scale.

4. Remove the diopter adjustment tubes

The diopter adjustment tubes turn and move in- and outwards on greased helicoid brass threads (Figure 4.) Old, hardened grease makes the diopter adjustments sluggish.

Unscrew and remove the sluggish diopter adjustment tubes from the eyepiece tubes (Figure 4.) Avoid excessive force, in difficult cases carefully use an electric heat gun to blow warm air on the outside of the eyepiece tubes. Avoid blowing warm air into the eyepiece tubes – it may adversely affect the sensitive prisms in the head.

Figure 4: Diopter adjustment tube removed from the eyepiece tube. The helicoid threads are clearly visible in the image.

5. Clean the helicoid threads

Use pieces of cloth and cotton swabs wetted with petroleum-based solvent (e.g., white spirit) to clean the helicoid threads – both the threads on the outside of the diopter adjustment tubes and those on the inside of the eyepiece tubes (with the latter still attached to the head.) Allow the threads to air-dry after the cleaning.

Warning: Cleaning of the inside threads of the eyepiece tubes requires special attention so no solvent or cleaning utensils are allowed to contaminate the head's prisms that sit only approx. 10 mm below the

lower end of the helicoid thread. During cleaning hold the head with the eyepiece tube openings facing downwards, clean the threads with several solvent wetted cotton swabs while being very careful not to touch the prisms or splatter solvent on them. Wipe the threads dry with dry cotton swabs.

Even after solvent cleaning the diopter adjustment tubes may still have some whitish, solid residue left in the helicoid threads. Because of the dangers with washing these threads so close to the head prisms, I would suggest just ignoring that and leave it as it is.

6. Grease and reassemble the diopter adjustment tubes.

Apply a very thin layer of grease on the helicoid threads of the eyepiece tubes and the diopter adjustment tubes. Helimax-XP (MicroLubrol) is a grease specifically made for camera and telescope helicoid threads making these to move very lightly and smoothly. Other greases could of course be used, for example, use a more viscous grease if somewhat stiffer diopter settings are desired. Carefully screw the diopter adjustment tubes into the eyepiece tubes in the head. Turn the diopter adjustment tubes back and forth a couple of times to spread the grease. Leave the diopter adjustment tubes screwed halfway into the eyepiece tubes.

Put the diopter adjustment knob rings over the ends of the diopter adjustment tubes. Make sure to get the left side knob on the left tube and vice versa. Insert the small (M2x2) headless screws along the periphery of the rings making sure that the screw tips properly reach down into the groove close to the top of the diopter adjustment tubes (Figure 2.) Tighten the screws just barely; the knob rings should be only very lightly attached to the diopter adjustment tubes - it should still be possible to turn the rings only by letting the screw tips slide in the groove.

7. Synchronize the diopter adjustment scales with the interpupillary distance scale.

Recall that any time the interpupillary distance has been adjusted for a new user, the diopter adjustment scales also must be adjusted to ensure that the designated mechanical tube length of 160 mm is retained. This requires that the scale settings of both diopter adjustment tubes are properly matched with the readout of the interpupillary distance scale on the head (refer to Figure 2.)

Push the eyepiece shields (Figure 1) towards each other as far as it goes and record the value that the interpupillary distance scale shows. This is the minimal interpupillary distance that can be set on the head. The scale may disappear below the right eyepiece shield, but it should still be possible to estimate the minimal interpupillary distance. For the head in Figure 2 the minimal interpupillary distance was 53½ mm.

Put a finger just slightly into the inside of one of the diopter adjustment tubes (avoid touching the prisms in the head!) and turn the tube counterclockwise as far as it goes. This takes the tube out into its maximally extended position. Then turn only the knob ring further counterclockwise (the

Figure 5: The left eyepiece tube with its diopter adjustment scale at the minimal interpupillary distance of 53½ mm.

screw tips will now slide in the groove of the tube) until its scale position for the above recorded minimal interpupillary distance (in this case 53½ mm) aligns with the white indicator bar on the side of the eyepiece tube (Figure 5.) Now tighten the three locking screws (but not too much, the pointed screw tips get a very good grip by digging into the groove of the diopter adjustment tube) to secure the knob ring with its scale.

Do the same for the other eyepiece tube. With this, both diopter adjustment scales will be synchronized with the interpupillary distance scale.

8. Finishing touch

Check, and if required clean the window in the center of the mount on the underside of the head.

Attach the eyepieces to the head, or alternatively cover the eyepiece tubes with suitable caps.

(Consider performing an eyepiece collimation even though the eyepiece tubes never were removed from the head.)

2. Complete cleaning and regreasing of the interpupillary distance and the diopter adjustments

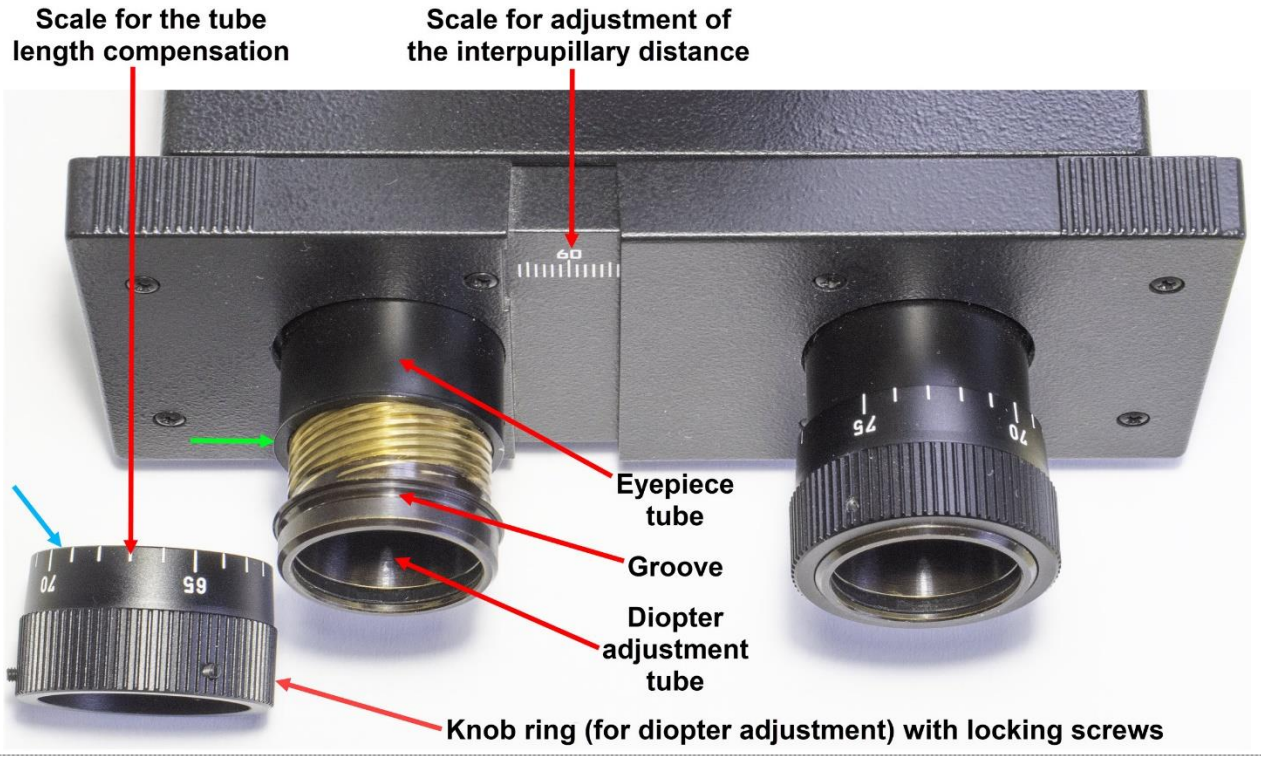

Figure 6: The knob ring of the diopter adjustment mechanism disassembled on the left side. Note that the eyepiece tube remains attached to the head.
The green arrow points to a small outward facing ledge on the rim of the eyepiece tube.
The blue arrow points to a small inward facing ledge on the backside of the knob ring.

The head contains several optical components that need to be protected from dust, fingerprints, grease and solvent droplets released during cleaning. It is recommended to wear disposable nitrile rubber gloves whenever there is risk that any optical surfaces could be touched with the fingers, for example,

when the eyepiece prisms are removed or reattached to the head. Protection measures often conflict with comfortable maintenance work, so we leave it to you to find a workable compromise.

1. Remove the head from the microscope.

Remove all eyepieces from the head. Cover the phototube opening (Figure 1) to protect the optics on the inside od the head during the work.

The head is attached to the microscope by a circular dovetail mount (Figure 7.) Release the head by pushing back the lever next to the mount on the microscope stand and lift off the head.

2. Clean the head's dovetail mount.

The head's dovetail mount (Figure 7) has probably accumulated some old grease and dust.

Use cotton swabs and solvent to clean the mount. Be careful not to splash solvent on the glass window in the mount. Also clean the mount in the microscope stand.

Figure 7: The dovetail mount on the head's underside.

3. Remove the diopter adjustment knob rings

The outsides of the knob rings have scales that are used to compensate for the changed mechanical tube length after the interpupillary distance has been changed.

The back end of the knob ring has a barely distinguishable inward facing ledge (blue arrow in Figure 6.) This ledge catches another outward facing ledge on the rim of the eyepiece tube (green arrow in Figure 6) thus setting the limit for how far the diopter adjustment tube can be extended during routine use. The knob ring is secured with three small locking screws (M2x2, headless, with pointed tips) along its periphery (Figure 6.) The knob ring can only be removed from the eyepiece tube after loosening of these screws.

Use a narrow 1.5 mm screwdriver (not wider to avoid damaging the screw threads in the knob rings) to unscrew the three small locking screws and then wiggle the knob rings to release and remove them from the eyepiece tubes. Notice that the knob rings are not identical! It's a good idea to label them now in some way to be able to distinguish the left eyepiece knob from the right eyepiece knob. They can be distinguished by the location of the peripheral screw holes as follows:

Left side knob ring: Screw holes adjacent to the 55, 63, and 71 mm marks on the scale.

Right side knob ring: Screw holes adjacent to the 59, 67 and 75 mm marks on the scale.

4. Remove the eyepiece shields and the eyepiece tubes from the head.

Remove both eyepiece shields (Figure 1) from the head. They are attached on the front of the head with four M2x6 Philips screws. Now the eyepiece tubes and the slides for the interpupillary distance adjustment are accessible (Figure 8.)

Remove both eyepiece tubes from the interpupillary distance adjustment slides - each tube is attached with four M2x6 Philips screws (green arrows in Figure 8.)

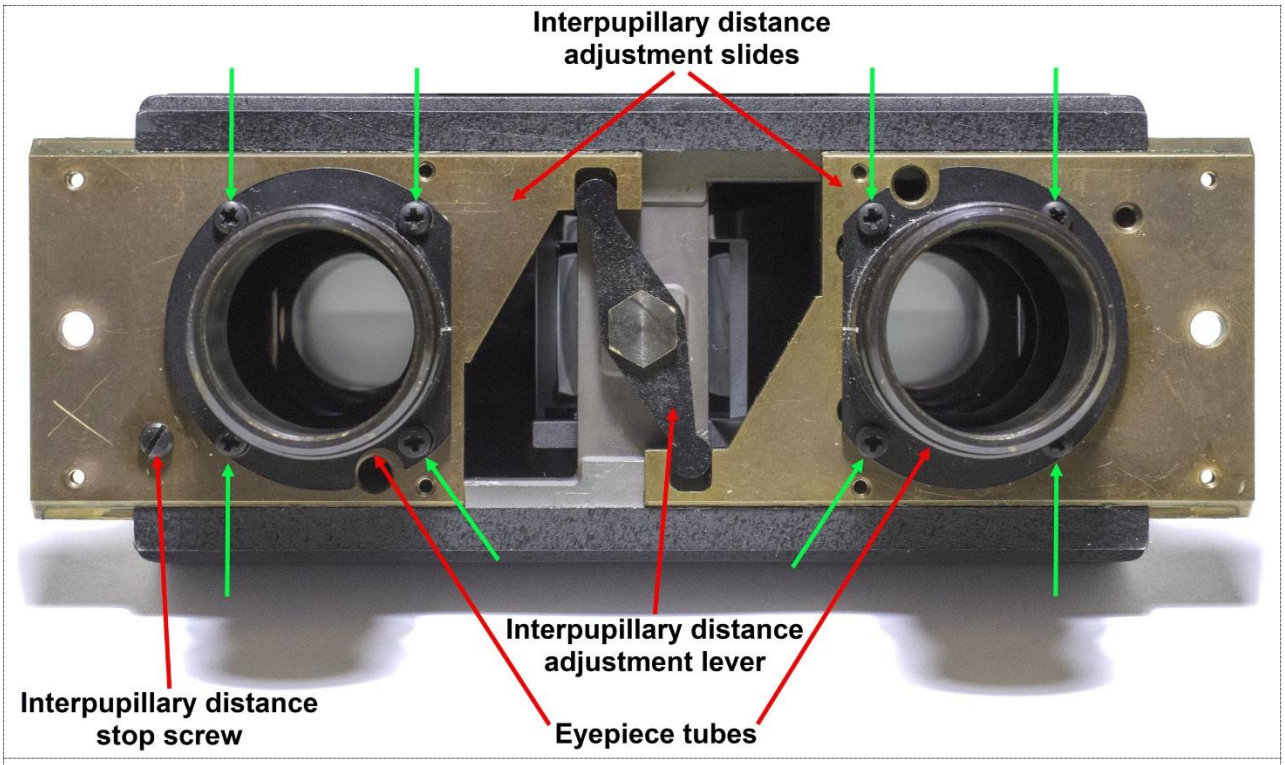

Figure 8: The front of the microscope head after the eyepiece shields have been removed.
The green arrows point to the screws that attach the eyepiece tubes to the interpupillary distance adjustment slides.

5. Remove the diopter adjustment tubes from the eyepiece tubes

The diopter adjustment tubes turn and move in- and outwards on greased helicoid brass threads (the brass-colored thread is exposed on the left eyepiece tube in Figure 6.) Old, hardened grease makes the diopter adjustments sluggish.

Unscrew and remove the sluggish diopter adjustment tubes from the eyepiece tubes (Figure 6.) Avoid excessive force, in difficult cases try either of the following approaches:

1) Carefully use an electric heat gun to blow warm air on the eyepiece tubes (but don't overdo it.) This will soften the hardened grease and facilitate the disassembly.

2) Soak the eyepiece tube with the stuck diopter adjustment tube in a glass container with petroleum-based solvent (e.g., white spirit). After a few hours (or days) of soaking the parts should easily be disassembled.

6. Clean the helicoid threads

Use pieces of cloth and cotton swabs wetted with petroleum-based solvent (e.g., white spirit) to clean the helicoid threads. Clean both the threads on the outside of the diopter adjustment tubes and those on the inside of the eyepiece tubes. Allow the threads to air-dry after the cleaning.

Even after solvent cleaning the diopter adjustment tubes may still have some whitish, solid residues left in the helicoid threads. The residues can be removed by washing the tubes with an old hard toothbrush and warm water with dishwasher detergent. Dry the parts thoroughly.

7. Grease and reassemble the diopter adjustment tubes to the eyepiece tubes

Apply a very thin layer of grease on the helicoid threads of the eyepiece tubes and the diopter adjustment tubes. Helimax-XP (MicroLubrol) is a grease specifically made for camera and telescope helicoid threads making these to move very lightly and smoothly. Other greases could of course be used, for example, use a more viscous grease if somewhat stiffer diopter settings are desired. Carefully screw the diopter adjustment tubes into the eyepiece tubes. Turn the diopter adjustment tubes back and forth a couple of times to spread the grease. Leave the diopter adjustment tubes screwed halfway into the eyepiece tubes.

Put the tubes to the side for later. We will now continue to work with the interpupillary distance slider in the head.

8. Remove the interpupillary distance adjustment slides.

Remove the stop screw for the interpupillary distance adjustment which sits on the lower left side of the left slide (Figure 8.) It is a special M3x4 screw with a 2 mm smooth tip that limits how far apart the slides can travel (thereby also protecting the eyepiece prisms on the backside of the slide from colliding into the inside of the head.) The tip is stopped at the square cutting-out in the lower right side of the head base (Figure 12).

Warning: Don't yet try to move the slides further outwards – it could jeopardize the alignment of the eyepiece prisms.

Remove the black plastic lever (Figure 8) that synchronizes the movements of the interpupillary distance adjustment slides. It is attached by and pivoting about a special M3 screw with an 8 mm hexagon ("hex") head that is only 1 mm deep. The shallow head in combination with the soft brass makes the head vulnerable to damage if the wrench used doesn't fit snugly. Socket type wrenches often have rounded socket rims that prevent a good grip and should therefore be avoided. Best is to use a flat and snugly fitting 8 mm open-ended wrench, but a small adjustable spanner could also do the work.

The last thing that prevents us from removing the interpupillary distance adjustment slides are the eyepiece prisms that are attached behind the eyepiece tubes on the backside of the slides. To access and remove the prisms, we however first need to remove the phototube and then the head cover.

Use a 1.5 mm Allen key to loosen, but not remove, the three locking screws along the periphery of the phototube collar (Figure 1) and pull up the collar off from the phototube.

Remove the head cover; it is attached to the head base with two Philips screws (M2.5x6) on each side of the head and with two thread forming Philips screws () on the bottom of the head base.

Remove the phototube from the head base. It is attached with four M3x12 screws with Allen heads. Now the eyepiece prisms (Figure 9) are accessible for removal.

Remove the four screws (red arrows in Figure 10) that hold each eyepiece prism attached to the backside of the interpupillary distance adjustment slides. To protect the prisms, it is highly

recommended to wear disposable nitrile gloves during the removal. Handle the prisms carefully and avoid any contact with grease, fingers, etc. Even with gloves, avoid any touching of the prisms' optical surfaces. Hold the prism with one hand so it doesn't fall off and get damaged while the screws are removed. Put the prisms to the side in a dust protected plastic container.

(Fortunately, the prisms in the center of the head don't need to be removed.)

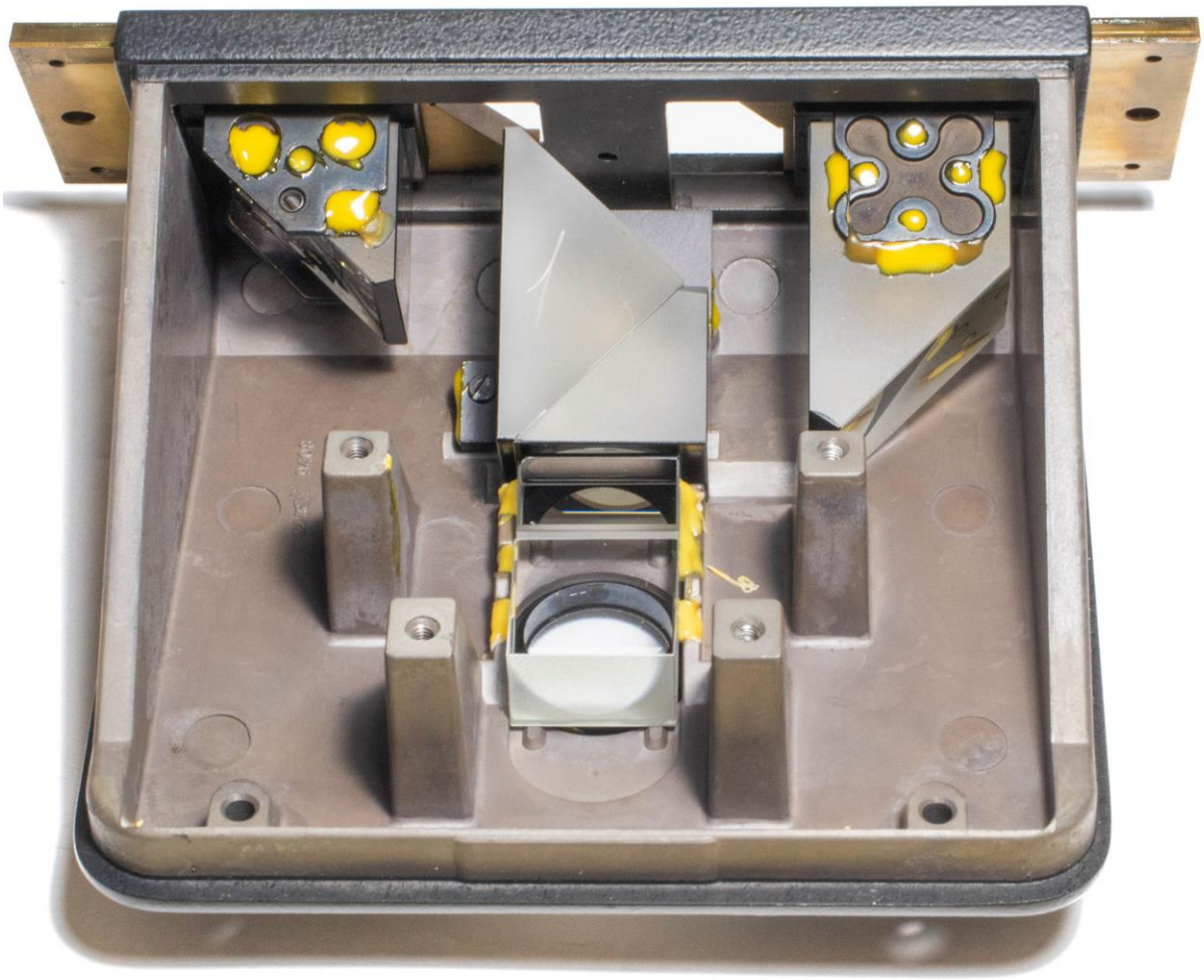

Figure 9:The head viewed from above after the cover and the phototube have been removed. The eyepiece prisms are attached on the backside of the slides (on the top of the image).

The yellow mass on the side of the prisms is cement that was used at manufacturing to align and fix the prisms in their metal holders.

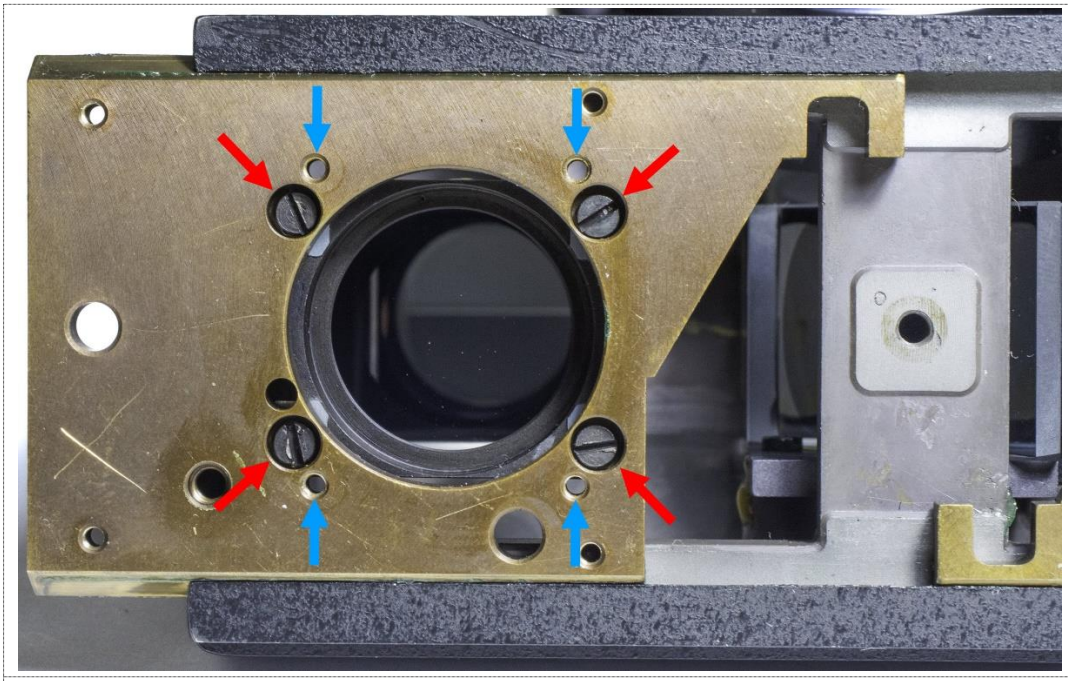

Figure 10: The front of the left interpupillary distance adjustment slide showing the four screws that hold the eyepiece prism attached.

The red arrows point to the screws that attach the left eyepiece prism to the backside of the slide.
The blue arrows point to the screw holes for the screws that attach the left eyepiece tube to the slide.

Now finally the interpupillary distance adjustment slides are ready for removal. Pull them outwards to remove them from the head (Figure 11.) Retrieve the springs that sit in grooves in the lower slide rail of the head base (Figure 12.)

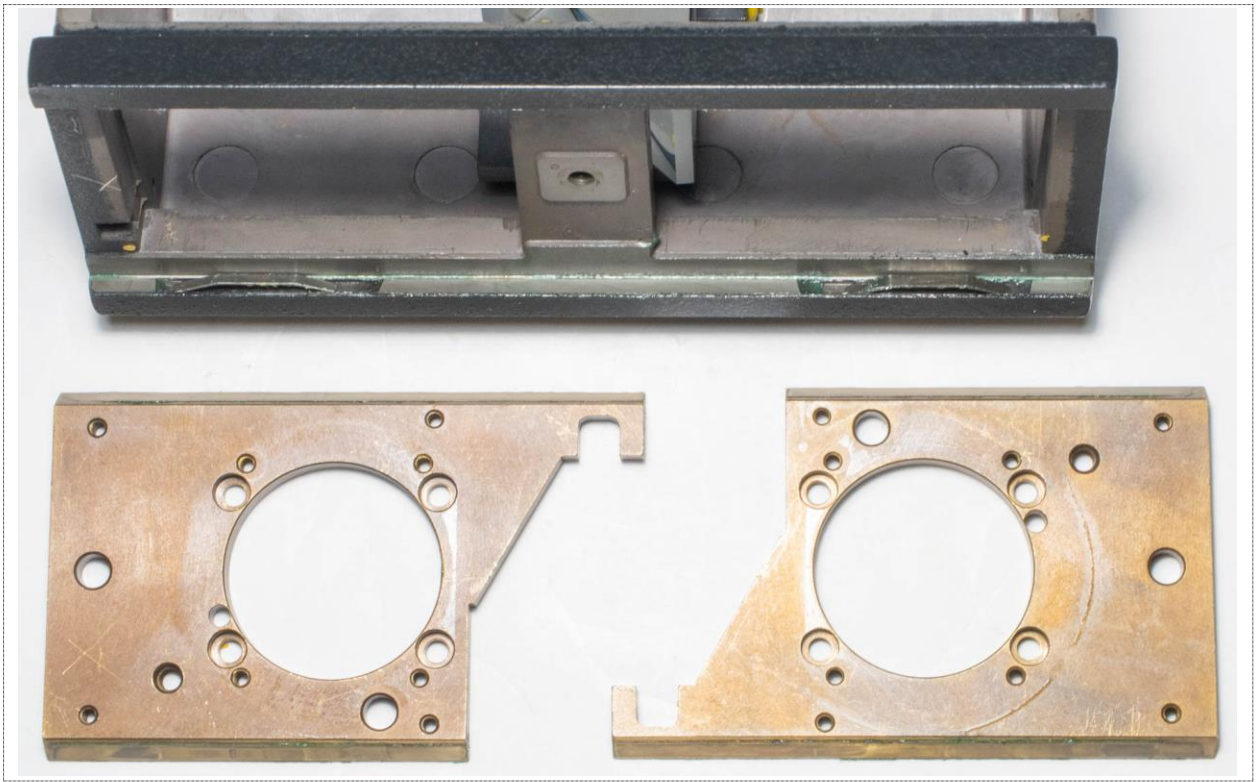

Figure 11: The front of the head with the interpupillary distance adjustment slides removed and placed below.

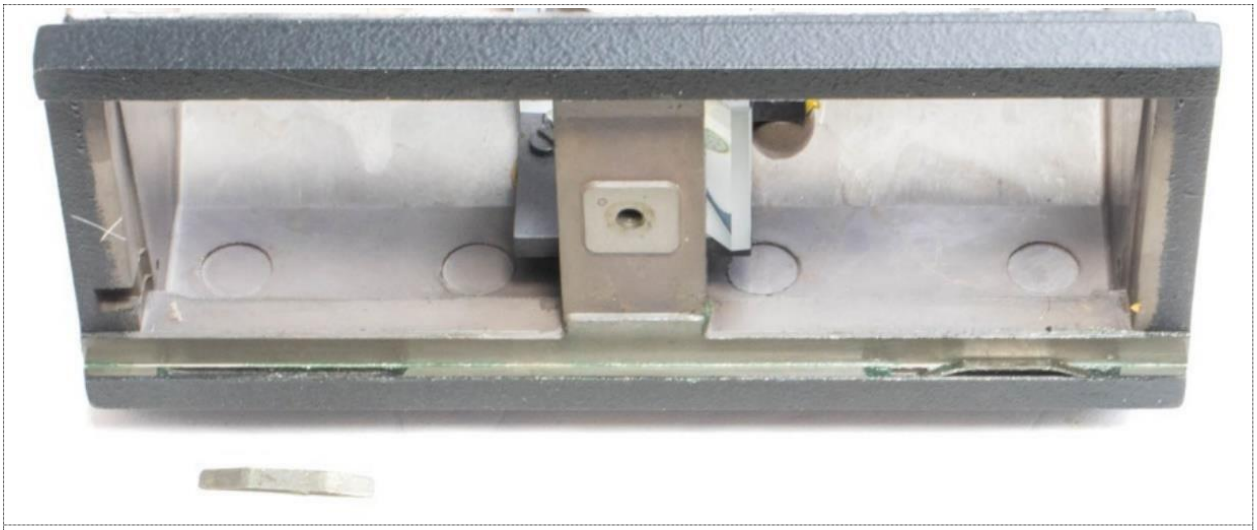

Figure 12: The front of the head base after the interpupillary distance adjustment slides have been removed. Note the springs from the lower slide rail (the left spring has been removed and placed below the head.)

9. Clean all slide rails.

Use petroleum-based solvent (e.g., white spirit) to clean the following surfaces from old grease:

- The upper and lower slide rails on both interpupillary distance adjustment slides
- The lower and upper slide rails on the front of the head base
- Both springs in the head base's lower slide rail
- The plastic interpupillary distance adjustment lever (but first check that the solvent doesn't attack the plastic)

10. Grease all sliding surfaces pertaining to the interpupillary distance adjustment.

Apply a rather thin layer of grease (for example, Super Lube) on the interpupillary distance adjustment slide rails – the upper and the lower rails on the head base, and the upper and lower rails on both brass slides. Also put grease on the two springs from the lower rail in the head base.

Place the springs into the grooves of the lower rail in the head base, see Figure 11 and Figure 12. Carefully push the brass slides (note that the slides are not identical due to the hole for the stop screw in the left slide) into the head base's rails making sure that the springs stay in their grooves. Attach the stop screw (Figure 8) into the left slide making sure that the screw tip is inside of the head base. Lightly grease the rounded ends and the hole in the middle of the lever (Figure 8), attach the lever between the brass slides with the rounded ends locking with the slide notches, and secure it with the special screw with the shallow hexagonal head.

Push the slides back and forth a few times to distribute the grease and check that the slides move smoothly. Wipe off any superfluous grease.

Check that the prisms in the middle of the head base are clean. Blow off any dust with a camera air blower, and if required, clean the surfaces carefully with lens cleaning solution and cotton swabs.

11. Reattach the eyepiece prisms to the slides.

Check that the previously removed eyepiece prisms are clean. Blow off any dust with a camera air blower, and if required, clean the surfaces carefully with lens cleaning solution and cotton swabs.

Attach the eyepiece prisms to the backsides of the interocular distance adjustment slides using the four previously removed screws (Figure 9 and Figure 10.) The left-side and the right-side prisms are different, don't confuse them. As before, use nitrile gloves and avoid touching the optical surfaces. Before the screws are tightened note that there is some play that allows for minor adjustment of the prisms; we don't have the tools for any sophisticated alignment, so just do your best trying to keep the sides of the eyepiece prisms parallel with the head's middle prism before tightening the screws.

12. Reassemble the head.

Attach the phototube to the head base using the four M3x12 screws with Allen heads.

Attach the head cover. Secure it with the two M2.5x6 Philips screws on each side of the head and the two thread forming Philips screws from the bottom of the head base.

Attach the phototube collar. Check its underside to align it properly and then tighten the three locking screws along its periphery.

If required, clean, grease and reattach the clamp screw on the side of the phototube.

If available, put a cap on top of the phototube to protect the internal optics from dust.

13. Reattach the eyepiece tubes.

Attach the eyepiece tubes (with the diopter adjustment tubes already inserted, but without the knob rings) to the interpupillary distance adjustment slides using four M2x6 Philips screws for each tube (Figure 8, and the blue arrows in Figure 10.) Tighten the screws only lightly for now.

Before the eyepiece shields are reattached, the eyepiece tubes must be carefully collimated to ensure that the head doesn't cause double vision or visual fatigue. The screw holes in the flanges of the eyepiece tubes allow for some play so the tubes can be slightly moved sideways until their optical axes overlap exactly.

14. Check/adjust the eyepiece collimation

Adjust the eyepiece collimation, refer to maintenance notes "Eyepiece Collimation of Leitz 160 mm TL Microscopes".

15. Finish the reassembly of the diopter adjustment tubes

After completed eyepiece collimation attach first the left and then the right eyepiece shield to the interpupillary distance adjustment slides using four M2x6 Philips screws for each shield (Figure 1.)

Put the diopter adjustment knob rings over the ends of the diopter adjustment tubes that previously have been cleaned, greased and assembled with the eyepiece tubes, refer to subsection 7. Make sure to get the left side knob on the left tube and vice versa. Insert the small (M2x2) headless screws along the periphery of the rings making sure that the screw tips properly reach down into the groove close to the top of the diopter adjustment tubes (Figure 6.) Tighten the screws just barely; the knob rings should be

only very lightly attached to the diopter adjustment tubes - it should still be possible to turn the rings only by letting the screw tips slide in the groove.

16. Synchronize the diopter adjustment scales with the interpupillary distance scale.

Recall that any time the interpupillary distance has been adjusted for a new user, the diopter adjustment scales also must be adjusted to ensure that the designated mechanical tube length of 160 mm is retained. This requires that the scale settings of both diopter adjustment tubes are properly matched with the readout of the interpupillary distance scale on the head (refer to Figure 6.)

Push the eyepiece shields (Figure 1) towards each other as far as it goes and record the value that the interpupillary distance scale shows. This is the minimal interpupillary distance that can be set on the head. The scale may disappear below the right eyepiece shield, but it should still be possible to estimate the minimal interpupillary distance. For the head in Figure 6 the minimal interpupillary distance was 53½ mm.

Put a finger just slightly into the inside of one of the diopter adjustment tubes (avoid touching the prisms in the head!) and turn the tube counterclockwise as far as it goes. This takes the tube out into its maximally extended position. Then turn only the knob ring further counterclockwise (the screw tips will now slide in the groove of the tube) until its scale position for the above recorded minimal interpupillary distance (in our case 53½ mm) aligns with the white indicator bar on the side of the eyepiece tube (Figure 13.) Now tighten the three locking screws (but not too much, the pointed screw tips get a very good grip by digging into the groove of the diopter adjustment tube) to secure the knob ring with its scale.

Figure 13: The left eyepiece tube with its diopter adjustment scale at the minimal interpupillary distance of 53½ mm.

Do the same for the other eyepiece tube. With this, both diopter adjustment scales will be synchronized with the interpupillary distance scale.

17. Finishing touch

Check, and if required clean the window in the center of the mount on the underside of the head.

Attach the eyepieces to the head, or alternatively cover the eyepiece tubes with suitable caps.