Leitz Periplan GF 10x M Eyepiece Maintenance

Introduction and Scope

These maintenance notes cover the disassembly and basic maintenance of Leitz Periplan GF M eyepieces (Figure 1, Figure 2 and Figure 3.) This is an eyepiece family with the common 23.2 mm barrel diameter intended for Leitz microscopes with 170 mm mechanical tube length and available with different magnifications. Figure 1 shows a typical model inscription ("Periplan GF 10x M") where "Periplan" indicates that the eyepiece is designed to correct residual chromatic aberration when used with high-end Leitz objectives, "GF" stands for the German word "Groβfeldokular" (Eng. "widefield eyepiece"), the number followed by "x", (like 10x or 12.5x) is the eyepiece's magnification, and "M" indicates that its eyelens is focusable and that the field lens has a graticule mount (presumably M stands for "Messung", or "measuring" in English.)

Figure 1: A Leitz Periplan GF 10x M eyepiece. View from the top.

Figure 2: Leitz Periplan GF 10x M eyepieces. The focusing eyelens in its most extended (left) and most contracted (right) setting.

It's important to understand that Leitz Periplan eyepieces were manufactured for several years during which they underwent several design variations, both internal and external. The eyepieces manufactured for 170 mm tube length microscopes can be distinguished from the later 160 mm eyepieces because the latter include the field-of-view number in the inscription. As an example, the 160 mm version of the eyepiece in Figure 1 would have the inscription "Leitz Periplan 10x/18 M"; where 18 is the field-of-view number.

Generally, the naming of the eyepieces from the 170 mm tube length era only gives a few clues to their place in the Periplan production timeline, one has to rely on sometimes subtle external design details to try to make an estimate. Unfortunately, there doesn't appear to be any publicly available information that describes all existing design variations. One conclusion is that swapping spare parts between Periplan eyepieces should only be done with discrimination, if at all.

Figure 3: Leitz Periplan GF 12.5x M eyepieces. The focusing eyelens in its most extended (left) and most contracted (right) setting.

These maintenance notes cover two very similar but still differently designed versions of Periplan GF M eyepieces (Figure 2 and Figure 3.) Read the maintenance notes with the understanding that the Leitz Periplan GF M eyepiece that you have on your table may look different from what is described here. On the other hand, the procedures should be at least partially applicable for other Periplan eyepieces from the 170 mm tube length era.

Here are some maintenance tasks that could be required for a Periplan GF M eyepiece:

1. **Replacing a graticule or inserting a new graticule.** The M type eyepiece has a holder for a 17.5 mm graticule situated in the field lens assembly (Figure 5) at the same level as the internal eyepiece diaphragm. Graticules are available with several different engraved patterns or inscriptions, e.g., concentric circles, grids, crosshairs, measuring scales, camera image format outlines, etc.
2. **Cleaning and re-greasing the eyelens focusing mechanism.** The eyelens focus is adjusted by turning the eyepiece front (i.e., the eyelens) which moves on a greased helicoid (Figure 4) thread. The eyepiece will today be near half a century old, and it should not be a surprise that the grease may have hardened and made it difficult or even impossible to turn the focusing ring. The only remedy is to disassemble the focusing mechanism and clean and re-grease the thread.

Figure 4: Helicoid thread.

3. **Cleaning the outer lens surfaces.** This important task will not be covered here, refer to the many detailed lens cleaning instructions available in microscopy pamphlets and on Internet.

Figure 5 and Figure 6 illustrate a Periplan GF 10x M eyepiece after disassembly and indicate how the various parts are assembled and the corresponding threads. Similarly, Figure 7 and Figure 8 illustrate a slightly different Periplan GF 12.5x M eyepiece design. Both of these eyepiece designs can of course appear with different magnifications; I just happened to work with the 10x and 12.5x eyepieces illustrated here while writing the maintenance notes.

I don't know for sure, but assume that the eyepiece design in Figure 2, Figure 5 and Figure 6 represents an older design than the eyepiece shown in Figure 3, Figure 7 and Figure 8. Therefore, I will take the liberty here to distinguish between these designs by calling them "older" vs. "newer".

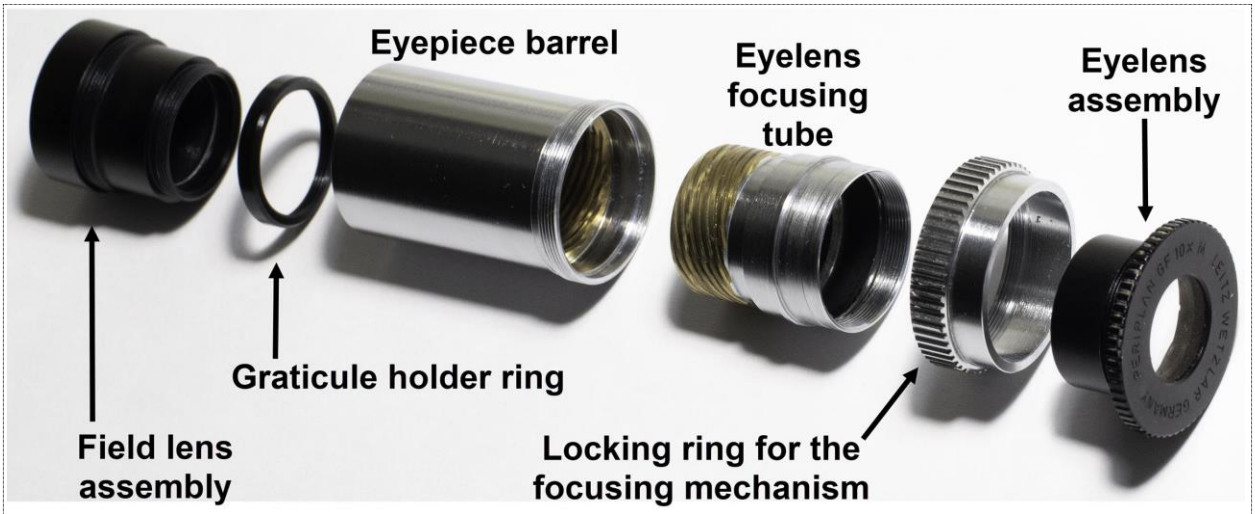

*Figure 5: Exploded view of the Leitz Periplan GF 10x M eyepiece. It illustrates the "**older**" design.*

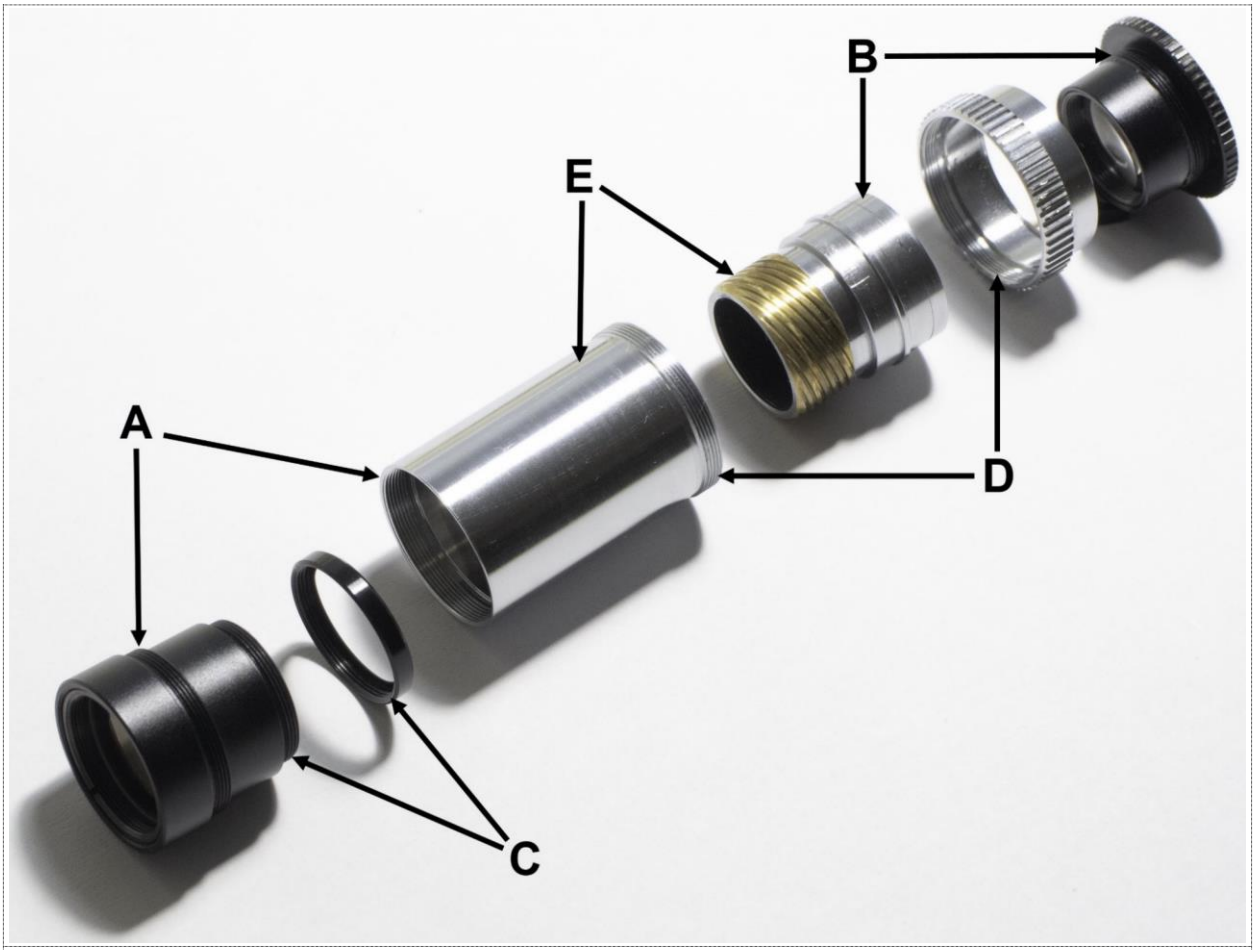

*Figure 6: Another view of the "**older**" Leitz Periplan GF 10x M eyepiece. The letters indicate where the various threads fit.*
A = The field lens assembly → the eyepiece barrel's underside
B = The eyelens assembly → the eyelens focusing tube
C = The graticule holder ring → the graticule holder end of the field lens assembly
D = The locking ring for the focusing mechanism → the eyepiece barrel's upper side
E = The eyelens focusing tube's helicoid thread → the inside of the eyepiece barrel's upper side

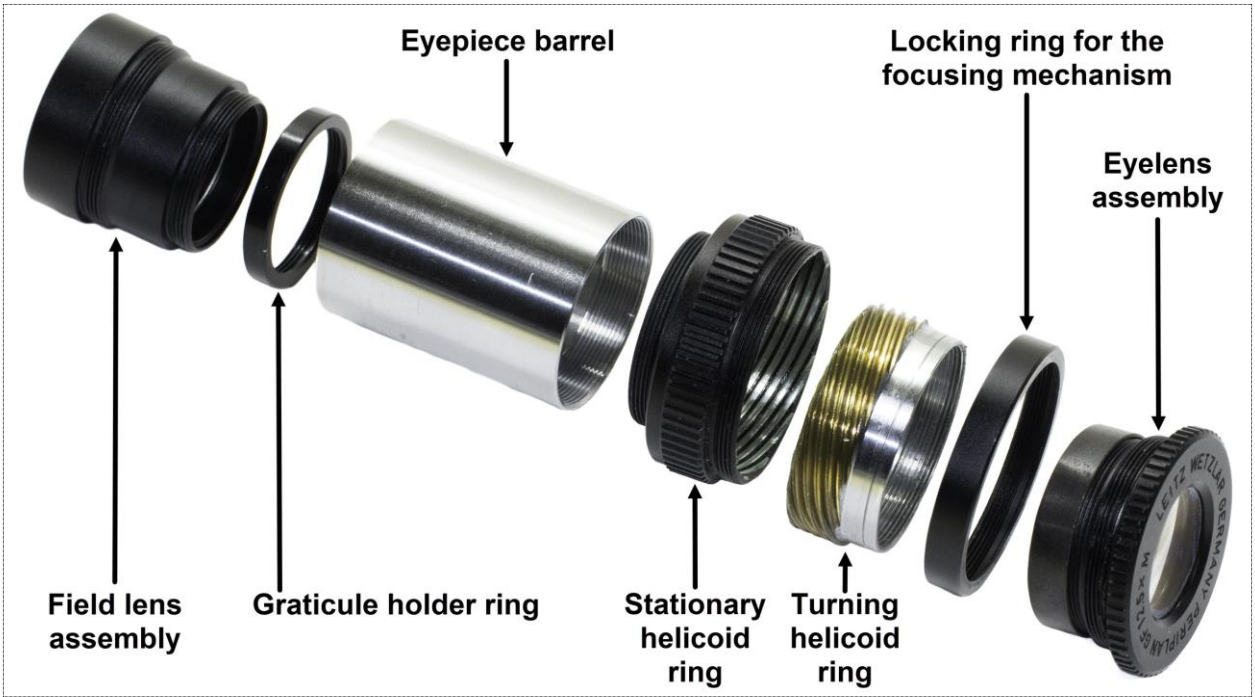

*Figure 7: Exploded view of a Leitz Periplan GF 12.5x M eyepiece. It illustrates the "**newer**" design.*

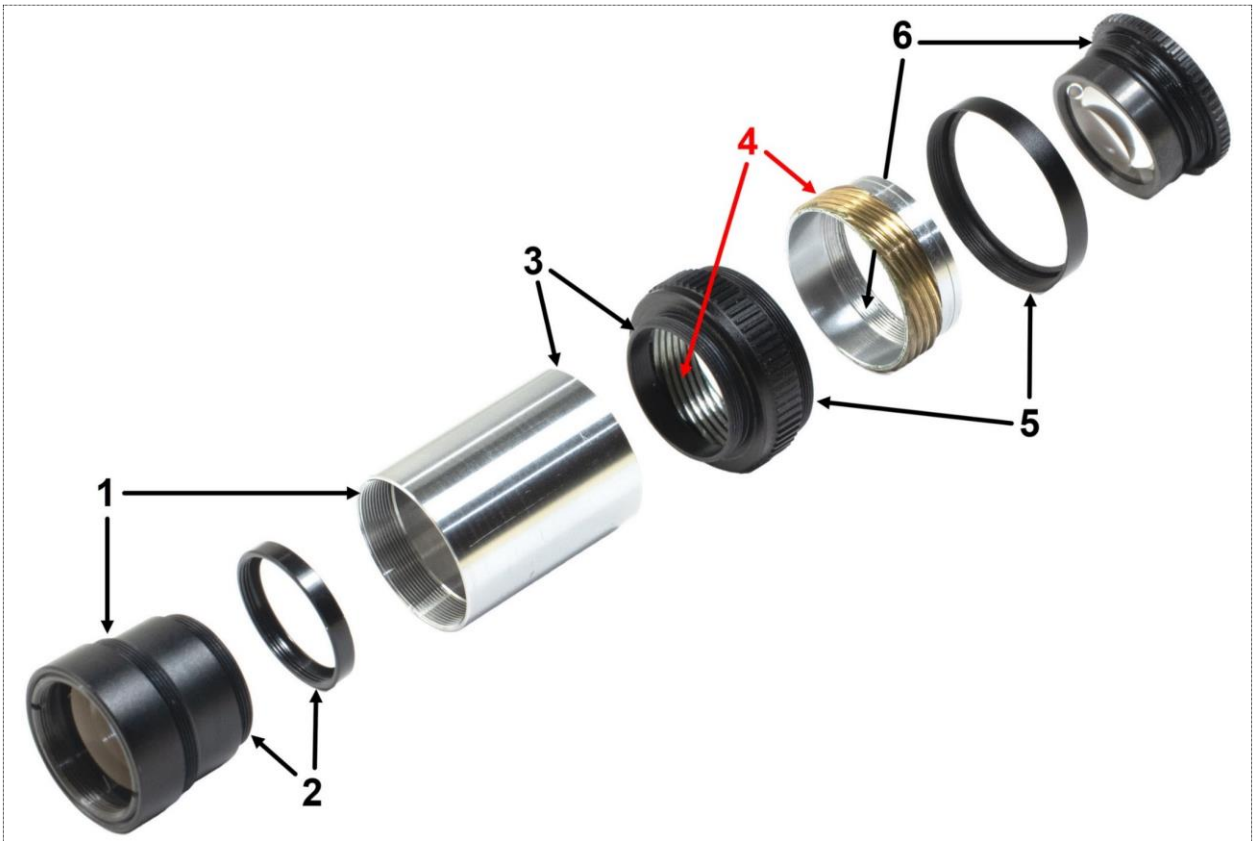

*Figure 8: Another view of the "**newer**" Leitz Periplan GF 12.5x M eyepiece. The numbers indicate where the various threads fit.*

1 = The field lens assembly → the eyepiece barrel
2 = The graticule holder ring → the graticule holder end of the field lens assembly
3 = The outer thread of the stationary helicoid ring → the eyepiece barrel
4 = The turning helicoid ring → the stationary helicoid ring
5 = The locking ring → the outside thread on the stationary helicoid ring
6 = The eyelens assembly → the thread on the inside of the turning helicoid ring

Precautions

In microscopy literature it is often, and with good reasons, advised against disassembling eyepieces and objectives – this is to avoid that the internal lens surfaces inadvertently get contaminated or compromised. The work described in these maintenance notes however requires that the eyepieces indeed are taken apart. Therefore, while working with your eyepieces be very mindful to uphold clean working routines. Protect the lens surfaces from contamination by grease – some lens surfaces are very close the greased helicoid threads. Dirt or dust on any of the eyepiece lenses tend to show up superimposed on the microscope image and can be quite distracting for a critical observer.

Threads and edges can be very sharp and cut your fingers if you are not careful. Such cuts are usually superficial and not dangerous in any way, only quite annoying.

Releasing Stuck Threads

A typical difficulty during eyepiece disassembly is that any of its threads may be stuck. After unsuccessfully (due to slipping) having tried to release a thread with the fingers, it is tempting to turn to stronger measures, like holding the eyepiece with adjustable pliers or in a vise. This comes with three caveats. First, the items must be carefully protected from ugly surface damage caused by the metal teeth of the pliers or the vise. Second, by forcefully squeezing an eyepiece barrel or any threaded ring with pliers or between vise jaws, the item is forced into a slightly oval shape which will make the threads to stick even harder. Third, the additional force applied increases the risk for breaking the eyepiece.

A slipping finger grip can be improved by wrapping each of the eyepiece parts in approx. 1-3 mm thick rubber sheets or strips. Avoid silicone rubber, which is slippery. Suitable rubber sheets can be cut from rubber pads that are used to open can lids and available in kitchen utensil shops. Wide rubber bands can also be very helpful.

If the use of pliers or a vice becomes necessary, the affected eyepiece parts must be protected with rubber sheets, preferably vulcanized rubber or PVC (vinyl, or more correctly, polyvinylchloride plastics) which are more resistant to breakthrough from the teeth of the pliers or the vise. A simple solution is to cut a PVC hose into a 5-10 mm piece and wrap it around any sensitive eyepiece part. If the diameter of the hose is too small to fit over the eyepiece, then cut up its side so it can be wrapped over a larger diameter.

Another remedy is to put the unrelenting parts in a freezer for a few hours and then try to release the stuck thread. Alternatively, one could carefully heat the parts with an electric heat gun. Avoid however to use cold or heat on parts that contain lenses, i.e., on any of the field lens or eyelens assemblies. It's generally a good idea to protect lenses from temperature variations, particularly if the lenses are cemented in a mount or cemented together in a doublet or triplet.

On Internet one can find instructions for a clever homemade non-marring clamp that can be tailored for various microscope objective and eyepiece sizes (Carl Hunsinger, Freeing Spring-Loaded Tips and Cover-Slip Correction Collars of Olympus LB Objectives, Appendix 1.) Such clamps, particularly if lined with a rubber sheet, are gentle to the surface of the objective/eyepiece and provide a more even grip around the barrel which prevents it from being forced into the undesired oval shape.

A decent alternative to Hunsinger's clamp is to use a strap wrench (Figure 9.) These wrenches are often used to release pipes or engine oil filters. For use with eyepieces and objectives, you should purchase a strap wrench of the smallest size that you can find. Actually, you will need two.

Figure 9: A small strap wrench with the strap tightly wrapped around an eyepiece.

A jar opener (Figure 10) is another tool that may be useful for releasing stuck items.

Figure 10: Jar opener, rubber lined.

About Grease

The only parts of the Periplan GF M eyepieces that need lubrication are the focus control's helicoid threads (Figure 4.) There are two things to consider when choosing the grease. First, because the helicoid threads are so close to the eyepiece's lenses, it is important that the grease doesn't emit any semi-volatile compounds that with time could form a hazy film on adjacent lens surfaces. Several special "helicoid greases" are available that are tailored for optical use and should be safe for the lenses. Second, the consistency of the grease should be chosen to provide the eyepiece focus controls with a good balance between lightness and heaviness. It certainly is desirable that the focus adjustments are smooth and comfortable, but the grease also needs to be thick enough to prevent inadvertent changes. Where the "good balance" is, is determined by you and your personal preferences.

Helicoid greases are often characterized by "grades" with values in the range 10 – 3000. Low numbers provide focusing that feels light, high numbers means heavier focusing. The "grades" appear to be

proprietary designations and not really tied to any standardized physical measurements. They may also vary between different manufacturers. As an aid to compare some relevant grease properties ChatGPT prepared the following table that *approximately* matches helicoid grease "grades" with the more formal units of NLGI consistency numbers and kinematic viscosities:

Helicoid grade	NLGI consistency number	Base oil viscosity (cSt at 40°C)	Feel/notes
10	000 - 00	10 - 30	Almost fluid, like thin machine oil
50	00 - 0	50 - 100	Very light, free-running helicoid
100	0 - 1	100 - 200	Light damping, close to gear oil
150	1	150 - 300	Noticeable drag but still smooth
200	1 - 2	200 - 400	Medium damping, common general helicoid grade
300	2	400 - 600	Syrupy feel, good for moderate resistance
500	2 - 3	800 - 1200	Heavy damping, stiffer focus rings
1000	3	1500 - 2500	Thick, "honey-like" resistance
2000	3-4	3000 - 6000	Very stiff, sluggish helicoid
3000	4+	7000 - 10000+	Extremely heavy, almost paste-like

Use the table with a critical mind. Based on my greasing trials I believe that the "feel/notes" column exaggerates the actual heaviness that the eyepiece focus controls acquire. My guess is that the table has been compiled for camera helicoid threads that have sliding surfaces that may be an order of magnitude larger than the eyelens' sliding surfaces. Using the same grease, a larger sliding surface will clearly be heavier to move than a smaller surface.

I have tried a few helicoid greases with base viscosities ranging between 200 and 30000 cSt. The one I liked best for the eyelens focus was rated as a helicoid grade 3000 grease. Lighter greases were OK but tended to be somewhat too loose for my liking. Nyogel 767A (otherwise a great grease) at approximately 30000 cSt was way too stiff for the eyelens focusing. Don't take my impressions as the final word, only use them as a starting point to narrow down your own preferences.

As an interesting digression, it seems that few grease manufacturers are keen to sell their specialty greases in small packages to the public. Some businesses have identified this as an opportunity; they buy the large (like gallons) grease jars that are offered by the manufacturers, repackage the greases in small, consumer friendly containers (perhaps at 10 g), and resell them for (more or less) modest prices on eBay and Amazon. For us amateurs it makes the greases easier to purchase, but the disadvantage is that the traceability of the grease is usually lost (the original names of the greases and the manufacturers, and any batch numbers are typically absent) and we are left to just trust the reseller that the product is genuine and as advertised.

Replacing or inserting a new graticule

This section applies to both of the eyepiece models that are shown in Figure 2 and Figure 3.

The Leitz Periplan GF M eyepiece contains a mount that fits to a 17.5 mm graticule.

Avoid getting dust into the eyepiece. Also avoid getting fingerprints or dirt on any exposed lens surfaces. Using disposable nitrile rubber gloves may be a good idea during critical work moments.

1. Loosen and unscrew the field lens assembly from the bottom of the eyepiece (thread A in Figure 6 or thread 1 in Figure 8; and also Figure 11.)

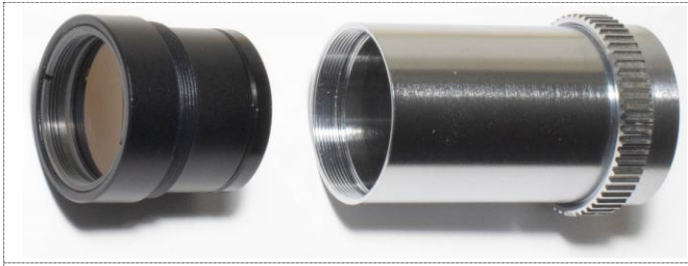

Figure 11: Removal of the field lens assembly.

2. Loosen and unscrew the graticule holder ring from the field lens assembly (thread C in Figure 6 or thread 2 in Figure 8; and also Figure 12.) Be careful not to lose the graticule (if one is already present.)

3. Remove the old graticule (if one is present) from the graticule holder (red arrow in Figure 12) at the upper end of the field lens assembly. Before removing the graticule, take a note of which of its sides faces upwards - this is important to know when it is time to put back the graticule again. The graticule's inscription is typically sandwiched between two plastic and/or glass layers. Looking at the graticule from the side often reveals that the layers are of different thicknesses which helps to distinguish between the graticule's upper and lower side. Only for a graticule with numbers or letters it will be immediately obvious whether it has been attached correctly or not.

Figure 12: The graticule holder and the graticule holder ring from the field lens assembly. The red arrow points to the circular ledge where the graticule is positioned.

4. Check that the new graticule is clean (any remaining dust will be visible with the microscope image) and put it into the holder ledge (red arrow in Figure 12) on the field lens assembly. Make sure that the graticule's designated upside is facing upward. Also make sure that the graticule is properly seated and centered on the ledge.

5. Attach the graticule holder ring to the field lens assembly. Tighten the ling lightly.

6. Check that the graticule still is clean. Reattach the field lens assembly to the eyepiece barrel. Tighten it lightly.

Cleaning and regreasing the eyelens focusing mechanism of the "older" eyepiece design

This section applies to eyepieces that look like those in Figure 2. If your eyepieces look like those in Figure 3, then instead go to section Cleaning and regreasing the eyelens focusing mechanism of the "newer" eyepiece below.

Avoid getting dust into the eyepiece during this work. Also avoid getting fingerprints, dirt or grease on any exposed lens surfaces. Using nitrile rubber gloves may be a good idea at critical work moments.

1. Loosen and unscrew the field lens assembly from the bottom of the eyepiece (thread A in Figure 6.) Put away the field lens assembly in a dust free place. Having this part removed makes it more convenient to work with the focusing mechanism.

2. Loosen and unscrew the eyelens assembly from the top of the eyepiece (Figure 13, and thread B in Figure 6.) The thread is typically quite hard to release as it appears to have been secured with a threadlocker. Applying a threadlocker at manufacturing actually makes sense – a user would see it as a serious quality failure if the eyelens assembly released from the eyepiece when the user only attempted to change the eyepiece focus by turning the focus ring. But for servicing of the focus control the threadlocker is a nuisance. With some luck, you may be able to release the eyelens assembly from the barrel with your fingers only – if that indeed is the case, then proceed to point 4 below. Most probably you will however find that the eyelens assembly is stuck in the thread - then you will have the following two options to choose from:

Figure 13: Removal of the eyelens assembly.

   A. **Procedure if the eyelens focus control is completely frozen and stuck in its fully contracted position** (i.e., screwed all the way down as in the right eyepiece in Figure 2.)

      The only way to access the frozen helicoid thread is to remove the eyelens assembly with some force. Be aware that such forced removal may lead to damage.

      Release the eyelens assembly by putting one strap wrench (Figure 9) over the rim of the locking ring (Figure 5) and another strap wrench (turned in the opposite direction, of course) over the rim of the eyelens assembly (Figure 5.) Tighten the straps and try to release the thread. Alternatively (and with a greater risk for damaging the parts!), after protecting the locking ring and the eyelens assembly as mentioned in section Releasing Stuck Threads use pliers and/or a vise to help releasing the eyepiece assembly. In any case, you will achieve one of the following three outcomes:

      a. The eyelens assembly releases. Proceed to point 4 below to clean and regrease the helicoid thread.

      b. The eyelens assembly will not release, but the use of the tools will force the stuck helicoid to open up into the focus control's fully extended position. This, in turn, leaves you with three choices for how to continue:

I. Proceed to point 3 below to release the eyelens assembly after soaking and softening its thread with solvent (this is the recommended, safest procedure), or,

II. proceed to point 5 below to remove the eyelens focusing tube (Figure 5) from the barrel's helicoid thread while the eyelens assembly still is attached, or,

III. continue using the tool(s) to escalate and increase the applied force until the eyelens assembly releases from the focusing tube. If you manage to remove the eyelens assembly without damaging it, proceed to point 4 below.

c. The eyepiece breaks. End of story. (Sorry.)

B. **Procedure if the eyelens focus control <u>EITHER</u> can be turned into its most extended position** (i.e., as in the left eyepiece in Figure 2), **<u>OR</u> if it is completely frozen and stuck in this position**.

You need to choose between these two options:

a. Proceed to point 3 below to release the eyelens assembly after soaking and softening its thread with solvent, or,

b. proceed to point 5 below to remove the eyelens focusing tube (Figure 5) from the barrel's helicoid thread while the eyelens assembly still is attached.

3. **Release and remove the eyelens assembly after soaking and softening its thread with solvent.**

Here the threadlocker that holds the eyelens assembly (in thread B in Figure 6) will be softened by treatment with solvent before we try to unscrew the eyelens assembly from the focusing tube (Figure 5.) Note that this approach only works if the eyelens focus can be unscrewed into (or near to) its most extended position (like the left eyepiece in Figure 2.) Acetone will be used as the solvent (other common solvents as isopropanol or toluene don't work) and a wick manufactured from a short piece of wool yarn will help to keep the thread wetted with the solvent. Acetone is very flammable – take any necessary safety precautions.

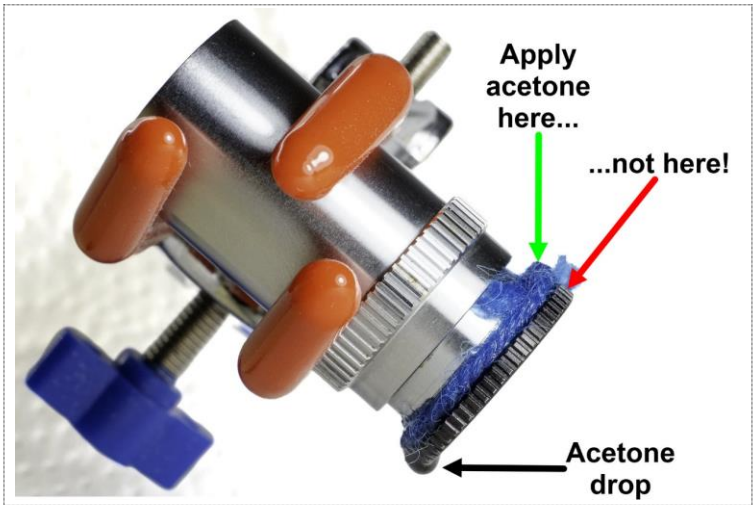

Figure 14: Acetone soaking of the eyelens assembly's thread.

Fasten the eyepiece in a clamp (or any other similar arrangement) with the eyelens assembly pointing downwards at approx. 45° (Figure 14.) Put a towel or some tissue a few cm (or inches) under the eyepiece to catch and absorb any falling acetone drops. Tie a short string of a wool yarn (blue in Figure 14) over and around the thread slit between the eyelens focusing tube and the eyelens assembly. Make sure that the yarn is tight and attached as closely as possible to the thread slit. Use a pipette or an eye dropper to wet the yarn with acetone. Add the acetone drop-wise to the yarn (at the green arrow in Figure 14) until the solvent just starts to drop from the under-side of the eyelens assembly. Avoid using too much solvent (flooding) and avoid getting solvent on any of the lens surfaces – the solvent should only wet the yarn and occasionally drop off from the underside of the eyelens assembly. Because acetone is highly volatile, fresh acetone must be added

every 3 minutes (until a drop again forms on the underside of the eyelens assembly.) It is important to make sure that the yarn remains wet and in good physical contact with the thread slit all the time. Continue the acetone treatment for an hour, remove the yarn, and then, without delay, try to release the eyelens with the help of suitable tools (as per section Releasing Stuck Threads – using two strap wrenches is the safest approach.) The eyelens assembly thread may still need some force to release, but the solvent treatment will significantly facilitate the task.

Once released (Figure 13), consider not to clean the eyelens assembly thread (thread B in Figure 6) from residual threadlocker. This may to some extent help to prevent the thread from accidentally releasing when the eyepiece is ready and back again in regular use.

Proceed to point 4 below to clean and regrease the helicoid thread.

4. **Clean and regrease the focusing control of the eyepiece after the eyelens assembly has been successfully removed** (Figure 13.)

Loosen and unscrew the focusing mechanism's locking ring from the eyepiece barrel (Figure 15, and thread D in Figure 6.) It's difficult to get a good finger grip around the eyepiece barrel so the thread may be hard to release. Using rubber sheets may improve the grip. Otherwise, using two strap wrenches (Figure 9) will typically be successful. Putting the barrel in a freezer for a few hours may also facilitate the removal of a stuck locking ring from the barrel. (Refer to section Releasing Stuck Threads.)

Figure 15: Removal of the locking ring for the focusing mechanism.

Unscrew and remove the eyelens focusing tube from the eyepiece barrel (Figure 16, and helicoid thread E in Figure 6.) If the old, hardened grease makes the removal difficult, press your finger against the inside of the focusing tube and rotate the tube counterclockwise to have it removed. Heating the barrel with hot air from an electric heat gun can help to soften old grease. If the focusing tube is completely stuck it can usually be unstuck by wetting the helicoid thread with penetrating oil (e.g., WD-40.) Turn the eyepiece with its focusing tube facing up and put just a few drops of the penetrating oil into the crevice between the focusing tube and the eyepiece barrel (green arrow in Figure 15.) Let the penetrating oil work for a few hours before trying to release and unscrew the

Figure 16: Removal of the eyelens focusing tube.

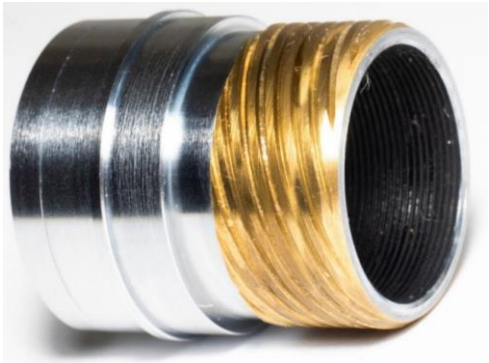

Figure 17: The eyelens focusing tube showing the helicoid thread and the inside with its black paint.

focusing tube. Avoid getting penetrating oil or solvent on the inside of the focusing tube – the ribbed surface on the inside is painted matte black (Figure 17) to eliminate internal reflexes, and the paint may dissolve by the oil or solvent.

Use solvent (white spirit) to thoroughly clean off all of the old grease from both helicoid threads.

Apply fresh helicoid grease on the focusing tube's (Figure 17) helicoid thread (refer to section About Grease.) Use a decent amount of grease, but without overdoing it. Reassemble the focusing tube to the helicoid thread on the inside of the eyepiece barrel. It may take some fidgeting to get the helicoid threads to catch - be patient and don't use force, just try again and again until the threads catch nicely. Then turn the tube back and forth several times to distribute the grease evenly.

Put back the focusing mechanism locking ring (Figure 5) on the barrel and tighten it (not too hard) with your fingers.

Put your finger into the inside of the eyelens focusing tube and turn it counterclockwise as far as it goes. Hold your finger pressed onto the outside rim of the now extended focusing tube to prevent it from turning and replace the eyelens assembly by screwing it into the focusing tube thread (thread B in Figure 6.) Tighten the eyelens assembly with your fingers as hard as you can. This thread should be left well tightened to avoid that the eyelens assembly inadvertently comes loose from the eyepiece when the eyelens focus is adjusted. I'm inclined to recommend against using a threadlocker because of the hassle and uncertainty when the thread again some day later must be released. If you insist to use a threadlocker, at least avoid the modern curing threadlockers (Loctite, and similar) that are resistant to solvents, use instead the old-fashioned rosin or shellac based threadlockers that can be softened with solvents.

Check that the eyelens focus mechanism moves freely and smoothly through its entire range. Check that the lens surfaces are clean.

Reattach the field lens assembly (Figure 5) to the underside of the eyepiece barrel.

The eyepiece is ready for use.

5. **Remove the focusing tube while the eyelens assembly still is stuck on it.**

   Here the eyelens focusing (helicoid) thread will be cleaned and regreased while the eyelens assembly still is left attached on the eyelens focusing tube (refer to Figure 5 for the parts.) This procedure only works if the focusing tube is in (or can be turned into) its fully extended position (as in the left eyepiece in Figure 2) to allow space for releasing the locking ring (Figure 5.)

   Loosen and unscrew the locking ring for the focusing mechanism from the eye-piece barrel (Figure 18, and thread D in Figure 6.) It's difficult to get a good finger grip around the eyepiece barrel which may make the thread hard to release. Using rubber sheets may improve the grip. Otherwise, using two strap wrenches (Figure 9) will typically be successful. Refer to section Releasing Stuck Threads.

Figure 18: The eyepiece after the locking ring has been released.

With the locking ring loosened, unscrew and remove the eyelens focusing tube from the eyepiece barrel (Figure 19, and helicoid thread E in Figure 6.) Old, hardened grease may make the removal difficult. A completely stuck focusing helicoid thread should with some effort release after softening the old grease either with solvent or by *careful* heating.

We start with the solvent option because it is the gentler approach. Turn the eyepiece with the eyelens assembly facing up (Figure 20) and put a few drops of white spirit into the crevice between the focusing tube and the eyepiece barrel (green arrow in Figure 20.) Let the solvent work in the helicoid thread for a few hours before trying to release and unscrew the focusing tube from the barrel. In severe cases it may be necessary to prolong the solvent treatment to several days (then you will need to add more white spirit drops twice a day to compensate for evaporation.) Avoid getting solvent on the inside of the focusing tube and, above all, keep the solvent away from the eyelens assembly.

For the heating option, be aware that the heat may damage the lenses in the attached eyelens assembly. Carefully heat the outside of the barrel with hot air from an electric heat gun. Avoid heating the eyelens assembly, the lenses tend to be very sensitive to damage from elevated temperatures. To save the lenses use a low heat setting and apply the heat only for a short time. With some luck the old grease in the helicoid should soften enough to allow the eyelens focusing tube to release from the barrel.

Figure 19: The eyelens focusing tube removed with the eyelens assembly still attached.

Figure 20: The green arrow points to the crevice where to put the penetrating oil.

Use solvent (white spirit) to thoroughly clean off all of the old grease from both helicoid threads.

Apply fresh helicoid grease on the focusing tube's (Figure 19) helicoid thread. Refer to section About Grease.

Reassemble the greased focusing tube to the helicoid thread on the inside of the eyepiece barrel (Figure 19.) It may take some fidgeting to get the helicoids to catch - be patient and don't use force,

just try again and again until the threads catch smoothly. Then turn the tube back and forth several times to distribute the grease evenly.

Screw down the focusing mechanism locking ring (Figure 5) over the barrel thread and tighten it (not too hard) with your fingers.

Check that the eyelens focusing mechanism moves freely and smoothly through its entire range. Check that the lens surfaces are clean.

Reattach the field lens assembly (Figure 5) to the underside of the eyepiece barrel.

The eyepiece is ready for use.

Cleaning and regreasing the eyelens focusing mechanism of the "newer" eyepiece design

This section applies to eyepieces that look like those in Figure 3. If your eyepieces look like those in Figure 2, then instead go to section Cleaning and regreasing the eyelens focusing mechanism of the "older" eyepiece design above.

Avoid getting dust into the eyepiece during this work. Also avoid getting fingerprints, dirt or grease on any exposed lens surfaces. Using nitrile rubber gloves may be a good idea at critical work moments.

1. Loosen and unscrew the field lens assembly from the bottom of the eyepiece (thread 1 in Figure 8.) Put away the field lens assembly in a dust free place. Having this part removed makes it more convenient to work with the focusing mechanism.

2. Loosen and unscrew the eyelens assembly from the top of the eyepiece (Figure 21, and thread 6 in Figure 8.) The thread is typically quite hard to release as it appears to have been secured with a threadlocker. Applying a threadlocker at manufacturing actually makes sense – a user would see it as a serious quality failure if the eyelens assembly released from the eyepiece when the user only attempted to change the eyepiece focus by turning the focus ring. But for servicing of the focus control the threadlocker is a nuisance. With some luck, you may be able to release the eyelens assembly from the barrel with your fingers only – if that indeed is the case, then proceed to point 4 below. Most probably you will however find that the eyelens assembly is stuck in the thread - then you will have the following two options to choose from:

Figure 21: Removal of the eyelens assembly. (The eyepiece in this image is of the "older" eyepiece design.)

   A. **Procedure if the eyelens focus control is completely frozen and stuck in its fully contracted position** (i.e., screwed all the way down as in the right eyepiece in Figure 3.)

      The only way to access the frozen helicoid thread is to remove the eyelens assembly with some force. Be aware that such forced removal may lead to damage.

Release the eyelens assembly by putting one strap wrench (Figure 9) over the knurled rim of the stationary helicoid ring (Figure 7) and another strap wrench (turned in the opposite direction, of course) over the rim of the eyelens assembly (Figure 7.) Tighten the straps and try to release the thread. Alternatively (and with a greater risk for damaging the parts!), after protecting the stationary helicoid ring and the eyelens assembly as mentioned in section Releasing Stuck Threads use pliers and/or a vise to help releasing the eyepiece assembly. In any case, you will achieve one of the following three outcomes:

a. The eyelens assembly releases. Proceed to point 4 below to clean and regrease the helicoid thread.

b. The eyelens assembly will not release, but the use of the tools will force the stuck helicoid to open up into the focus control's fully extended position. This, in turn, leaves you with three choices for how to continue:

   I. Proceed to point 3 below to release the eyelens assembly after soaking and softening its thread with solvent, or,

   II. proceed to point 5 below to remove the stationary helicoid ring (with the eyelens assembly still attached) from the eyepiece barrel (Figure 7), or,

   III. continue using the tool(s) to escalate and increase the applied force until the eyelens assembly releases from the focusing tube. Note that the risk for damage increases greatly, particularly for the fragile locking ring. If you manage to remove the eyelens assembly without damage, proceed to point 4 below.

c. The eyepiece breaks. End of story. (Sorry.)

B. **Procedure if the eyelens focus control <u>EITHER</u> can be turned into its most extended position** (i.e., as in the left eyepiece in Figure 3), **<u>OR</u> if it is completely frozen and stuck in this position**.

You need to choose between these two options:

a. Proceed to point 3 below to release the eyelens assembly after soaking and softening its thread with solvent, or,

c. proceed to point 5 below to remove the stationary helicoid ring (with the eyelens assembly still attached) from the eyepiece barrel (Figure 7).

3. **Release and remove the eyelens assembly after soaking and softening its thread with solvent.**

Here the threadlocker that holds the eyelens assembly (in thread 6 in Figure 8) will be softened by treatment with solvent before we try to unscrew the eyelens assembly from the turning helicoid ring (Figure 7.) Note that this approach only works if the eyelens focus can be unscrewed into (or near to) its most extended position (like the left eyepiece in Figure 3.) Acetone will be used as the solvent (other common solvents as isopropanol or toluene don't work) and a wick manufactured from a short piece of wool yarn will help to keep the thread wetted with the solvent. Acetone is very flammable – take any necessary safety precautions.

Fasten the eyepiece in a clamp (or any other similar arrangement) with the eyelens assembly pointing downwards at approx. 45° (Figure 22.) Put a towel or some tissue a few cm (or inches) under the eyepiece to catch and absorb any falling acetone drops. Tie a short string of a wool yarn (blue in Figure 22) over and around the thread slit between the turning helicoid ring and the eyelens assembly. Make sure that the yarn is tight and attached as closely as possible to the thread slit. Use a

pipette or an eye dropper to wet the yarn with acetone. Add the acetone dropwise to the yarn (at the green arrow in Figure 22) until the solvent just starts to drop from the underside of the eyelens assembly. Avoid using too much solvent (flooding) and avoid getting solvent on any of the lens surfaces – the solvent should only wet the yarn and occasionally drop off from the underside of the eyelens assembly. Because acetone is highly volatile, fresh acetone must be added every 3 minutes (until a drop again forms on the underside of the eyelens assembly.) It is important to make sure that the yarn remains wet and in good physical contact with the thread slit all the time.

Continue the acetone treatment for an hour, remove the yarn, and then, without delay, try to release the eyelens with the help of suitable tools (as per section Releasing Stuck Threads – using two strap wrenches is the safest approach.) The eyelens assembly thread may still need some force to release, but the solvent treatment will significantly facilitate the task.

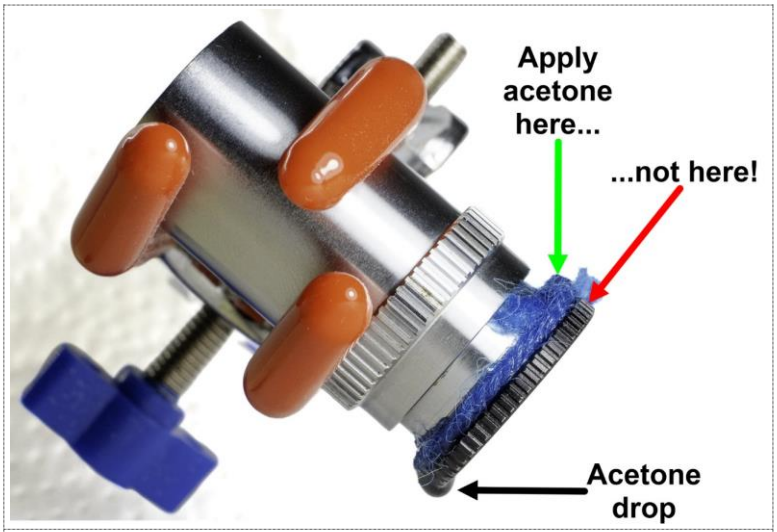

Figure 22: Acetone soaking of the eyelens assembly's thread. (The eyepiece in the image is of the "older" eyepiece design.)

Once released, consider not to clean the eyelens assembly thread (thread 6 in Figure 8) from residual threadlocker. This may to some extent help to prevent the thread from accidentally releasing when the eyepiece is ready and back again in regular use.

Proceed to point 4 below to clean and regrease the helicoid thread.

4. **Clean and regrease the focusing control of the eyepiece after the eyelens assembly has been successfully removed from the turning helicoid ring (Figure 7.)**

   Unscrew and remove the focusing mechanism's black locking ring from the stationary helicoid ring (thread 5 in Figure 8.) It's difficult to get a good finger grip around the locking ring which may make it hard to release. Using rubber sheets or a rubber band wrapped around it may improve the grip. Alternatively, using a strap wrench (Figure 9) or jar opener (Figure 10) should typically be successful. Refer to section Releasing Stuck Threads.

   Unscrew and remove the turning helicoid ring from the stationary helicoid ring (helicoid thread 4 in Figure 8) and then remove the stationary helicoid ring from the eyepiece barrel (thread 3 in Figure 8.) If the helicoid thread is completely stuck in aged grease, then just remove the stationary helicoid ring from the eyepiece barrel and soften the helicoid by soaking it in a solvent (white spirit) bath.

   Use solvent (white spirit) to thoroughly clean off all of the old grease from the helicoid threads of both the turning helicoid ring and the stationary helicoid ring.

   Apply fresh helicoid grease on the helicoid thread on the turning helicoid ring (refer to section About Grease.) Use a decent amount of grease, but without overdoing it.

   Reassemble the turning helicoid ring to the stationary helicoid ring. It may take some fidgeting to get the helicoid threads to catch - be patient and don't use force, just try again and again until the

threads catch smoothly. Then turn the turning helicoid ring back and forth several times in the stationary helicoid ring to distribute the grease evenly. Wipe off any grease that may have become squeezed outside of the helicoid thread (Figure 23.)

Remove the turning helicoid ring from the stationary helicoid ring. Use cotton swabs to wipe off any grease from the black ledge on the inside of the stationary helicoid ring (red arrows in Figure 24) – any excess of grease left here could eventually contaminate the lower lens of the eyelens assembly.

Figure 23: The stationary helicoid ring with the turning helicoid ring attached. Excess grease can be seen squeezed out between the parts.

Figure 24: The inside of the stationary helicoid ring. The red arrows point to the ledge that should be cleaned from excess grease.

For the following work moment it is worth to protect your fingers from being cut by the sharp helicoid thread; either wear a disposable glove or put adhesive bandages (plasters) over your thumb and your index finger. Also be sure to protect the eyelens assembly's lenses from being touched by your fingers or contaminated by grease. Hold the turning helicoid ring between your thumb and your index finger and loosely attach the black locking ring over its chromed end (Figure 7.) While still holding the turning helicoid ring, attach the eyelens assembly to it. Tighten it as hard as you can with your fingers. This thread (thread 6 in Figure 8) should be left well tightened to avoid that the eyelens assembly inadvertently comes loose from the eyepiece when the eyelens focus is adjusted. I'm inclined to recommend against using a threadlocker because of the hassle and uncertainty when the eyelens assembly again some day later will need to be removed. But if you insist to use a thread-locker, at least avoid the modern curing threadlockers (Loctite, and similar) that are resistant to solvents and difficult to loosen up, use instead the old-fashioned rosin or shellac based threadlockers that can be softened with solvents.

Use cotton swabs to wipe off any excess grease from the backside of the turning helicoid ring. Don't allow the swab to touch the lens that now will be very close (Figure 25.)

Attach the combined eyelens assembly/turning helicoid ring to the helicoid thread in the stationary helicoid ring. As before, be patient and don't use force. And keep the lenses clean.

Screw down the black focusing mechanism locking ring over the stationary helicoid ring (thread 5 in Figure 8) and tighten it (lightly only) with your fingers.

Turn the eyelens assembly's knurled rim counterclockwise to extend the eyelens as far as it goes and wipe off any excess grease that you can reach.

Check that the eyelens focusing mechanism moves freely and smoothly through its entire range. Check that the lens surfaces are clean.

Reattach the combined eyelens assembly/ helicoid rings to the eyepiece barrel (thread 3 in Figure 8.)

Reattach the field lens assembly to the other end of the eyepiece barrel (thread 1 in Figure 8.)

The eyepiece is ready for use.

Figure 25: The eyepiece assembly attached to the turning helicoid ring.

5. **Remove the turning helicoid ring while the eyelens assembly still is stuck on it.**

Here the eyelens focusing (helicoid) thread will be cleaned and regreased while the eyelens assembly still is left attached on the turning helicoid ring (refer to Figure 7 for the parts.) This procedure only works if the turning helicoid ring is in (or can be turned into) its fully extended position (as in the left eyepiece in Figure 3) to allow space for releasing the black locking ring (Figure 7.)

Loosen and unscrew the black locking ring for the focusing mechanism from the stationary helicoid ring (Figure 26, and thread 5 in Figure 8.) It's difficult to get a good finger grip around the locking ring which may make it hard to release. Using rubber sheets or a rubber band wrapped around it may improve the grip. Alternatively, using a strap wrench (Figure 9) or jar opener (Figure 10) should typically be successful. Refer to section Releasing Stuck Threads.

Figure 26: The eyepiece after the locking ring has been released.

With the locking ring loosened, unscrew and remove the turning helicoid ring from the stationary helicoid ring (Figure 25, and helicoid thread 4 in Figure 8.) Old, hardened grease may make the removal difficult. To succeed you may need to use the tools described in section Releasing Stuck Threads.

Use solvent (white spirit) to thoroughly clean off all of the old grease from both of the now exposed helicoid threads. Be careful not to contaminate the lens surfaces of the still attached eyelens assembly.

Apply fresh helicoid grease on the turning helicoid ring's helicoid thread (Figure 25.) Don't overdo the greasing – it's important to avoid that grease leaks out from the helicoid thread and contaminates the adjacent lens. (Refer to section About Grease.)

Reassemble the greased turning helicoid ring to the stationary helicoid ring. It may take some fidgeting to get the helicoid threads to catch - be patient and don't use force, just try again and again until the threads catch smoothly. Then turn the turning helicoid ring back and forth several times to distribute the grease evenly.

Screw down the focusing mechanism locking ring over the stationary helicoid ring (Figure 26, and thread 5 in Figure 8) and tighten it (lightly only) with your fingers.

Turn the eyelens assembly's knurled rim counterclockwise to extend the eyelens as far as it goes and wipe off any excess grease that you can reach.

Check that the eyelens focusing mechanism moves freely and smoothly through its entire range. Check that all lens surfaces are clean.

Reattach the combined eyelens assembly/helicoid rings to the eyepiece barrel (thread 3 in Figure 8.)

Reattach the field lens assembly (Figure 7) to the underside of the eyepiece barrel.

The eyepiece is ready for use.

What to do if the helicoid thread resists releasing and remains stuck

If the helicoid thread is so stuck that it can't be released even after using the tools mentioned in section Releasing Stuck Threads, then unfortunately there is really no safe way to proceed without a serious risk to damage the eyelens assembly. The "newer" eyepiece design differs from the "older" by having the helicoid thread very close to the eyelens assembly (as is evident in Figure 25.) Trying to use solvent to soften the aged grease in the helicoid thread would almost certainly result in solvent and grease contamination of the lower lens surface of the eyelens assembly. Similarly, using heat treatment would almost certainly also lead to potentially dangerous heating of the eyelens assembly.

This means that the only remaining safe option is to first remove the eyepiece assembly from the turning helicoid ring before trying to release the eyepiece focusing mechanism. To do this, proceed to subsection 3 above.