Leitz Universal Condenser UKL – Maintenance Notes

Introduction

Leitz universal condenser UKL (**UK** from German **U**niversal**k**ondensor, and supposedly **L** for **L**aborlux, Figure 1) with Leitz catalog number 513 558 is a dual lens condenser with a turret that can be used to quickly switch between brightfield, darkfield and phase contrast microscopy. The turret is turned to get the desired ring stop into the optical path – numbers on the turret's periphery indicate which of the ring stops is active. The condenser's top lens is capable of yielding an n.a. (numerical aperture) of 0.90. The lower lens is protected in the condenser house between the top lens and the aperture diaphragm.

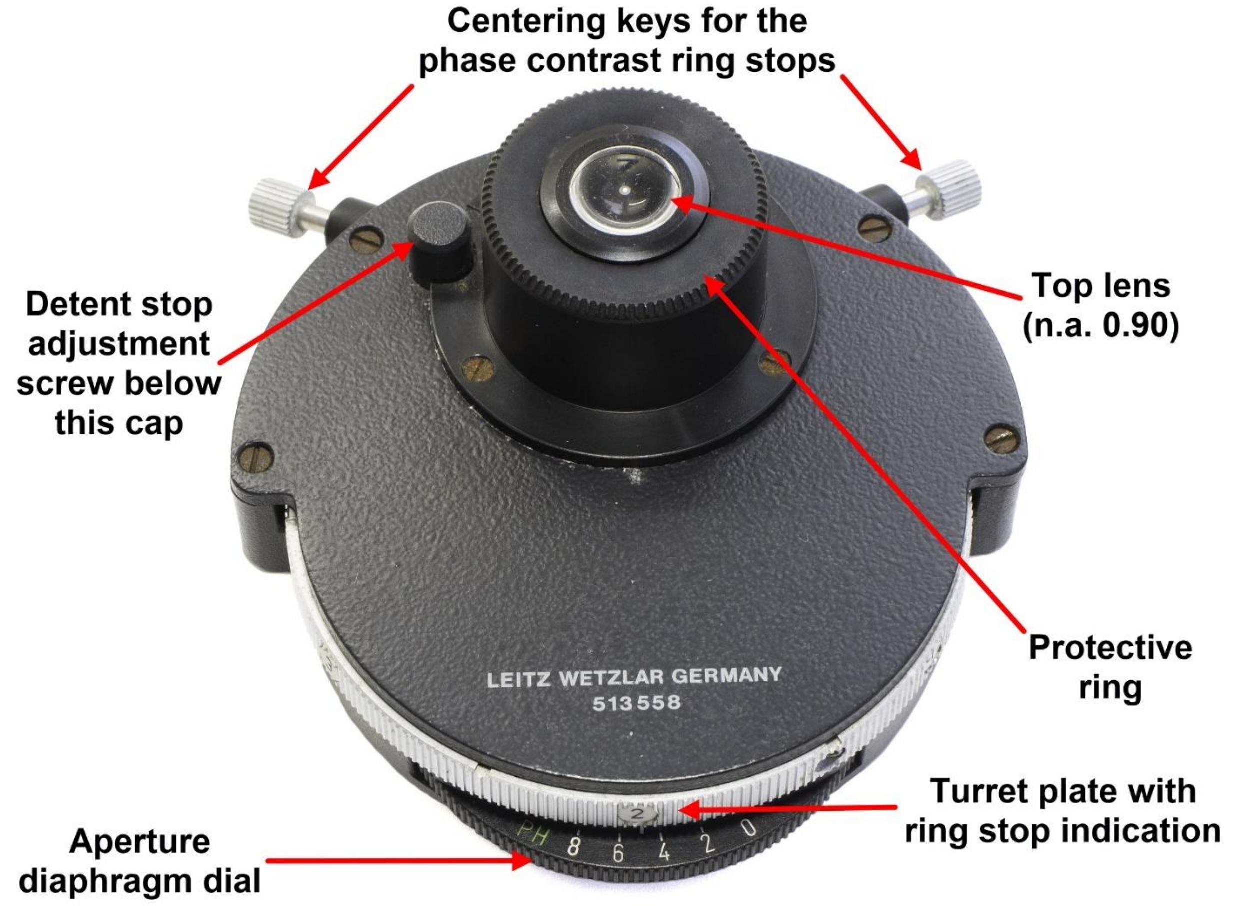


Figure 1: The Universal Condenser UKL.

The condenser is designed to be used with Leitz microscopes with 160 mm mechanical t.l. (tube length), except for those microscopes that belong to the Diaplan and Aristoplan family. In brightfield the condenser can be used with objectives from 4x magnification and higher (with a field-of-view index of up to 20 mm) and there are no supplemental or auxiliary lenses that need to be moved in and out of the optical path. The condenser's darkfield setting is suitable for objectives in the range 10x to 40x. Three phase contrast settings are available: Phaco 1, 2 and 3, according to Leitz' terminology.

An oil immersion cap with n.a. 1.25 (Figure 2) could also be separately purchased (Leitz catalog no. 512 652) for attachment on top of the front lens. The nine-blade aperture diaphragm (used for bright-field microscopy only) is adjusted with a lever that has an arbitrarily numbered scale. On the microscope the condenser is easily interchangeable thanks to its standardized dovetail slide. There is no built-in centering mechanism for the entire condenser - the condenser centering is done with the centering mechanism built into the microscope's condenser holder. There is however a built-in centering mechanism that can be used for accurate centering of each of the darkfield and phase contrast light rings.

Figure 2: N.a. 1.25 oil immersion cap.

The UKL condenser is optically identical with Leitz condenser no. 56 (Figure 3), except that the latter has a slot for filter slides and ring stop slides instead of the UKL condenser's turret.

Figure 3: Leitz condenser no. 56.

Although several parts of the UKL condenser appear similar and mechanically interchangeable with other Leitz universal condensers from the 160 mm t.l. era, there may however be critical differences and incompatibilities that make such combinations dubious (refer to A tour round a Leitz Diaplan microscope.) For example, the UKL condenser turret has the same dimensions as, and is actually interchangeable with, the earlier UK condenser's turret. The light rings are however different and specific for the condenser model. This is hardly surprising given that the optics of these condensers are quite differently designed.

The table below summarizes the Leitz universal condensers from the 160 mm t.l. era:

Model	**Leitz catalog number** (condenser base only)	**Microscopes**
UK	513 467	Dialux 20, 20 EB, 22 and 22 EB, Labovert, Fluovert
UKL	513 558	Laborlux models, Biomed
UKA	513 738	Laborlux models
UK0	513 594	Diaplan, Aristoplan (the UK0 condenser doesn't have any aperture diaphragm)

The table below summarizes the designations written on the light rings of the UK and UKL condensers:

Phase contrast objective type/use	**UK condenser light ring marking**	**UKL condenser light ring marking**
Phaco 1	1 S 1.1	1
Phaco 2	2 S 1.1	2
Phaco 3	3 S 1.1	3
Phaco 4	4 S 1.1	-
Darkground	DF S 1.1	DF

General user instructions for the UKL condenser are available in Leitz Laborlux S - Instructions.

Scope

After nearly 50 years of use the UKL condenser may typically be dirty (dust, corrosion, and/or immersion oil contamination) and may sometimes suffer from a sluggish or frozen aperture diaphragm.

These maintenance notes describe the disassembly and some cleaning and greasing procedures for the Leitz UKL condenser.

About Iris Diaphragms

Refer to the Internet for general descriptions, drawings, and animations of how iris diaphragms work.

Iris diaphragm blades are cut out from thin steel sheets. They are sensitive to corrosion (rust) and mechanical abuse. A common problem with iris diaphragms is that they can become sluggish or stuck due to old, hardened oil, typically immersion oil. It appears that Leitz refrained from lubricating the aperture diaphragms in the UKL condensers. Generally, iris diaphragm blades may become bent and dented if the diaphragm is forced to close beyond its designated limit, but the UKL condenser has protection against such damage. The aperture diaphragm has however no protection from damage if it is poked from the underside of the condenser. Bent or damaged diaphragm blades are potentially serious problems and can be difficult or impossible to repair.

Rusty iris diaphragm blades are not uncommon in older microscope condensers. Light rust doesn't impair the function of the iris diaphragm but be aware that rust dust/particles may fall down on any lens that is below the diaphragm.

To take apart an iris diaphragm is easy but putting it together again with all the blades in proper order can be challenging. If the diaphragm blades are bruised or not completely flat and even, then your patience will face the ultimate test. But it certainly *can* be done, as examples of successful attempts see this article and this video clip. Fortunately, issues like a sluggish or stuck aperture diaphragm can often be remedied without taking it completely apart.

Work Preparations

Before you go ahead with fixing your UKL condenser there are two things to consider:

i. Check that the condenser's top lens is in good shape. Inspect its outer lens surface, this is best done with a stereo microscope. Further servicing of the condenser is probably not very meaningful unless you know that the top lens is in good shape and without any persistent surface blemishes.

ii. Plan ahead. Get an idea of which parts of the condenser you need to fix. Then you can focus on these parts only and save time and effort by avoiding disassembling the entire condenser.

Maintenance Notes

1. Remove the light ring turret.

Unscrew the large locking screw in the center of the bottom side of the condenser (Figure 4.) The screw can't be removed (which is a good thing), but just unscrew it as far as it goes. Pull out the light ring turret (Figure 1) from the side of the condenser. The turret has six circular holders for light rings (Figure 5 and Figure 6). Indicators along the turret periphery (Figure 1) show which light ring currently is in the optical path. When a light ring is in the condenser's optical path the ring can be accurately centered with the built-in centering keys (Figure 1.)

Figure 4: The UKL condenser viewed from the underside. The red circle indicates the locking screw for the light ring turret.

Clean the turret surfaces, if required.

Check that the light rings (Figure 5 and Figure 6) that you need for your microscopy are present, and that they appear intact and clean. Note that one of the light ring spaces in the turret can't hold any light ring and should be empty – this the position that is used for brightfield microscopy.

Brief instructions for replacing, centering and use of the light rings are available in Leitz Laborlux S - Instructions.

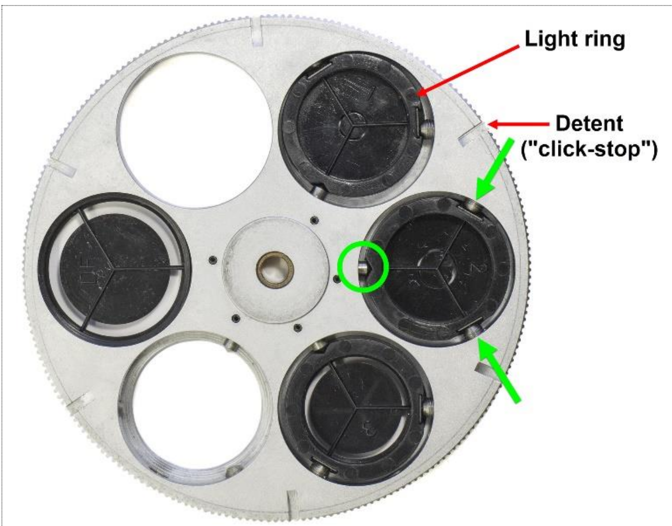


Figure 5: View of the upper side of the light ring turret.

The green circle indicates the spring-loaded pin that holds the light ring.
The green arrows indicate the direction of the centering screws for one of the light rings.

Figure 6: View of the underside of the light ring turret.

This turret has one light ring for darkfield microscopy and three light rings for phase contrast microscopy.

2. Remove the protective ring from the condenser top.

The only reason to remove the black plastic protective ring (Figure 1) from the condenser is to be able to replace it with an immersion oil cap (Figure 2 and Appendix: The n.a. 1.25 oil immersion cap.) There are no serviceable parts that can be accessed below the protective ring.

Remove the protective ring (Figure 1) from the condenser top by unscrewing it. It is attached to the condenser top by a thread and has a knurled rim to allow for a better finger grip. It may however for various reasons remain more or less stuck. If required, use a wide rubber band to get a better grip around the knurled rim. If that doesn't help, try the following:

a) Soak the thread with solvent: It's common that condensers have been subjected to overflowing immersion oil. If the oil has penetrated the threads and been sitting there for years, it may have solidified into a resin- or glue-like mass. Treating the thread with solvent may dissolve the hardened oil and facilitate the removal of the protective ring. A disadvantage is that solvent treatment is slow because it takes some time for the solvent to penetrate and soften the old, hardened oil in the clogged thread. Here is a suggestion for how to do it:

Figure 7: The condenser's protective ring wrapped with a gauze bandage strip wetted with white spirit.

Wrap the rim of the protective ring with a few turns of a gauze bandage strip (Figure 7.) Use a pipette or an eyedropper to wet the strip with solvent. For optimal efficiency keep the strip well wetted all the time but avoid overflowing. White spirit works well as the solvent because it has a good dissolving capability and is only moderately volatile, so it will be sufficient to re-wet the strip only every 4-12 hours. It may be a good idea to put a second bandage strip 5-10 mm below the first strip (as in Figure 7) to protect the condenser by catching any accidental solvent overflow. Keep the solvent working for 2-3 days making sure that the strip is well wetted all the time, and then try to release the protective ring again with the aid of the wide rubber band.

b) Squeeze the thread in a vise: Clamp the top 3 millimeters (but not more than 3 mm, otherwise you may damage the condenser) of the condenser (Figure 8) in a vise where the jaws have been lined with some suitable plastic protecting covers. Gently squeeze the condenser top with the vise, turn the condenser 90 degrees and squeeze it again. The trick is to squeeze hard enough to force the threads to release from the solidified resin, but absolutely not as hard as to damage the condenser top. Try to release the protective ring with the help of the wide rubber band. It may be necessary to repeat the squeezes a few times.

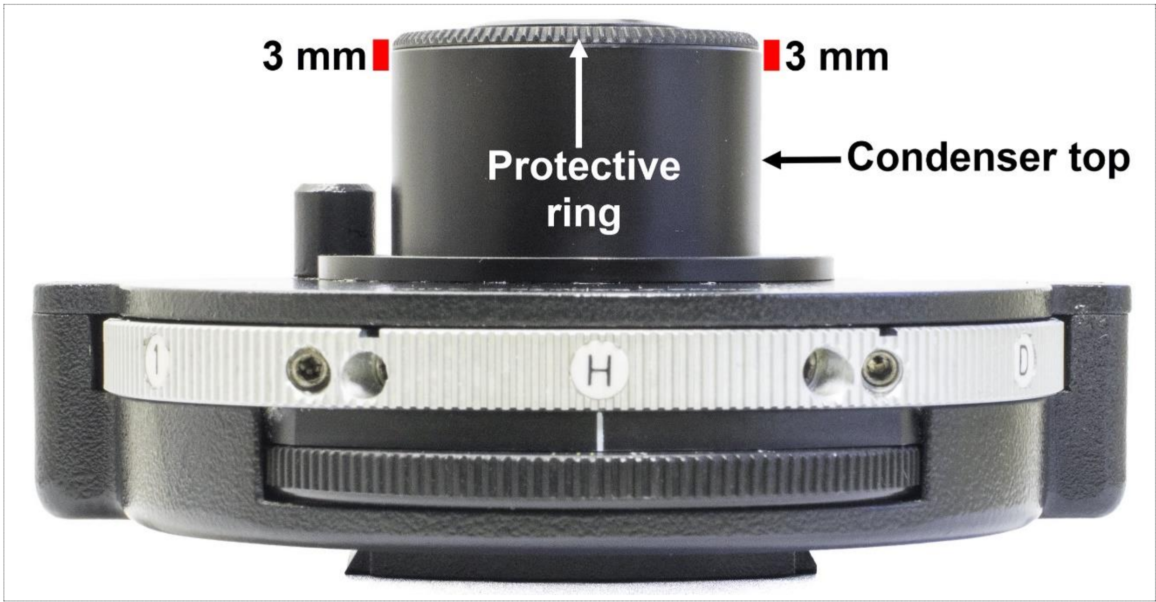


Figure 8: Indications on the condenser top where to squeeze it in the vise.

c) Apply heat to the thread: Heating with an electric heat gun is a quick and efficient way to release stuck threads but it may damage any sensitive optical parts if not applied precisely and with discrimination. It could work for the protective ring if only you can manage to insulate the top lens to protect it from the hot air. A suggestion is to protect the top lens first with a piece of lens paper and then above that attach a circular piece of cork secured with tape. The hot air should then be directed to blow obliquely from below and from all sides around the top to minimize the air flow over the front lens.

After removal, clean the protective ring and the inside of the condenser's cylindrical top (Figure 9) with pieces of cloth or cotton swabs wetted with white spirit. Make sure that the threads are clean.

Figure 9: Condenser UKL with the protective ring removed and put to the side.

Figure 10: View from the underside of the condenser top.

3. Remove the condenser top.

The condenser top (Figure 8) holds the condenser's both lenses. It is attached to the condenser with three black M2x3 screws with conical heads. Unscrew the screws and remove the entire top (Figure 10.)

The lower lens' lower surface can now be accessed for cleaning. It is quite well protected from exposure to undesired external influences, so blowing air over it with a camera blower may be sufficient. The inside of the top between the two lenses is even better protected from contamination and should hopefully not need any cleaning at all. However, if required, the inside can be accessed for cleaning, refer to subsection 4 below.

4. Access the inside of the condenser top.

The inside of the condenser top should typically not need to be accessed for cleaning, although there may be exceptional cases when you still will need to clean the inside surfaces of the lenses.

The lower lens in the condenser top must be removed to access the inside of the top. The lens is attached with a black, plastic and threaded locking ring (Figure 12.) The locking ring has two slots to accommodate a camera spanner and is also secured with spots of a blue threadlocker (Figure 11.)

Begin by using a steel needle to scrape off any visible threadlocker from the locking ring. To soften the threadlocker that has penetrated the threads blot the area carefully with a cotton swab well wetted with acetone. Keep the area wet, but avoid flooding, and let the acetone work for a few minutes.

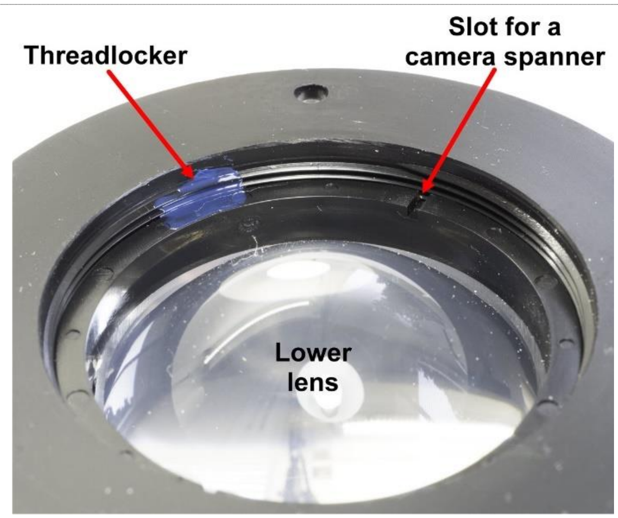


Figure 11: The underside of the condenser top showing the locking ring that holds the lower lens.

Figure 12: The parts of the disassembled condenser top: The top, the lower lens, and the locking ring.

Use a camera lens spanner equipped with screwdriver-like flat tips (Figure 13) to release and unscrew the locking ring. Be careful not to slip with the spanner and avoid scraping the lens with the spanner pins. The lower lens is now loose and can be removed from the condenser top by turning the top upside-down over a soft cloth and shaking it lightly to allow the lens to fall out. The lens (Figure 14) is of a somewhat unusual shape as it is quite thick and has a flat area on its side. It has a mildly convex upper side and a strongly convex bottom side.

Figure 13: A common camera lens spanner with a closeup view of the screwdriver-like tips.

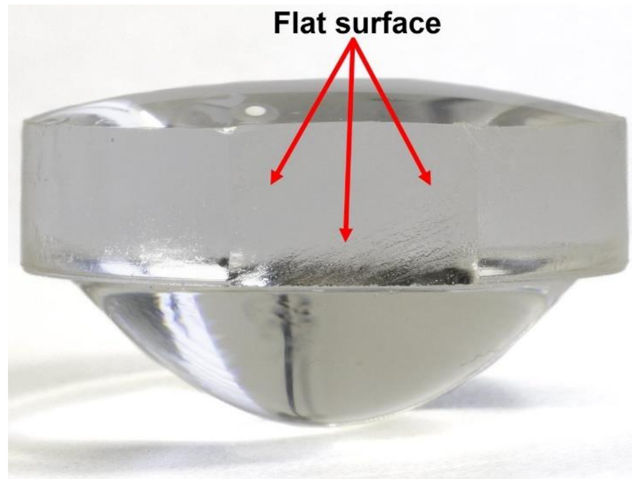


Figure 14: The lower condenser lens.

Clean any dirty lens surfaces with your preferred lens cleaning protocol.

Put back the lower lens into the condenser top. The strongly convex side should face downward (i.e., towards the condenser's aperture diaphragm) and the flat surface on the side of the lens should be turned towards the small vent hole in the side of the condenser top. In this location in the condenser top's inside there are also a few ribs that should face the lens' flat surface (see the orange arrow in Figure 12.)

Once the lens has been properly seated, reattach the plastic locking ring. Tighten the ring only lightly. I choose not to apply any threadlocker to the ring, but feel free to apply some, if you prefer.

5. Remove the condenser's dovetail mount.

You can probably skip this subsection, because the only reason to remove the dovetail mount is if you need to access the threads of the locking screw (Figure 4) for the light ring turret to apply fresh grease. The turret locking screw is however easier to access from the inside of the condenser base, refer to subsection 13 below. Cleaning and greasing the locking screw should however only be necessary in the unlikely case that it is really stuck.

The dovetail mount on the underside of the condenser (Figure 4) is attached with four M2.5x6 screws with conical heads. Remove the screws and the mount. (Note how cleverly the screws are asymmetrically spaced to ensure that the mount will be correctly positioned when reattached again.)

With the mount out of the way you can unscrew the turret locking screw as far as it goes, clean the exposed thread and apply fresh grease.

6. Remove the condenser cover and the turret base.

From the top of the condenser cover unscrew the four M2.5x5 screws with cylindrical heads and remove the cover (Figure 15 and Figure 17) to reveal the turret base (Figure 16 and Figure 17.)

Figure 15: The UKL condenser viewed from above after the condenser top has been removed.

The red circles indicate the screws that hold the condenser cover attached to the condenser base.

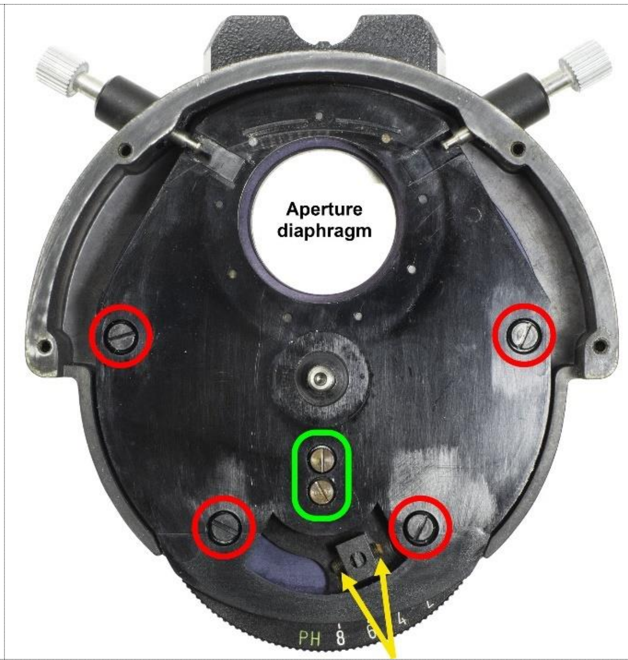


Figure 16: The turret base after the condenser cover has been removed.

The yellow arrows point to the adjustment screw that protects the aperture diaphragm from being closed beyond its safe limit.
The red circles indicate the screws that attach the turret base to the condenser base.
The green oval indicates the screws that attach the aperture diaphragm dial bushing to the turret base.

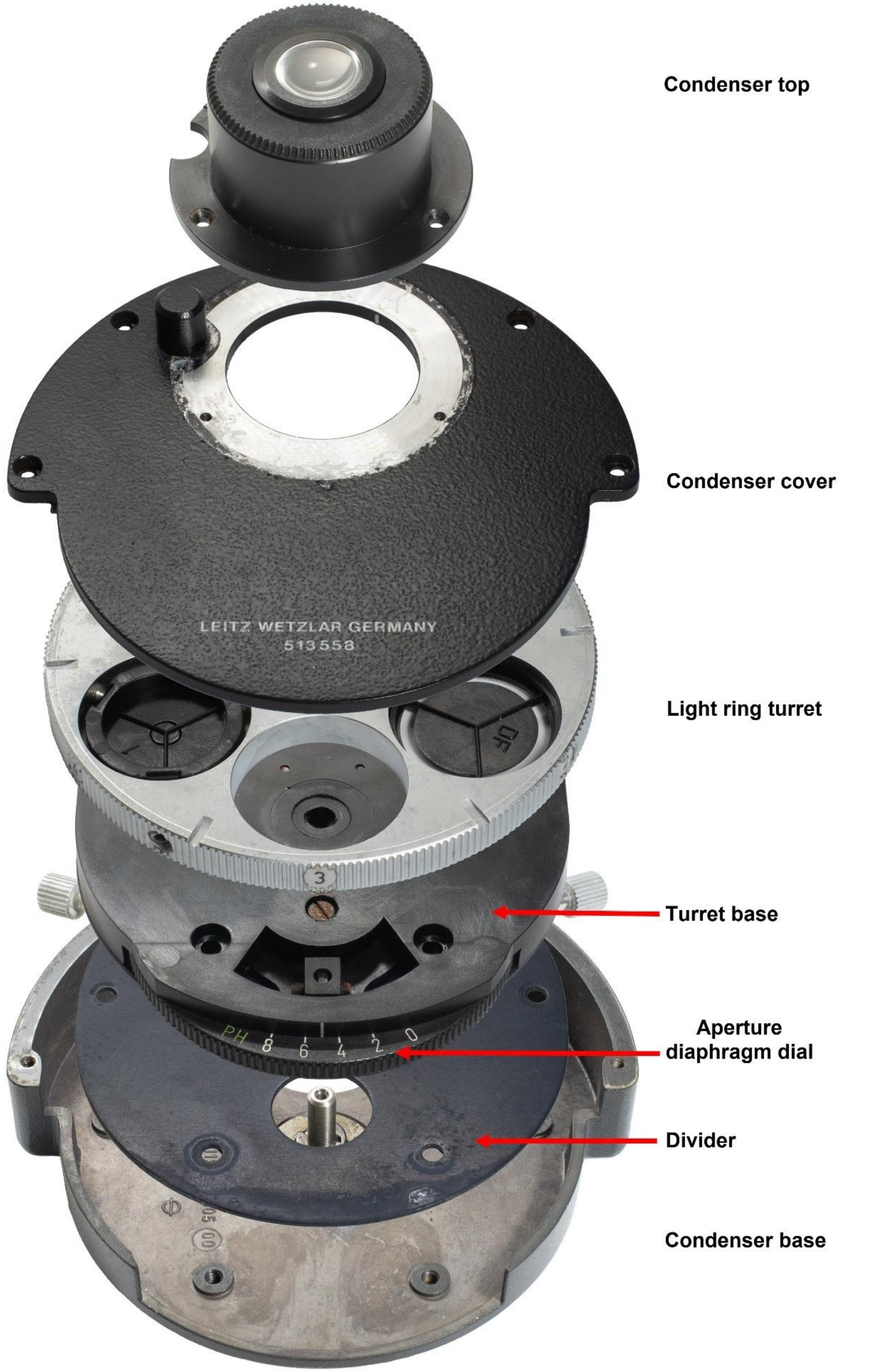


Figure 17: Exploded view of the main parts of the UKL condenser (the dovetail slide is not included.)

The light ring turret (Figure 5 and Figure 17) that we removed earlier rests on the turret base and revolves around the smooth tip of the turret locking screw that can be seen in the middle of the turret base in Figure 16. The turret base also provides the stationary anchoring of the aperture diaphragm. The 9 small holes that faintly appear around the aperture diaphragm opening in Figure 16 are the stationary anchoring points for the diaphragm blades' pivot pins.

Figure 18: The turret base viewed from the underside where it is covered with the divider. The green circles indicate the two small Philips screws that hold the divider attached to the turret base.

Remove the four M3x10 screws with cylindrical heads that hold the turret base (Figure 16) attached to the condenser base. Pull out the turret base from the condenser base.

A thin metal divider (Figure 18 and Figure 17) is attached with two very small Philips screws with conical heads (I haven't been able to identify the thread) over the bottom of the turret base. The divider encloses the aperture diaphragm components (i.e., the diaphragm blades, the actuator and the aperture diaphragm dial) within the turret base. The divider has an important function - it prevents the aperture diaphragm from falling apart when the turret base is removed from the condenser base.

7. Consider your options if the aperture diaphragm is sluggish, stuck, or needs repair or cleaning.

If your aperture diaphragm works satisfactorily and generally appears healthy there is little need to open up the turret base and expose the diaphragm. Then you can skip this and some of the following subsections and proceed to subsection 10 below.

At manufacturing apparently no oil was applied to the aperture diaphragm, but after many years of use it could have happened that accidentally some oil contamination (for example, immersion oil) had found its way down to the aperture diaphragm. If your aperture diaphragm indeed is unacceptably sluggish or stuck due to old, hardened grease, you will need to decide between two options for how to deal the problem:

1. The two "shortcut options" for cleaning of the aperture diaphragm are technically simpler (you will avoid risking that the aperture diaphragm falls apart) but may leave a minimal residue of the old grease on the aperture diaphragm blades. For the "shortcut options" choose between subsection 8 and subsection 9 below.

2. The "thorough option" for cleaning or repair of the aperture diaphragm is more challenging as it requires that the aperture diaphragm is taken apart. The challenge is to reassemble the aperture diaphragm after cleaning. It can be done, but it is somewhat tedious, refer to section About Iris Diaphragms above. For the "thorough option" proceed to subsections 10 and 11 below.

8. Clean the aperture diaphragm by “shortcut option” 1 – blotting with solvent.

In this shortcut option the aperture diaphragm is cleaned from old grease by blotting the blades with solvent while the diaphragm is safely enclosed in the turret base.

Start with the removed turret base with the divider still attached.

Unless it is completely stuck close the aperture diaphragm. From the divider side carefully apply white spirit to the aperture diaphragm blades with the help of cotton swabs. White spirit is recommended as the solvent because it has a good oil dissolving capability with low risk for damaging the involved plastic parts and any paint. Make the blades as wet as possible, but without allowing the solvent to seep off from the blades and flood into the inside of the turret base. Let the solvent work for at least ½ hour and then gently try to repeatedly open and close the diaphragm with the aperture diaphragm dial. Carefully blot or wipe off excess solvent. Repeat the treatment at least two more times with fresh white spirit to further dissolve and remove as much as possible of the old, hardened grease. Close the aperture diaphragm fully and lightly wipe off as much as possible of the solvent from the diaphragm blades. Finish with a last solvent treatment, but this time using iso-propanol – this will shorten the drying time.

Now you will need to decide whether you wish to apply oil to the aperture diaphragm or not. By applying oil, you will be forgiven if there are any minor residues left of the old grease (the fresh oil will significantly dilute any remains of the old lubricant), but years later the cost may be that the oil will again age and harden or become sluggish due to accumulated dust and dirt. If the aperture diaphragm is rusty, it may make sense to apply oil to bind rust particles to prevent them from falling down and contaminate any lens below (typically the collector lens in the microscope foot.)

If you decide to apply oil, then wet a cotton swab with a high quality, non-drying oil and dab it carefully and sparsely on the aperture diaphragm blades. Spread the oil evenly over the blades by opening and closing the aperture diaphragm repeatedly. Don’t overdo the oiling!

If you decide to go oil-free, just let the aperture diaphragm air dry.

Proceed with subsection 10 below.

9. Clean the aperture diaphragm by “shortcut option” 2 – soaking in solvent.

In this shortcut option the aperture diaphragm is cleaned from old grease by soaking it in a container with solvent while the diaphragm remains safely enclosed in the turret base.

Start with the removed turret base with the divider still attached.

Find a suitable vial or container that is resistant to white spirit and is of a size that is suitable for immersing the turret base. Just as a suggestion, I cut off the top of a regular polyethylene ice pack to get a narrow container that wouldn’t unnecessarily waste the solvent.

Put the turret base into the container with the aperture diaphragm facing down. Add enough white spirit to cover not more than the height of the aperture diaphragm (Figure 19.) White spirit is recommended as the solvent because it has a good oil dissolving capability with low risk for damaging the involved plastic parts and any paint.

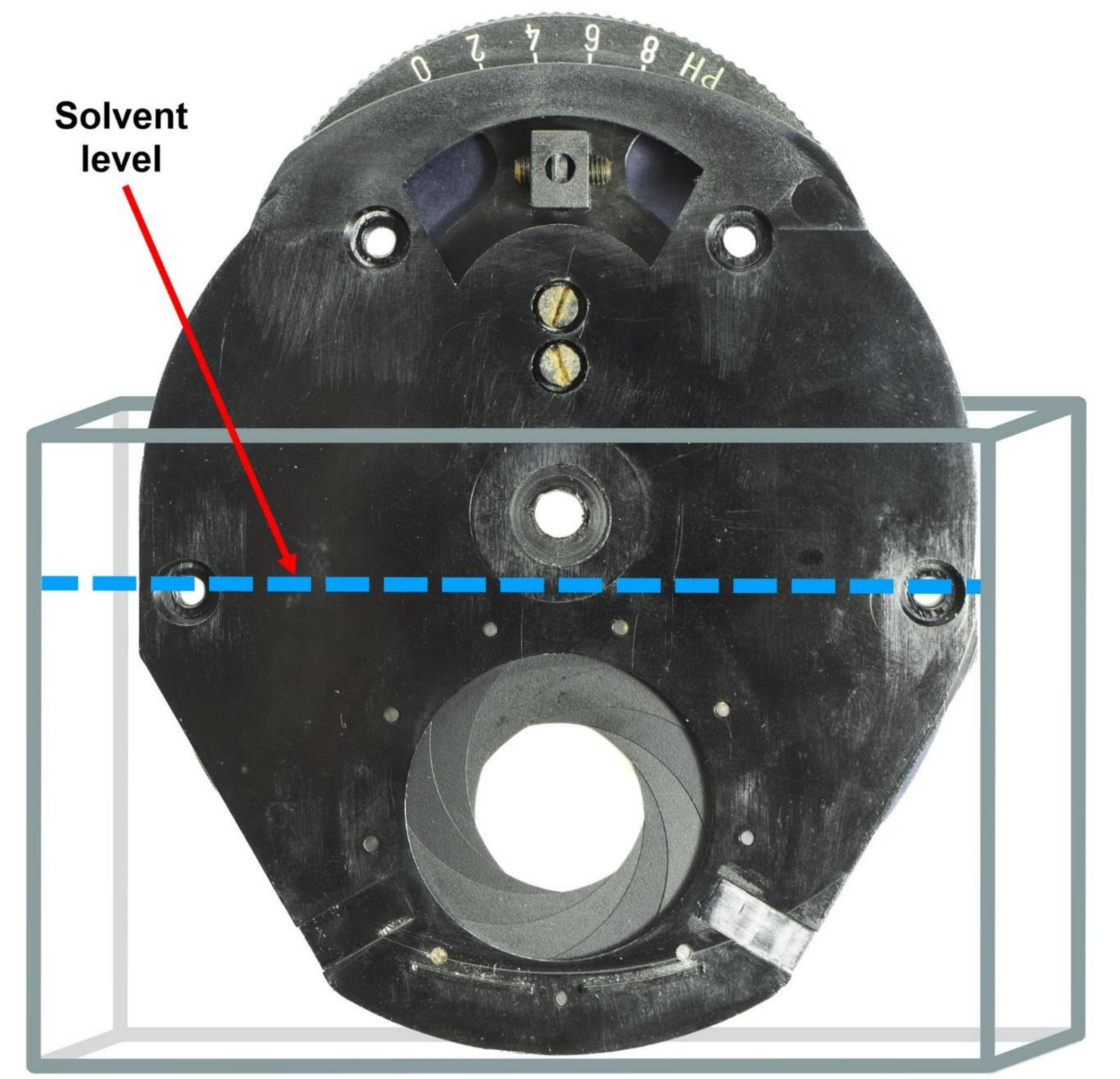


Figure 19: The turret base soaking in a narrow container with white spirit.

Leave the turret base to soak for an hour, and then move the aperture diaphragm dial back and forth several times to allow the solvent to penetrate and wash between the diaphragm blades. Repeat moving the dial in this way every few hours. The next day, change to fresh solvent in the container and continue moving the dial. On the third day, remove the turret base from the solvent, shake it lightly and blot it carefully with tissue paper to remove as much of the solvent as possible, and then let it sit to dry in the air. To speed up the drying, distribute the solvent over the diaphragm blade surfaces by moving the aperture diaphragm dial back and forth every now and then. White spirit has a relatively low volatility, so the drying may take several days. To find out when the solvent has dried completely move the aperture diaphragm dial back and forth and check that the diaphragm blades remain completely dry.

Now you will need to decide whether you wish to apply oil to the aperture diaphragm or leave it "dry". By applying oil, you will be forgiven if there are any minor residues left of the old grease (the fresh oil will significantly dilute any remains of the old lubricant), but years later the cost may be that the oil will again age and harden or become sluggish due to accumulated dust and dirt. If the aperture diaphragm is rusty, it may make sense to apply oil to bind rust particles to prevent them from falling down and contaminate any lens below (typically the collector lens in the microscope foot.)

If you decide to apply oil, then wet a cotton swab with a high quality, non-drying oil and dab it carefully and sparsely on the aperture diaphragm blades. Spread the oil evenly over the blades by opening and closing the aperture diaphragm repeatedly. Don't overdo the oiling!

Proceed with subsection 10 below.

10. Disassemble the condenser base. Clean and grease the aperture diaphragm dial.

Put the turret base on the table with its underside facing up. Unscrew the two small black Philips screws (surrounded by green circles in Figure 18, with conical heads; I haven't been able to identify the thread) from the divider (Figure 20) and remove the divider. From now on, be careful with the moving parts of the aperture diaphragm, they are now sitting somewhat unconstrained in the turret base (Figure 21) only covered and protected by the aperture diaphragm actuator (Figure 22.) The actuator may easily slip by a millimeter or so and let all diaphragm blades loose. Applying two or three narrow tape strips (like in Figure 22) to lock the actuator to the turret base can help to keep the actuator temporarily in place and to keep the aperture diaphragm safe from falling apart.

Figure 20: The divider.

Figure 21: The underside of the turret base after the divider has been removed.

The aperture diaphragm dial pivots around a brass bushing (Figure 21 and Figure 22.) The microscope user's dial settings are passed on to the aperture diaphragm's actuator by a simple rack and pinion mechanism.

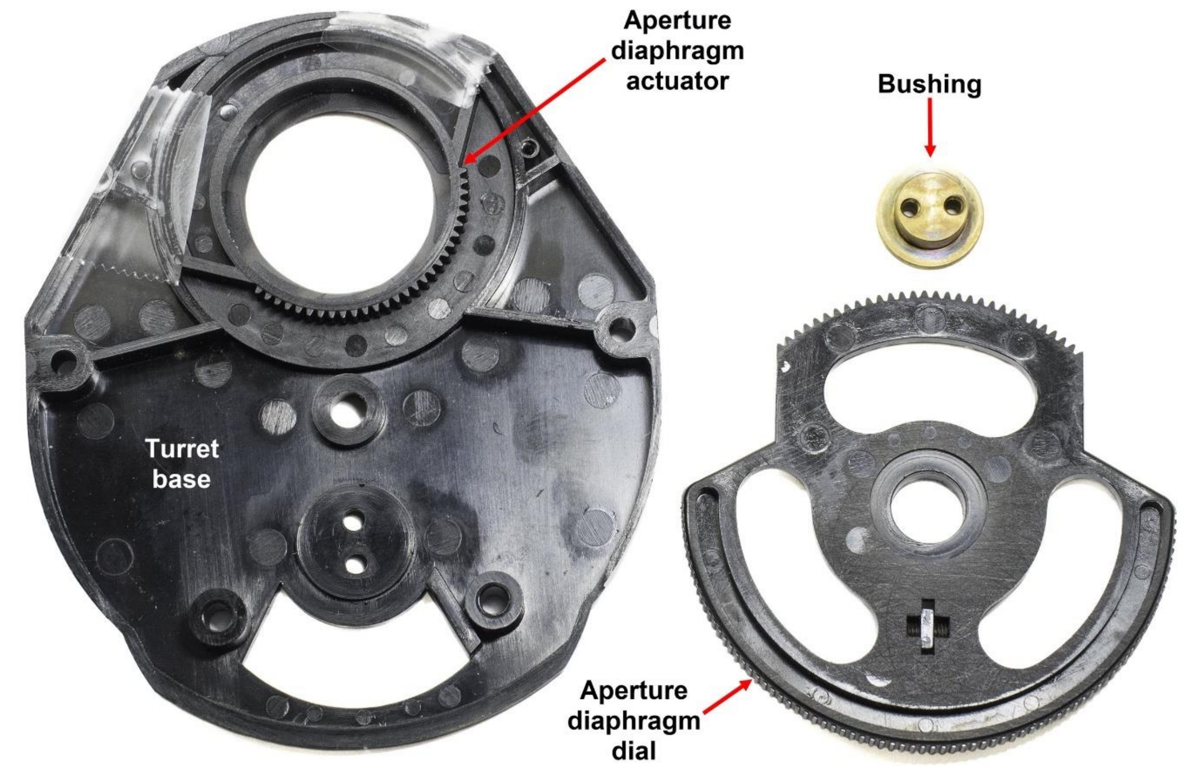
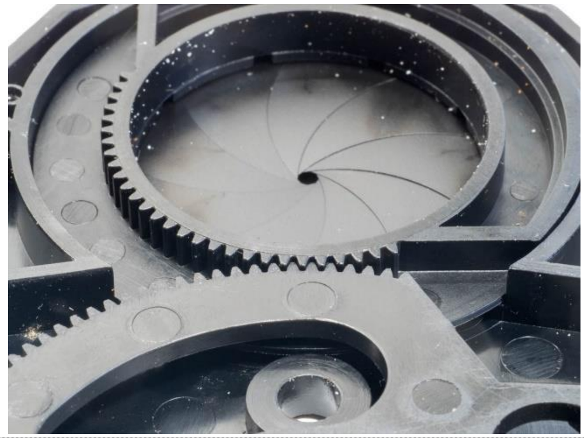


Figure 22: The turret base after the aperture diaphragm dial has been removed. Note the two pieces of transparent tape that keep the actuator tight over the aperture diaphragm.

The grease on the brass bushing and the dial's sliding surfaces will most probably be sluggish and therefore these parts may benefit from cleaning and regreasing. Secure the actuator with tape (as in Figure 22) and then from the upper surface of the turret base unscrew the two M2.5x5 screws with cylindrical heads that hold the bushing (marked with a green oval in Figure 16.) Carefully, and without disturbing the actuator, lift off the dial with the bushing from the turret base. Use white spirit and cotton swabs to clean the bushing and the dial's sliding surfaces from old grease. Apply some fresh grease (for example, Super Lube Multi-Purpose Synthetic Grease with Syncolon, NLGI grade 2) to all involved sliding surfaces (dial, bushing and turret base.) Reattach the dial with its teeth joined with the actuator teeth exactly like shown in Figure 23. This is easiest to accomplish with the aperture diaphragm fully open. Reattach the bushing to hold the dial fixed.

Unless you are proceeding with disassembling the aperture diaphragm, remove the tape from the actuator and reattach the divider (Figure 20) to the turret base with its two small Philips screws. Don't tighten the Philips screws all the way, you will need to leave a minimal amount of play between the divider and the turret base to allow the aperture diaphragm dial to turn smoothly. Use a trial-and-error approach - successively tighten the Philips screws as far as possible and stop just before the dial turning starts to feel restricted.

Fully open aperture diaphragm



Fully closed aperture diaphragm

Figure 23: The aperture diaphragm viewed from the underside of the turret base. Close-up views below.

11. Disassemble and clean/repair the aperture diaphragm by the "thorough option".

This subsection applies only if you decided to clean or repair your aperture diaphragm by the "thorough option".

In the "thorough option" the aperture diaphragm will be completely disassembled for cleaning and/or repair. You will need to finish the work by reassembling the aperture diaphragm, which may be challenging, refer to section About Iris Diaphragms above.

Remove the tape that you applied to secure the aperture diaphragm actuator in subsection 10 above.

Remove the actuator (Figure 24) carefully by lifting it straight up from the aperture diaphragm blades without disturbing the blades. You now have access to clean or repair the diaphragm blades that are only loosely held in the turret base by their downward pointing pins. The blades are cut out from thin sheets of steel and are fragile, so be careful not to bend them – even slightly disfigured blades will make the aperture diaphragm reassembly much more difficult. The stationary end of each diaphragm blade rests with a pivot pin in its own small hole in the turret base plate (Figure 16.) The other (moving) end of the diaphragm blade has another pivot pin sticking out in the opposite direction; this pin fits into a corresponding slot in the actuator (Figure 24.)

Be aware that if you remove the blades, you will later need to put them back again in proper order (refer to section About Iris Diaphragms.) I'm not able to provide any specific guidelines for reassembling the aperture diaphragm because I have never attempted to do it. General instructions for reassembly of aperture diaphragms can however be found in this article and this video clip.

Once you have managed to reassemble the aperture diaphragm reattach the divider (Figure 20) (and before that, if applicable, the aperture diaphragm dial as described in subsection 10 above) to the turret base with its two small Philips screws. Don't tighten the Philips screws all the way, you will need to leave a minimal amount of play between the divider and the turret base to allow the aperture diaphragm dial to turn smoothly. Use a trial-and-error approach - successively tighten the Philips screws as far as possible and stop just before the dial turning starts to feel restricted.

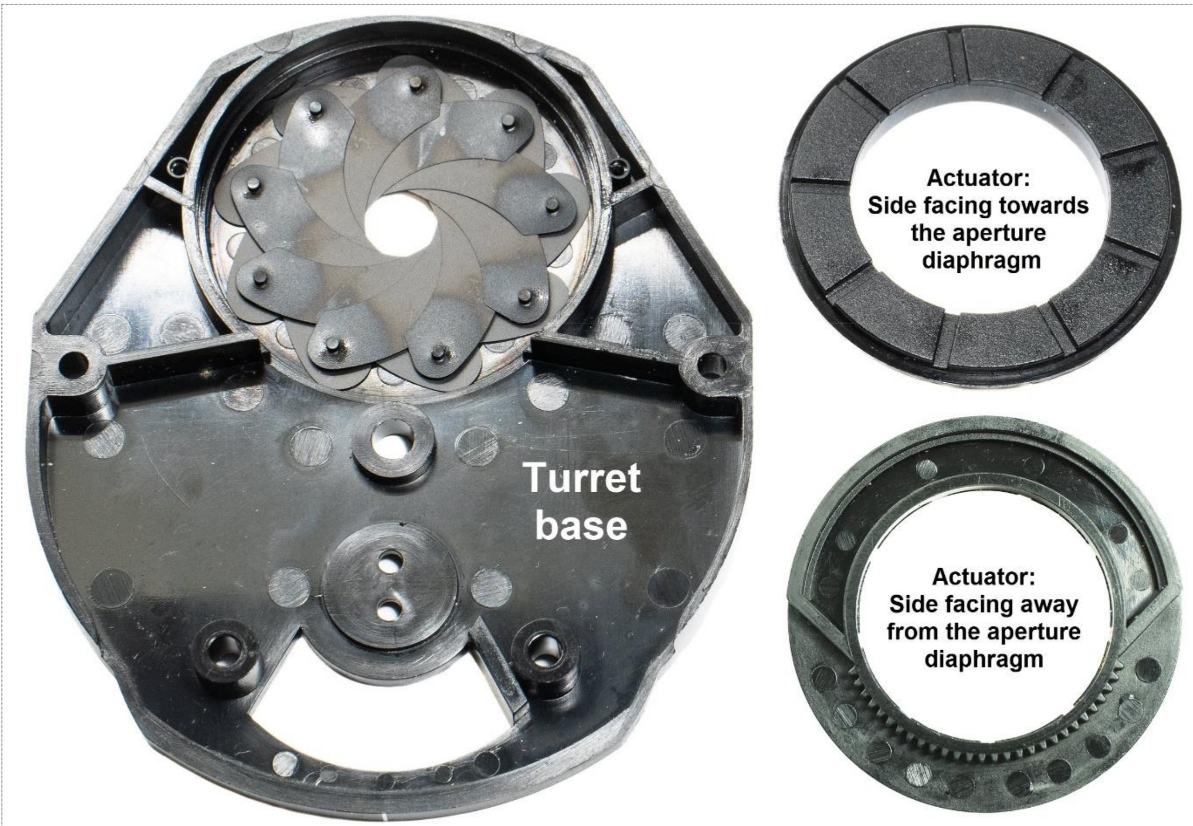


Figure 24: The turret base with the aperture diaphragm dial and the aperture diaphragm actuator removed.

Now you need to decide whether you wish to apply oil to the aperture diaphragm or leave it "dry". If you apply oil, the downside is that several years later you may find that the aperture diaphragm again has become sluggish due to oil aging and accumulated dust. If the aperture diaphragm is rusty, it may make sense to apply oil to bind released rust particles and prevent them from falling down and contaminate any lens below (typically the collector lens in the microscope foot.)

If you decide to apply oil, then wet a cotton swab with a high quality, non-drying oil and dab it carefully and sparsely on the aperture diaphragm blades. Spread the oil evenly over the blades by opening and closing the aperture diaphragm repeatedly. Don't overdo the oiling!

12. Adjust the range limiting screw in the aperture diaphragm dial.

Aperture diaphragm blades are sensitive items and should be protected from damage. One hazard is forcing the diaphragm to close beyond what is safe. Fortunately, the UKL condenser has a simple mechanism to protect the aperture diaphragm from this mishap.

The safety mechanism is an adjustable limiter of the range of the aperture diaphragm dial (indicated with yellow arrows in Figure 16.) The limiter consists of a plastic cube with a small adjustment screw that moves with the aperture diaphragm dial in a restricting opening in the turret base (Figure 25.) When the screw tip hits the wall of the opening, the dial can't move any further.

Fine tune the mechanism with a 1.5 mm hex ("Allen") key in the plastic cube's screw. The key can't be used perpendicularly to the screw because of the constrained space; therefore, the key tip must be of the ball-end type (Figure 26.) Use your best judgement to decide how far you wish to allow the aperture diaphragm to close – it should be with the opening somewhere in the range 1.5-2 mm.

Check that the aperture diaphragm works as expected.

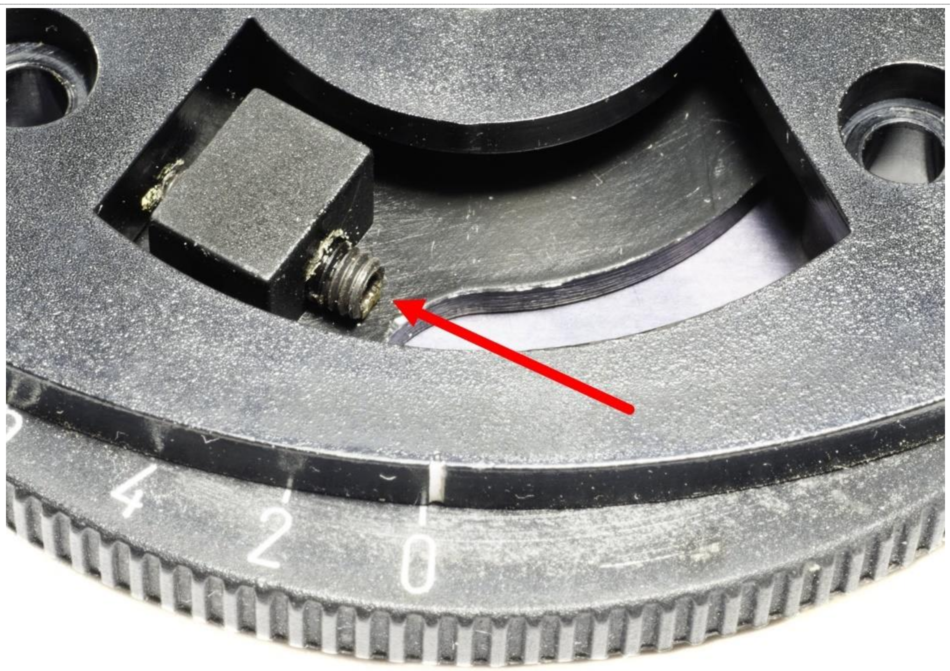


Figure 25: Close-up of the aperture diaphragm range limiting mechanism. The red arrow indicates the head of the adjustment screw.

Figure 26: Ball-end tip of a hex key.

13. Clean and regrease the turret's locking screw.

You can probably skip this subsection, because cleaning and regreasing the locking screw (Figure 4) for the light ring turret (as previously mentioned in subsection 5 above) will only be necessary in the unlikely case that it is really stuck.

From the underside of the condenser base screw down the locking screw all the way. From the inside of the condenser base pry off the E-clip from the screw. Be carful, the clip is prone to fly away.

Unscrew and remove the locking screw, clean all threads with cotton swabs wetted with white spirit, apply fresh grease (for example, Super Lube Multi-Purpose Synthetic Grease with Syncolon, NLGI grade 2) to the threads (but leave the tip ungreased), screw back the locking screw, and reattach the E-clip.

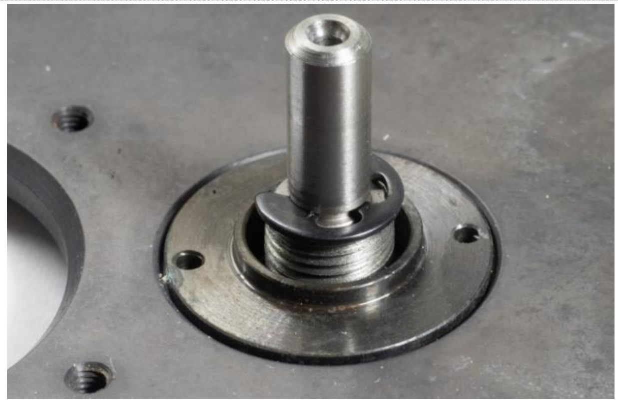


Figure 27: The turret's locking screw on the inside of the condenser base.

14. Re-assemble the entire condenser.

Attach the dovetail mount (Figure 4) to the underside of the condenser base using the four M2.5x6 screws with conical heads.

Unscrew the turret locking screw on the underside of the condenser base as far as it goes (Figure 4.) Attach the turret base (including the divider) to the condenser base with its four M3x10 screws with cylindrical heads (Figure 16 and Figure 17.) Make sure that the aperture diaphragm dial's scale faces upward.

Attach the condenser cover to the condenser base (Figure 15 and Figure 17) using the four M2.5x5 screws with cylindrical heads.

Attach the condenser top to the condenser cover (Figure 8, Figure 9 and Figure 17) using the three M2x3 screws with conical heads.

Unscrew the turret locking screw on the underside of the condenser base as far as it goes (Figure 4.) and insert the light ring turret (Figure 5 and Figure 17) into its slot in the side of the turret base. Check the numbers on the turret's periphery to ensure that it isn't inserted upside-down. Lock the turret by screwing down the locking screw on the underside of the condenser base (Figure 4.) The screw head should reach down barely below the surface of the dovetail mount; rock the turret back-and-forth to ensure that the locking screw doesn't get stuck before that. The screw should then be left only very lightly tightened.

Turn the turret into all of its six positions to check that the turret's detent stops latch on distinctly and without any play. Freedom from play is important to avoid that the light discs need to be re-centered all the time. The turret is typically somewhat hard to turn, which may obscure if there is any play. Therefore, you will need some finger strength for the checking. If required, adjust the detent stop adjustment screw as described in subsection 15 below.

15. Adjust the detent stop adjustment screw.

A detent stop mechanism is available to ensure that the light ring turret accurately and reproducibly locks into any of the six available positions. The mechanism consists of a spring-loaded steel ball (Figure 28) that snaps into detents (faintly visible in Figure 5) along the periphery of the turret. How firmly the steel ball snaps into the detent can be adjusted by a detent stop adjustment screw hidden under a cap on the surface of the condenser cover (Figure 1 and Figure 29.)

Figure 28: The steel ball on the underside of the detent stop mechanism.

Figure 29: The detent stop adjustment screw is accessible after the cap has been removed.

The detent adjustment screw should normally not need adjustment, but if you anyway would like to adjust it unscrew the cap (Figure 29) to access the screw below. If the cap is difficult to remove use combination pliers with the jaws lined with a piece of a PVC hose to spare the cap's surface.

Use a screwdriver to tighten or release the detent adjustment screw in minimal increments and test how the turret snaps. Go back and forth until you are satisfied. Optionally, the entire mechanism can also be adjusted by using a screwdriver that is wide enough to cover both slots in the threaded rim of the mechanism (Figure 29.)

Finish by reattaching the cap.

Appendix: The n.a. 1.25 oil immersion cap

There is one issue with the oil immersion cap (Figure 2) that I'm unable to resolve. According to the instructions (Leitz Laborlux S - Instructions) the cap should be attached over the condenser's top lens in the same thread as the protective ring (Figure 1 and Figure 9) after the protective ring has been removed, of course. Trying to do so, I immediately found out that something is terribly wrong: The oil immersion cap goes down over the top lens only approximately halfway, because before finished, the underside of the cap (Figure 30) hits the surface of the top lens. The right catalog numbers are printed on both the condensers and the cap, so it doesn't seem that I got the wrong parts, but I just can't bring myself to believe that Leitz meant that a) the cap should not be screwed all the way down (Figure 31), and b) it is OK to let the underside of the cap touch and rub against the top lens' glass surface. Should the top lens be removed before the cap is attached? The instructions don't say that, and anyway it doesn't seem that the top lens is removable at all.

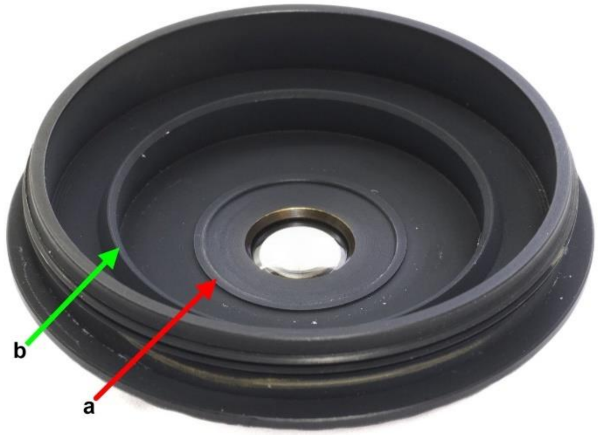


Figure 30: Oil immersion cap n.a. 1.25 viewed from the underside. When attached to the condenser the ring at “a” is touching the surface of the top lens. The ring at “b” goes outside of the top lens and doesn’t touch any part of it.

Figure 31: The condenser top with the immersion oil cap attached over the top lens as far as it goes. The red arrow points to the gap left between the condenser and the cap.

References

Instruction for the Leitz Laborlux S microscope including some information about the UKL condenser:
Leitz Laborlux S - Instructions

A user’s comments on the Leitz Diaplan microscope including some information about condenser component compatibility between different generations of Universal Condensers:
A tour round a Leitz Diaplan microscope

An article describing the function and repair of aperture/field diaphragms:
https://www.microscopy-uk.org.uk/mag/artfeb07/pj-iris.html

YouTube movie that illustrates the dexterity and patience needed to reassemble an aperture diaphragm:
https://www.youtube.com/watch?v=oH6GfyxpK9o