Leitz Ultropak Objective: Seized Condenser Adjustment

Introduction

Ultropak is a legacy series of objectives and accessories designed for vertical illumination using separate optical paths for the illumination and for the image formation. Apparently developed sometime in the late 1920s to the early 1930s under the lead of Hermann Heine at E. Leitz, Wetzlar, Ultropak objectives required a special microscope adapter/nosepiece/illuminator which could be obtained for most of Leitz' contemporary microscope models. For technical reasons the mechanical tube length of the Ultropak objectives was 185 mm, rather than the 170 mm Leitz standard at that time. Optically the Ultropak objective family was however compatible with the 170 mm tube length and worked therefore perfectly well on microscopes with the regular heads/tubes and eyepieces without requiring any further modifications. Leitz Orthoplan was the latest microscope model that supported Ultropak.

Ultropak objectives are designed to only work together with their appropriate annular condensers (a.k.a. ring condensers.) More than a dozen different objectives were available with magnifications ranging from 1.5x to 100x, although the magnifications and designs changed through the years. Most of the objectives were designed to be used without a cover glass. Their working distances were typically longer than for the corresponding objectives for transmitted light. Accessories were available for various modifications to enhance the imaging; for example, annular condensers for different kinds of oblique or relief illumination, polarization, fluorescence, various dipping cones or immersion caps, filters, sector stops, lamp house adapters, etc.

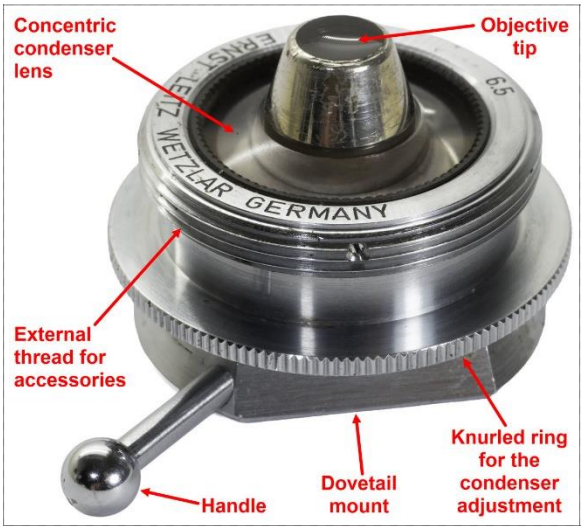


Figure 1: An Ultropak UO 6.5 objective complete with its annular condenser.

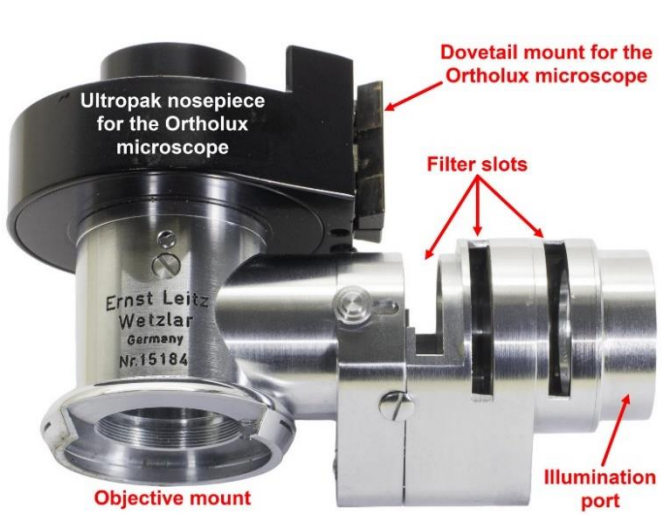


Figure 2: An Ultropak adapter/nosepiece/illuminator for the Leitz Ortholux microscope.

Leitz' brochures describe the appearance of the specimen image as being similar to darkground microscopy and particularly emphasize the freedom from glare and reflections (the latter can be further eliminated by using polarized illumination.) An interesting aspect is that Ultropak's vertical illumination easily can be complemented with simultaneous transmitted illumination using the microscope's regular condenser. The curious user can experiment by varying the intensity ratio of the two illuminations and trying out filters of different and complementary colors.

As for today's users, Ultropak equipment has not been manufactured for the last half century, but can sometimes be obtained used, for example, through eBay. For the buyer of used Ultropaks, here are a few issues to watch out for:

- Missing or mismatched parts. Because Ultropak objectives are not really mainstream equipment, a regular microscope user may not be able to recognize whether any important parts are missing or mismatched. Reviewing Ultropak printed material available on internet (see References below) may to some extent help.
- Broken lenses. Objectives can of course sometimes be broken or compromised, but lens breakage unfortunately appears to be quite common with the concentric lenses in the annular condensers.
- Dirty lenses. Sometimes easy to clean, other times impossible.
- The adjustment of the annular condenser may be sluggish or even completely seized due to hardened, old grease.
- The special mirror in the adapter/nosepiece/illuminator may be damaged.

Scope

These maintenance notes describe how to release an annular condenser adjustment that has become seized due to aged grease. The notes pertain particularly to the Ultropak UO 6.5 objective, but can (with some discrimination and modification) be adapted to other Ultropak objectives. It's hardly a statistically significant sample, but of the five UO 6.5 objectives that I have stumbled upon, three came with completely seized condenser adjustments.

Some Special Equipment

Besides a set of regular tools, some less common tools will be required:

- A 1.0 mm watchmaker screwdriver. Small watchmaker screwdrivers are delicate; they deform and break easily. Aim for the best quality you can find and afford.
- A strap wrench. Provides a good and even grip and good torque about round and slippery surfaces without damaging the surface. Get the smallest size you can find (Figure 3.)



Figure 3: An example of a strap wrench, in this image wrapped around an eyepiece.

- A vise, with some protection against damage by the vise jaws. The protection can be arranged in many ways, Figure 4 shows the vise jaws lined with double layers of reinforced tape ("duct tape".)

For the work in these notes the protection doesn't need to cover the entire jaw surfaces; only a length of approx. 3 cm (or 1¼ in) is needed to safely clamp the Ultropak objective's dovetail mount. Because of the shape of the objective make sure to apply the protection all the way to the top of the jaws and all the way to one side of the jaws as shown in Figure 4.

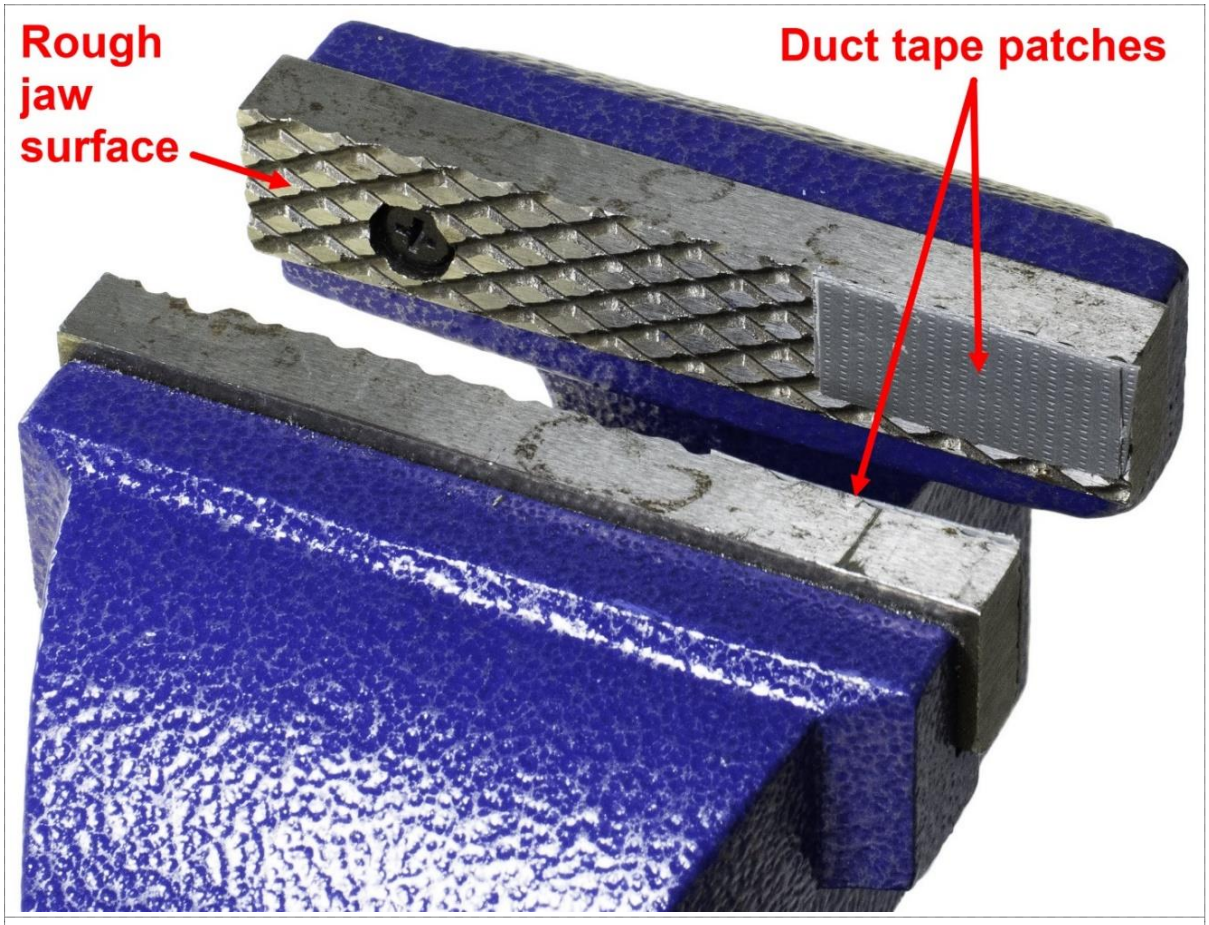


Figure 4: Vise, with protection against damage to sensitive objects.

Maintenance Notes

Checking whether the annular condenser adjustment is sluggish or seized is easy just by trying to turn the knurled adjustment ring (Figure 1) with the fingers. If the condenser adjustment only is sluggish, then the condenser can simply be unscrewed from the base and the threads cleaned and regreased. However, if the condenser indeed is seized, the fix will be more laborious. In that case, don't immediately proceed by trying to release it with the strap wrench (Figure 3) – what most probably will happen is that only the collar will begin to slide over the stuck annular condenser with the collar's grub screws scraping and scuffing the bottom of the condenser's groove (Figure 5.) Instead, the objective must be carefully disassembled into its four main parts, which for the Ultropak UO 6.5 objective are: The annular condenser, the collar, the objective base, and the objective casing, refer to Figure 5 and Figure 6.

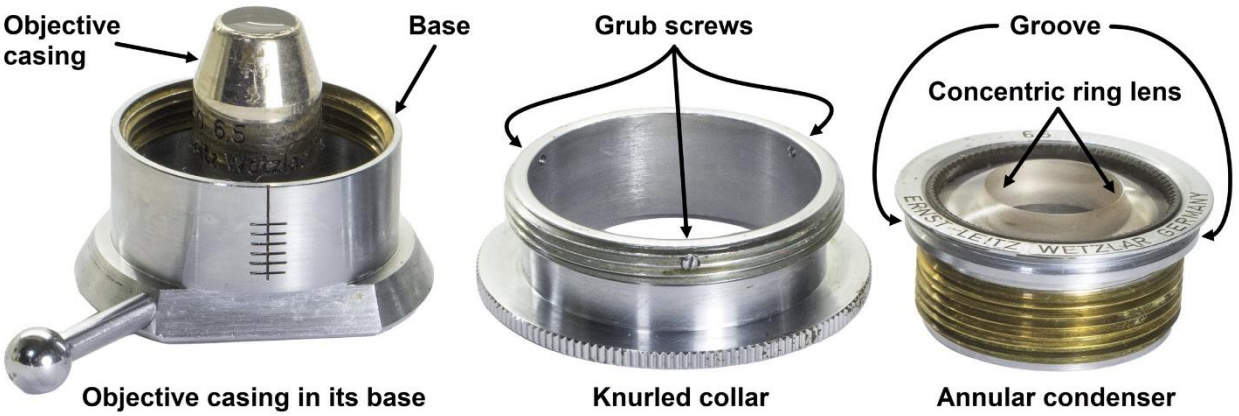


Figure 5: An Ultropak UO 6.5 objective partly taken apart.

1. Release the knurled collar.

Within the collar's external thread are three inconspicuous M1.4x2 grub screws (Figure 5 and Figure 7.) The screws' pointed tips hold the collar attached to the annular condenser. Typically, the recessed screw heads will be covered with a mixture of dirt and old grease – scape away as much as possible of it with a steel needle. Pay particular attention to remove the gunk from the screw drives (i.e., the slots in the screw heads); this is important to ensure that the screwdriver will catch the drives.

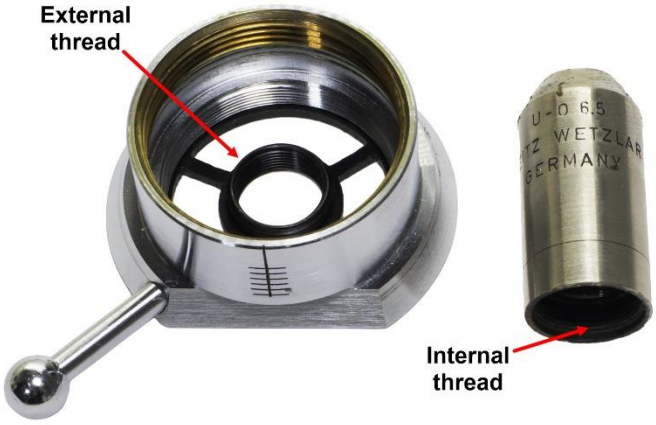


Figure 6: Ultropak UO 6.5: The objective casing removed from the objective base.

Use a 1.0 mm watchmaker screwdriver to release and remove the three grub screws. Be sure that the screwdriver tip goes completely down into the screw drives before attempting to release the screws. Remove the screws from the collar and save them somewhere safe so they don't get lost.

Using a 1.2 mm screwdriver may be tempting because it clearly will be hardier than a 1.0 mm screw-driver. I have however found that 1.2 mm screwdrivers don't work reliably in the narrow Ultropak screw holes and may even cause damage.

Furthermore, small grub screws are fragile, and their heads break easily if mistreated (for example, if the screwdriver is held angled.) The screws are also prone to cross-threading. Spare grub screws can with some effort be obtained through Amazon or eBay; if the screws are only available with rounded tips rather than pointed, they are still OK to use.



Figure 7: Grub screw (M1.4x2)

With the grub screws removed, the collar should in most cases release easily from the rim of the annular condenser. The collar can't however be completely removed yet because it is trapped between the objective base and the seized annular condenser (Figure 9.)



Figure 8: UO 6.5 objective with its collar attached to the annular condenser.



Figure 9: UO 6.5 objective after its collar has been detached from the annular condenser.

2. Release the collar if it still is stuck.

It may occasionally happen that the collar will remain stuck on the condenser even after the grub screws have been removed. The cause is of course that old grease has seeped down between the collar and the condenser and eventually hardened there, like a glue. If the collar can't be released with the fingers, put the Ultropak objective upside-down on a suitable support (while protecting the objective's front lens.) Soften the hardened grease by applying one or a few drops (avoid overflowing) of white spirit into the crevice between the base and the annular condenser



Figure 10: UO 6.5 objective: Solvent treatment for releasing the collar.

as shown by the green arrows in Figure 10 and leave the solvent to work at least over the night. (White spirit is better than isopropanol because the latter evaporates too fast and has less “dissolving power”.)

Clamp the Ultropak objective’s dovetail mount in the vise (see section Some Special Equipment) leaving as much free space as possible between the vise’s top surfaces and the collar (green arrows in Figure 11) - the space is needed for effective use of the strap wrench. Also place the objective close to one of the vise jaws’ sides to let the objective handle stick out to the side (Figure 11.) The vise jaws don’t need to be rock solidly tightened, just tighten them enough so the objective sits securely attached.

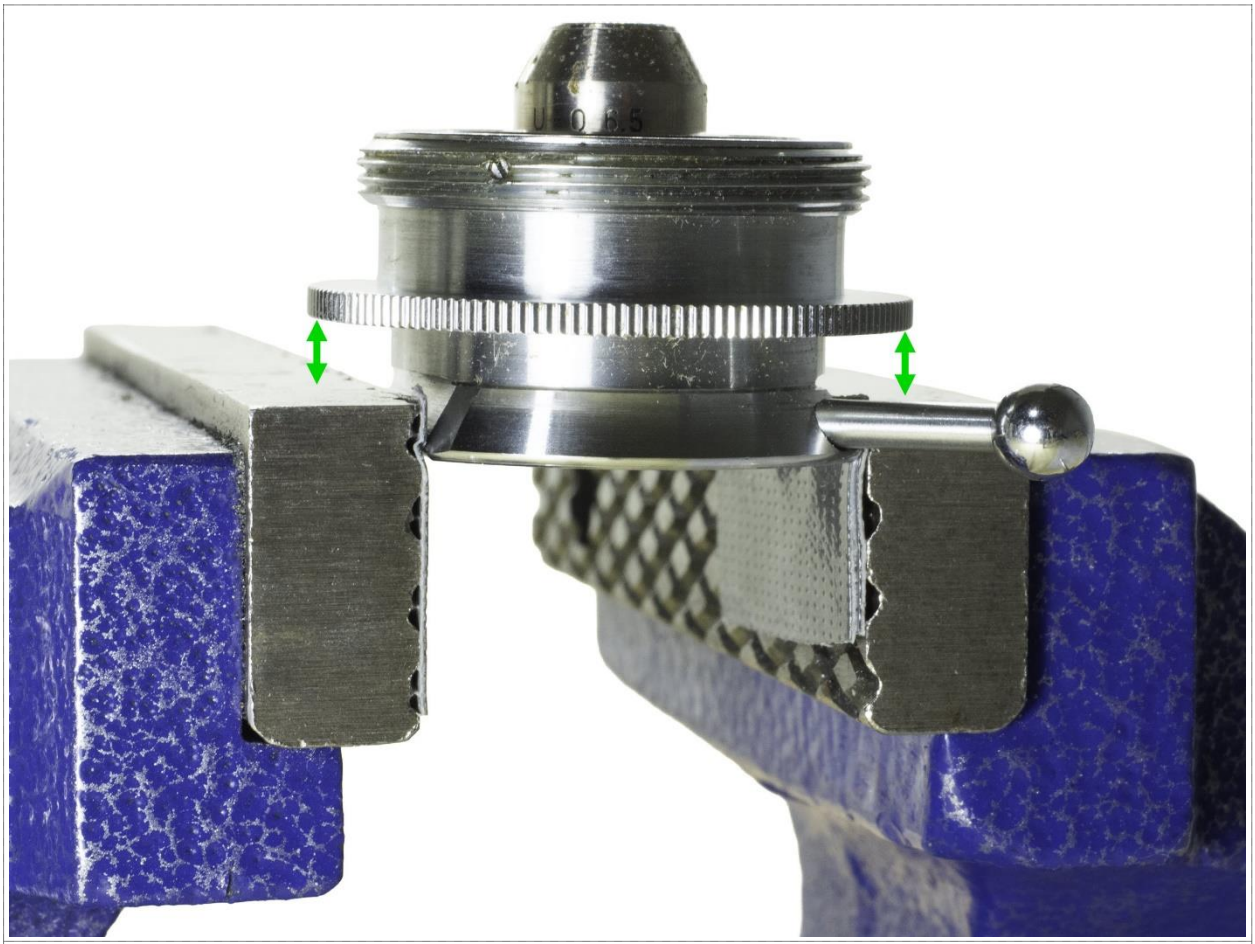


Figure 11: Ultropak UO 6.5 clamped in the vise. Note the duct tape padding on the vise jaws.

Turn the strap wrench (Figure 3) the proper way for releasing , wrap it around the knurled collar, tighten the strap as much as possible, and try to release the collar.

If the collar doesn’t release, repeat the white spirit treatment - this time for a longer period, like a couple of days. Every morning and evening add a few more drops of white spirit to the crevice (Figure 10) to replenish the solvent that has evaporated. Clamp the Ultropak again in the vise and try to release the collar.

The collar should now be loose from the annular condenser (as in Figure 9), although still trapped between the objective base and the seized condenser. With the collar resting on the objective base at least a small strip of the condenser adjustment thread (brass colored in Figure 9) will be accessible for further treatment.

3. Release and remove the seized annular condenser.

Put the Ultropak objective (with its objective tip facing up) on a paper towel on the table. With a pipette or a medicine dropper apply a few (3-4) drops of white spirit into the seized thread (indicated by the green arrow in Figure 12), i.e., between the brass-colored condenser thread and the rim of the objective base.

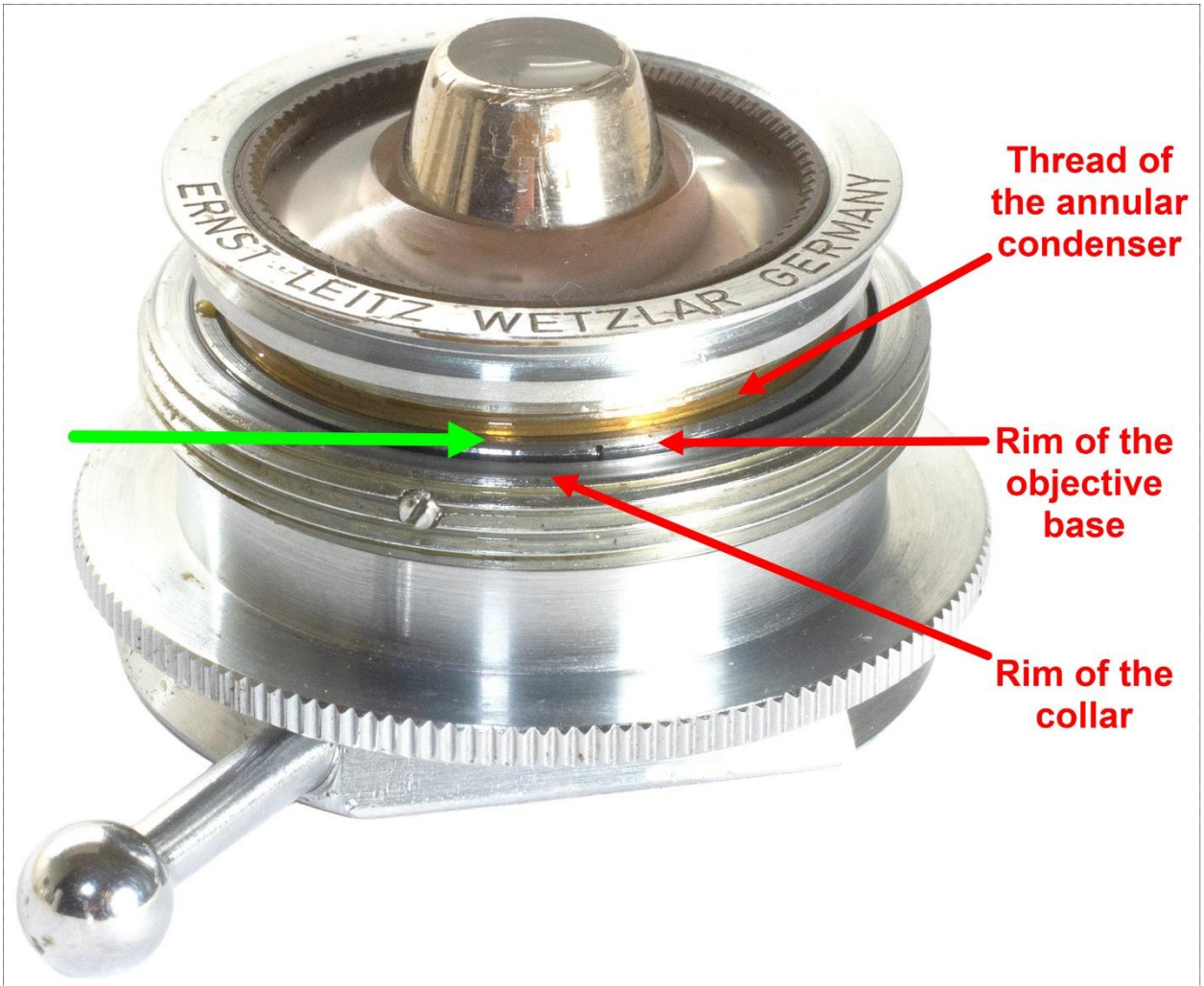


Figure 12: Ultropak UO 6.5: Solvent treatment for releasing the seized condenser.

Allow the solvent one or, if required, several days to slowly penetrate and soften the hardened grease in the thread. During the treatment, add a few drops of fresh white spirit three times a day to compensate for evaporation. Any overflowing solvent will not reach the objective casing's lenses; it will flow down between the collar and the base to be absorbed by the paper towel below.

After the first day of solvent treatment make an initial try to release the condenser from the base. Wipe off any visible solvent from the objective and attach it in a vise as described in subsection 2 above. Turn the strap wrench (Figure 3) the proper way for releasing, wrap it around the condenser's flange (green arrows in Figure 13), tighten the strap as tightly as possible, and try to release the collar. One difficulty is that the strap wrench may slip because the condenser's flange provides only a very narrow and slippery surface for the strap wrench. To minimize slipping, be sure that the flange is completely dry, that the strap is properly placed over the flange, and that it is maximally tightened. If necessary, the friction between the flange and the strap can be improved by applying a 5-10 mm wide strip of reinforced tape ("duct tape") around the periphery of the flange before attaching and tightening the strap.



Figure 13: Ultropak UO 6.5: Where to wrap the strap wrench.

If the condenser doesn't release from the base on the initial effort, continue the treatment with white spirit but this time for a longer period, like a couple of days or even a week. Three times a day add a few more drops of white spirit to the thread to replenish any evaporated solvent. Clamp the Ultropak again in the vise and try again to release the condenser with the strap wrench.

4. Clean off all old lubricant.

Once the condenser has been removed (into the parts shown in Figure 5) it will be helpful for a thorough cleaning to also remove the objective casing from the objective base (as in Figure 5.) Try first to unscrew the objective casing with the fingers – but be careful not to touch or compromise the front lens.

If the objective casing can't be removed with the fingers, put a short length of ½" PVC tubing as protection over it and use combination pliers (Figure 14) to release and unscrew it from the base. Avoid clamping the casing harder than necessary – after all, it contains very sensitive lenses.

Should the objective casing resist the removal efforts, just leave it attached to the base. The cleaning can still be completed, although it will be more difficult to access and clean the thread on the inside of the objective base.



Figure 14: A piece of PVC tubing protects the objective casing during removal.

You should now (hopefully) have the Ultropak objective disassembled into the four parts indicated in Figure 5 and Figure 6.

Cleaning of the collar and the objective base: These parts are easy to clean because they don't contain any sensitive parts or lenses. Immerse the parts in a vial with white spirit and let them soak for a few hours to soften the aged grease. Finish off the cleaning with cotton swabs wetted with white spirit. If you are fortunate to have an ultrasonic cleaner the soaking can be completed in a few minutes. Just put the vial with the white spirit and the items into the cleaner's water bath and sonicate for 3-10 minutes. If required, scrape off any solid remains with a pointed wooden or plastic toothpick. After the cleaning, wipe the items dry and leave them for a few hours to dry completely.

Cleaning by soaking can't of course be done if the objective casing remains stuck in the objective base. The thread on the inside of the objective base is difficult to access because the objective casing is in the way, therefore the thread must be cleaned with cotton swabs wetted with white spirit. Be careful not to soil or compromise the casing's lenses.

Cleaning of the objective casing: The objective casing doesn't normally require cleaning from grease. Use a can with compressed air or a camera blower to blow off as much particles as possible from the lens surfaces. If required, clean the lens surfaces with your preferred lens cleaning protocol. Do not try to disassemble the objective casing.

Cleaning of the annular condenser: Use cotton swabs wetted with white spirit to thoroughly clean the condenser's outside, and particularly the thread, from any old grease. Avoid soiling the condenser lens. Some of the old grease may be so severely degraded that it doesn't dissolve in solvents; it will remain as solid, yellowish to greenish residues on the brass thread (Figure 15.) These residues need to be scraped off with pointed wooden or plastic toothpicks, perhaps even with a steel needle. Be thorough – the residues are difficult to see with the naked eye. Finish off the scraping with a final cleaning with cotton swabs wetted with white spirit. Let the annular condenser dry in the air for a few hours.

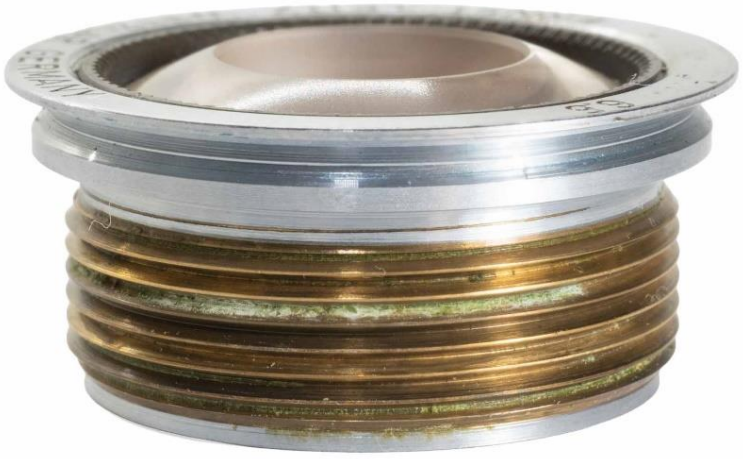


Figure 15: The annular condenser with remains of insoluble, solid residues of aged grease.

5. Reassemble the Ultropak objective.

First you will need to decide whether you wish to reapply fresh grease to the condenser adjustment thread or leave it "dry", i.e., ungreased. The decision is a trade-off.

If you decide to regrease, apply a thin layer of grease on the outside thread of the annular condenser. (I have used the ubiquitous synthetic grease Super Lube Multi-Purpose Synthetic Grease with Syncolon® [PTFE], NLGI grade 2.) Screw the condenser down all the way into the objective base and turn it back and forth a couple of times to distribute the grease. Unscrew and remove the condenser. Wipe off any excess of grease that may have been squeezed outside of the threads.

Reattach the objective casing to the objective base. Tighten it only lightly.

Put the knurled collar over the objective base; be sure to turn it as shown in Figure 9. Attach the annular condenser to the objective base and screw it down all the way.

Pull up the collar as far as it goes against the flange of the condenser and attach the three M1.4x2 grub screws into the collar. Be sure that the grub screws align with the groove just below the condenser flange and tighten them very lightly only (but be sure that the screws have reached all the way down into the bottom of the groove.) The scale on the underside of the collar is arbitrary – there is no need to align or calibrate it.

Check that the annular condenser adjustment is smooth and works as expected.

References

Comprehensive user instructions for Ultropak (Leitz, 1968):
Ultropak Instructions

Information brochure for Ultropak (Leitz, 1965):
Incident Light Illuminator for Microscopic Observations

Appendix 1: Cracked Ultropak condenser lenses



Figure 16: A concentric condenser lens with three cracks. (The objective casing has been removed.)

Although my experience with Ultropak objectives is limited I've noticed that cracked condenser lenses are disproportionally common in used objectives. It appears to indicate a systematic problem rather than random occurrences. My guess is that the cracks happen when a user adjusts the condenser upwards and inadvertently bumps its lens into the tapered tip of the objective casing. Unfortunately Ultropak objectives don't have any safety mechanism that prevents that the condenser's annular lens collides with the objective casing. Except of being mindful and paying close attention during condenser adjustments, the only real remedy I can think of would be to use a 3D-printer to make a spacer (like a large washer) and put it between the objective base and the collar. The thickness of the spacer would need to be tailored to each objective to stop the condenser from being raised past the point where its lens touches the objective.

A sluggish condenser adjustment may probably contribute this accident. The sluggishness makes it more difficult to sense when the condenser lens touches the objective tip, and the user will have less opportunity to stop before it is too late. This is a good reason to clean and regrease the annular condenser adjustment even if it is only slightly sluggish.

A cracked condenser lens isn't necessarily a complete disaster – after all, it affects only the Ultropak's illumination path, the much more critical image forming path should be virtually unaffected.

Appendix 2: Ultropak UO 32 images

As mentioned previously these maintenance notes pertain specifically to the Ultropak UO 6.8 objective. With some modifications the notes also apply for other Ultropak objectives, like Ultropak UO 32 which is depicted in Figure 17 and Figure 18.



Figure 17: Ultropak UO 32.



Figure 18: Ultropak UO 32 – exploded view.