Leitz Berek Condenser

Introduction

The Berek condenser (Figure 1, Figure 2 and Figure 3), a.k.a. the two-diaphragm condenser, is a centerable brightfield condenser with two iris diaphragms and an interchangeable swing-out top element. Its most prominent feature is that besides of the usual aperture diaphragm it also includes a field diaphragm. This made it possible to acquire Köhler illumination even on earlier Leitz microscopes that didn't include any built-in field diaphragm.

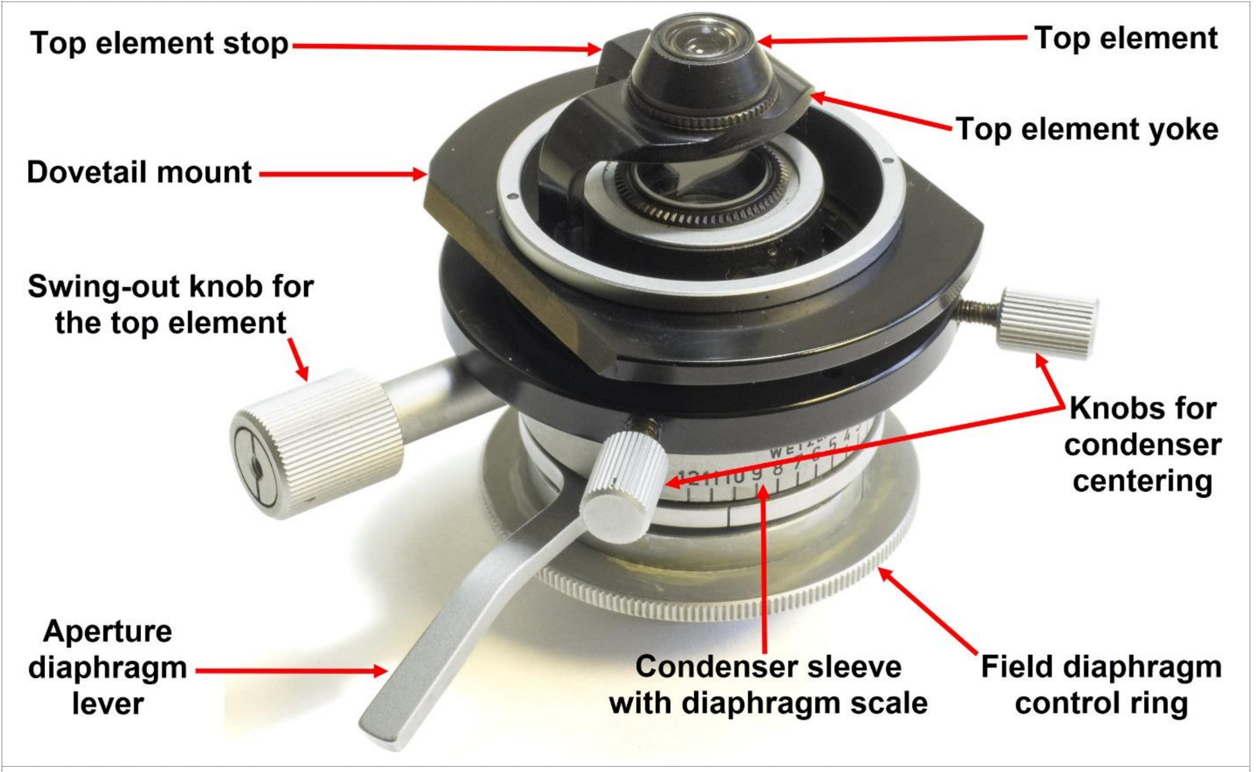


Figure 1: The Berek condenser. With a 0.95 n.a. swing-out top element and a dovetail mount.

The default top element has a numerical aperture of 0.95 (some sources say 0.90); it can however be replaced with two different top elements, one with a numerical aperture of 0.65, and the other with a numerical aperture of 1.40 (some sources say 1.25) for use with oil immersion objectives. When the condenser is used with weaker objectives (less than 10x magnification) the top element should be flipped to the side and out of the optical path. In this case the field diaphragm (i.e., the lower of the diaphragms) assumes the function of the aperture diaphragm while the upper diaphragm should be left completely open.

Condenser centering is accomplished with a regular two-knob centering mechanism.

Some contemporary sources advise that the Berek condenser is achromatic, but I haven't been able to find this confirmed in the available original brochures and price lists issued by Leitz.

The Leitz Berek condenser (Zweiblendenkondensor in German) was manufactured in the earlier part of the "Leitz black microscope era" that lasted from approximately 1937 to 1972. It was invented by the physicist Max Berek who was employed by Leitz and is most famous for designing the first of the legendary Leitz camera objectives and for his inventions in the field of rock and mineral microscopy. Reichert, Austria, also offered Berek condensers for their microscopes.

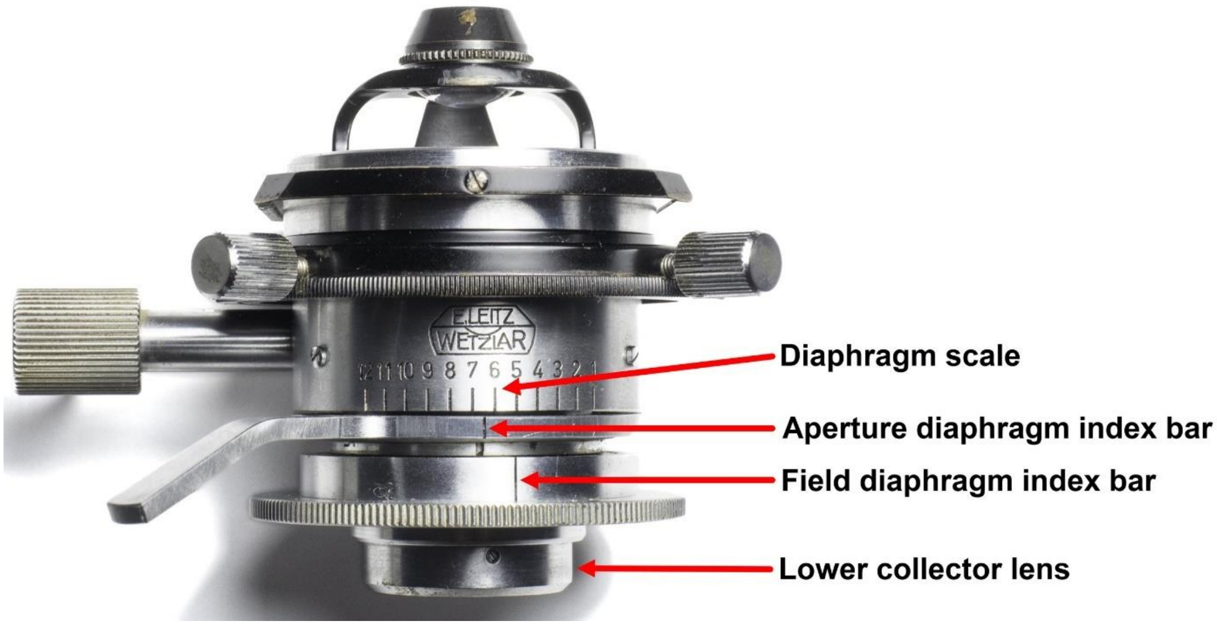


Figure 2: The Berek condenser. View from the side.

In 1963 the cost of a Leitz Berek condenser with the n.a. 0.95 top element was US $150. Adjusted for inflation it would today (May 2024) be US $1510.

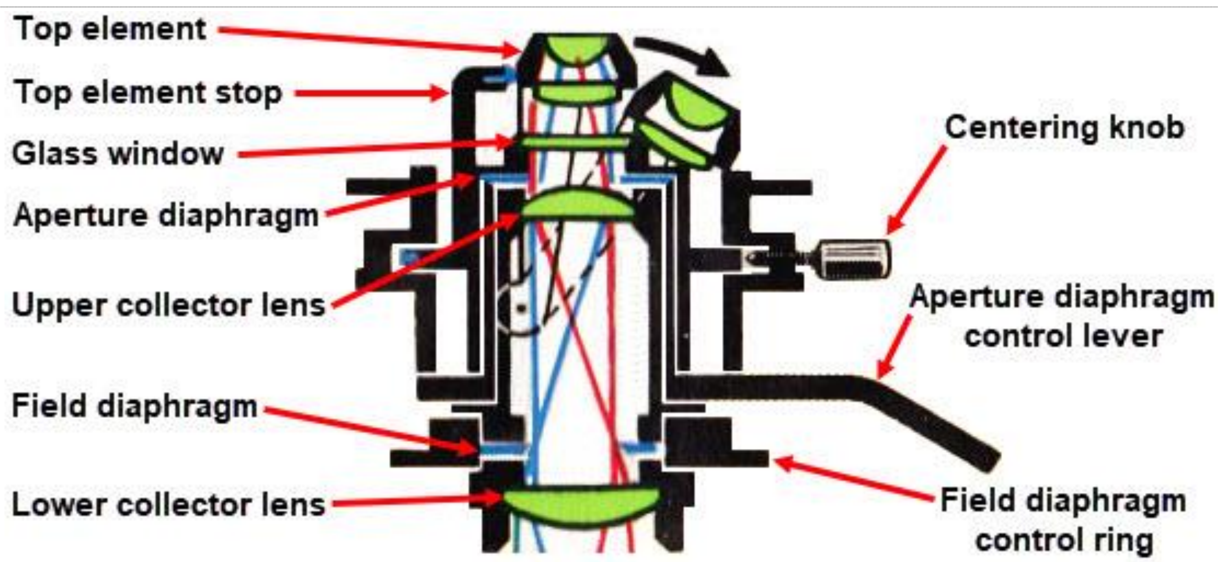


Figure 3: Drawing of the Berek condenser showing its optical configuration.

The Berek condenser underwent several modifications during the years, Figure 5 illustrates only a few variants. The most conspicuous differences are the various lower collector lenses sticking out from the bottom of the condenser (probably tailored to the illumination designs particular to the different microscope models) and some changes of the Leitz logo inscription on the side of the condenser. Early models had a circular sleeve mount (Figure 4), later condensers were also manufactured with the more versatile dovetail mount (Figure 1.) The following table lists some Berek condenser models:

Figure 4: Berek condenser with a sleeve mount.

Leitz model no.	Leitz code name	Used with
76	ORBER	Ortholux, Dialux, SM and Orthoplan microscopes with a dovetail condenser mount
77	IKOHR (and IKBEC?)	Microscopes with a sleeve condenser mount
78	OPWEL	Labolux and SM-D Lux microscopes with a dovetail condenser mount

Figure 5: Three Berek condensers with slightly different lower collector lens designs.

Figure 6: Berek condenser, view obliquely from below.

Figure 7: Berek condenser, view from the top, with the swing-out top element engaged.

Figure 8: Berek condenser, view from the top, with the swing-out top element folded to the side.

Scope

Older microscope condensers may typically be dirty and suffer from sluggish or frozen iris diaphragms and controls. One common problem is accidental contamination of the condenser with immersion oil.

Sometimes the centering mechanism may get mechanically stuck, either along the direction of one of the centering screws only, or completely. This may happen if you try to test the function of the centering slide by pushing the condenser case with your fingers rather than using the centering screws. Normally the pushers (Figure 30) are firmly kept in place by the tips of the centering screws (Figure 28), but by forcing the case away from the centering screw, the pushers are free to move sideways, get wedged and make the centering inoperable (Figure 29.)

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

Berek condensers were apparently manufactured in several build versions; therefore be prepared that you may find descriptions and procedures that don't seem to apply to your condenser.

Some Special Equipment

- Some of the screws in the Berek condenser are very small, like the 1.4 mm grub screws (), and require watchmaker type screwdrivers of various sizes around 1 mm.
- PVC sleeve, custom made. Useful if you need to reassemble the Berek condenser's iris diaphragms. Cut an approx. 8 mm wide piece from a rigid PVC tube with 23 mm inner diameter and 1 mm wall thickness. Other types of plastic may be used, the main requirement is that it is rigid, but still flexible. A miter box is recommended to get a perpendicular, straight, and even cut. Make a cut across its side (as in Figure 9) to make it easier to fit it on objects with slightly different diameters.

Figure 9: Custom made PVC sleeve (8 mm thick, 23 mm i.d.)

  As an aside, two of these 8 mm sleeves are also useful if you need to adapt Leitz eyepieces for 170 mm mechanical tube length to a Leitz microscope and objectives that are manufactured to the 160 mm tube length DIN standard. Pushing the sleeves all the way over the eyepiece barrels positions these eyepieces 8 mm further out from the head which makes them optically compatible with Leitz 160 mm tube length systems.

- Adjustable face pin spanner (Figure 10), with replaceable pins of varying sizes up to 3 mm diamter. Very useful, even indispensable, but typically expensive.
- Camera lens spanner (Figure 11), with various, exchangeable tips. Usually affordable. Unfortunately prone to slipping.
- I have arbitrarily chosen to use Mobilgrease 28 for lubrication of the Berek condenser's moving parts. Other greases can certainly be used as well.

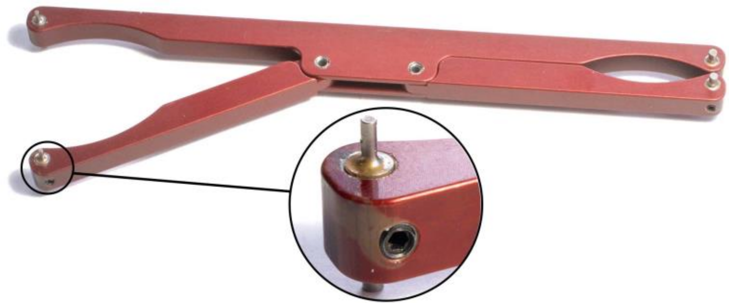


Figure 10: Face pin spanner with interchangeable pins.

Figure 11: Camera lens spanner, with interchangeable tips. The tips in the image are pointed, for flat tips see Figure 26.

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 and mechanical abuse. The most common problem with iris diaphragms is that they can become sluggish or stuck due to old, hardened lubricant (and sometimes dirt.) The diaphragm blades may become bent and dented if the diaphragm is forced to close beyond its designed limit. Bending of the blades can accidentally happen during maintenance. Bent or damaged diaphragm blades are potentially serious problems and can be difficult or impossible to repair.

To take apart an iris diaphragm is easy but putting it together again with all the blades can be challenging. Constrained space, like in the inside of a condenser, doesn't make the task easier. And 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, for some successful attempts see this article and this video clip. In these maintenance notes, we will attempt to clean the iris diaphragms without disassembling them first. The restriction is that the diaphragms must be separated from any parts that are not compatible with solvent soaking, for example certain plastics, and, of course, any optical components.

Should diaphragm blades be oiled? Oil protects the blades from jamming (which can damage them) and corrosion, and makes the diaphragm movements very nice and smooth, but oil is also prone to harden with time and to collect dust (although the dust problem should be negligible in the Berek condenser where the diaphragms are well protected.) I don't have any final answer, but I lean toward the oil and grease free approach.

Work Notes

Before you go ahead with fixing your Berek condenser there are two things that you should consider:

i. Check that the condenser's top element is in good shape. Unscrew the top element from the yoke (Figure 1 and subsection 1.a below) and inspect its lens surfaces, both the external and the internal. Look for any haze, particles, fibres, fungus, or scratches. This is best done with a stereo microscope. If required, clean the top element's outer lens surfaces according to your favorite lens cleaning protocol. If the inner lens surfaces appear dirty or hazy, you may be able to clean them if you can manage to take apart the top element, see Appendix: Disassemble and Clean the Top Element. The top element is the most critical component of the Berek condenser, so it is a good idea to make sure that the top element is in good condition before you invest any more time to service the other parts of your condenser.

ii. 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. Here are some of the problems that you may wish to fix on your Berek condenser:

Problem	**Required disassembly**
Sluggish or stuck aperture diaphragm	Usually due to dried, aged lubricants or mechanical failure. Proceed according to subsections 1–7, 11-13 and 18-19.
Sluggish or stuck field diaphragm	Usually due to dried, aged lubricants or mechanical failure. Proceed according to subsections 1-4 and 14-19.
Sluggish or stuck centering mechanism	The centering mechanism appears to be quite robust and not particularly prone to sluggishness due to aged grease. The threads of the centering screws/knobs are however easily contaminated with old grease and dirt - It may help to fix any sluggishness to clean and regrease them. The centering mechanism may also become stuck due to mechanical failures. Proceed according to subsections 1-6, 9-10, 12, 13, 18 and 19.
Dirty top element lens surfaces	Unscrew the top element and clean the lens surface(s) using your preferred lens cleaning protocol. Refer to subsection 1.a and Appendix: Disassemble and Clean the Top Element.
Dirty glass window (the window just below the top element)	Unscrew the glass window (refer to subsection 1.b) and clean the lens surface(s) using your preferred lens cleaning protocol. If the window is hopelessly stuck proceed according to subsections 1-4 to access its underside and try to clean it from the inside of the aperture diaphragm block.
Dirty upper collector lens	Proceed according to subsections 1-4, 14, 15 and 17-19. Clean the lens surface(s) using your preferred lens cleaning protocol.
Dirty lower collector lens	Unscrew the lower collector lens. Clean the lens surface(s) using your preferred lens cleaning protocol.

As mentioned above used condensers may be contaminated with immersion oil, sometimes seriously so. Also, many moving parts may be sluggish or stuck due to old, hardened grease and oil, and need to be cleaned and relubricated. To avoid tedious repetitions, only a few cleaning reminders will be specifically mentioned below. We'll leave it to you to decide whether you wish to clean the parts as they become disassembled, or if you prefer to leave the cleaning to be done after everything has been taken apart.

1. Remove the external optical parts.

Protect the following more sensitive optical parts from damage, dust, or dirt during the work by removing them from the condenser and store them somewhere safe:

a. The top element.

Unscrew and remove the top element (Figure 1 and Figure 3) from the yoke. Note that the metal parts of the top element are made of brass and therefore sensitive to damage. The top element should normally be easy to unscrew, but contamination with hardened immersion oil may make its removal very difficult. If you need to use pliers make sure to line the jaws with plastic or rubber foil, or perhaps tape, to protect the top element's knurled edge. And don't slip with the pliers! Releasing a stuck top element with tools, heat, penetrating oil, or solvent is risky due to the proximity to the sensitive lenses so perhaps the safest option may be to leave it as it is in the yoke. The disadvantage would be that the bottom lens surface is strongly convex and difficult to clean while the top element is attached on the yoke.

Clean the thread of both the top element and the yoke from any old grease with a cotton swab lightly wetted with solvent (for example, isopropanol, white spirit, or toluene.)

b. The protective glass window.

The protective glass window (Figure 3 and Figure 12) on the top of the condenser has a knurled rim to aid in un-screwing and removing it. If you can't remove it with your fingers and nails, try to use a camera lens spanner (Figure 11), preferably with flat tips (Figure 26.) Adjust the tips meticulously to fit snugly into the knurled rim, and carefully unscrew the window. If it is too stuck, just leave it where it is. The priority is to avoid damage.

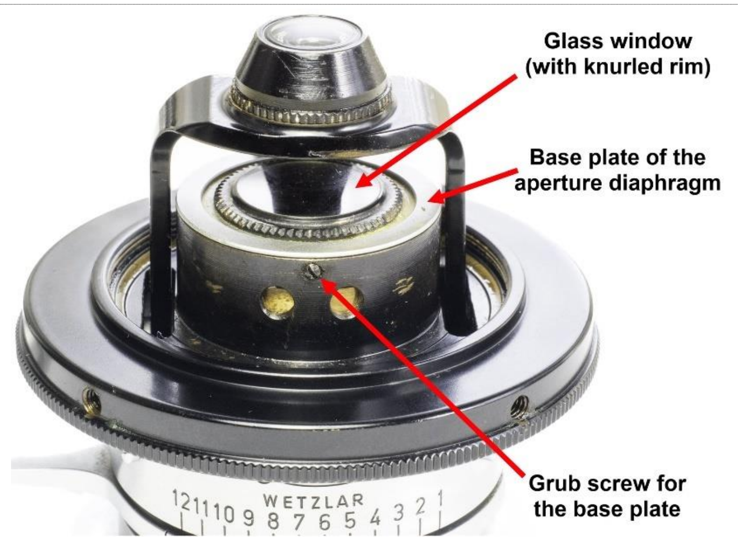


Figure 12: The upper part of the condenser (the aperture diaphragm block.)

c. The lower collector lens.

Some Berek condensers (but not all) may have three small screws along the periphery of the lower collector lens (Figure 3, Figure 5 and Figure 13.) The screws are apparently used for collimating the lower collector lens (i.e., centering it in the condenser's optical axis.) It's best to avoid tampering with the collimation, so don't touch these screws.

Unscrew and remove the lower collector lens from the condenser and put it away somewhere where it is protected from dust. Now the field diaphragm with its blades is accessible from the bottom of the condenser (Figure 14.)

Figure 13: The lower collector lens at the bottom of the Berek condenser. One of the three small centering screws is visible.

Figure 14: View from the bottom of the Berek condenser. The lower collector lens has been removed and the field diaphragm (almost closed here) is accessible.

2. Remove the locking ring for the dovetail mount and the dovetail mount (Figure 15.)

Figure 15: The Berek condenser with removed dovetail mount.

The locking ring has two small holes on its top – it is recommended to use an adjustable face pin spanner (Figure 10) with the pins put into these holes to unscrew and remove the ring. With care and some luck one may be able to remove the ring with the more common (and more affordable) camera lens spanner (Figure 11), but the typical conical tips on these spanners tend to slip when force is applied which easily may damage the condenser (and your hand as you hold the condenser.)

With the locking ring out of the way, the dovetail mount can easily be removed.

3. Remove the centering knobs from the condenser.

Simply unscrew the centering screws/knobs (Figure 1.) They may need to be cleaned from dirty old grease and then lightly regreased.

4. Separate the field diaphragm block from the aperture diaphragm block.

The condenser can conceptually and physically be divided into two parts, the *field diaphragm block*, and the *aperture diaphragm block*.

The *field diaphragm block* is the lower part of the condenser and comprises the lower collector lens, the control ring for the field aperture diaphragm, the field diaphragm, and the upper collector lens.

The *aperture diaphragm block* is the upper part of the condenser and comprises the aperture diaphragm control lever, the top element including the yoke and the top element swing-out knob, the aperture diaphragm, and the protective glass window above the aperture diaphragm.

Figure 14 shows 10 holes on the field diaphragm's base plate on the bottom of the condenser. On the inside of the base plate each hole anchors a pivot pin that is attached to the end of a diaphragm blade. We will take advantage of these holes and use them to help us to remove the field diaphragm block from the condenser.

Hold the condenser steadily with one hand around the sleeve (but don't touch the field diaphragm control ring!). Put the pins of a face pin spanner (Figure 10) steadily into any two holes situated on opposite sides on the bottom of the field diaphragm's base plate (Figure 14.) Use the spanner to unscrew the field diaphragm block and pull it carefully out without damaging or dirtying the upper collector lens that sits in its top end (Figure 16 and Figure 33.)

Figure 16: The Berek condenser divided into its two blocks – the aperture diaphragm block (left) and the field diaphragm block (right.)

With this we have the condenser separated into the aperture diaphragm block and the field diaphragm block (Figure 16.)

NOTE: On some Berek condensers the base plate holes may too shallow to safely use the face pin spanner; if such cases you may need to resort to the "brutal and potentially dangerous alternative method" described below.

"Brutal and potentially dangerous alternative method": In case you don't have a face pin spanner, or if the holes in the base plate are too shallow for the spanner, there is an alternative, but more brutal and dangerous method for removal of the field diaphragm block: Turn the field diaphragm control ring counterclockwise (when viewed from below) as far as it goes to open the field diaphragm completely. If the diaphragm is stuck don't force it but moisten its surface lightly (one drop) with penetrating oil (like WD-40), let it work for a few minutes, and then carefully turn the ring back and forth a couple of times to have the diaphragm unstuck. Don't use excess penetrating oil, you really don't want it to leak down to the upper collector lens that sits just an inch (2.5 cm) below.

With the field diaphragm fully open grab the condenser steadily with one hand around the sleeve and with the other hand unscrew the control ring further to release the entire field diaphragm block from the condenser. This is somewhat scary and potentially dangerous (it is a cardinal sin to exert force on a diaphragm), but in this case the diaphragm is already fully open, and the diaphragm control's robust design should hopefully safely endure this brutality. When released, pull the block carefully out without damaging or dirtying the upper collector lens in its top end (Figure 33.)

For now, put away the field diaphragm block somewhere where it is protected from dust. We are for a while turning our attention to the aperture diaphragm block.

5. Remove the aperture diaphragm control lever from the aperture diaphragm block.

Remove the aperture diaphragm control lever from the aperture diaphragm block by lifting it off (Figure 23) - some jiggling may be required to release it. There is a very small shiny grub screw on the backside of the control lever – don't do anything with it, just leave it as it is.

6. Remove and disassemble the top element yoke and the swing-out knob for the top element.

The knob for the top element turns around a pivot axle that has a slotted, round nut at its end (Figure 17.) If you look at the outer end of the knob (Figure 18) while you turn the knob you can see that the slotted nut doesn't turn with the knob. This is because the pivot axle is attached to the aperture diaphragm block by a thread at its inner end, while the knob is attached by another thread to the top element yoke.

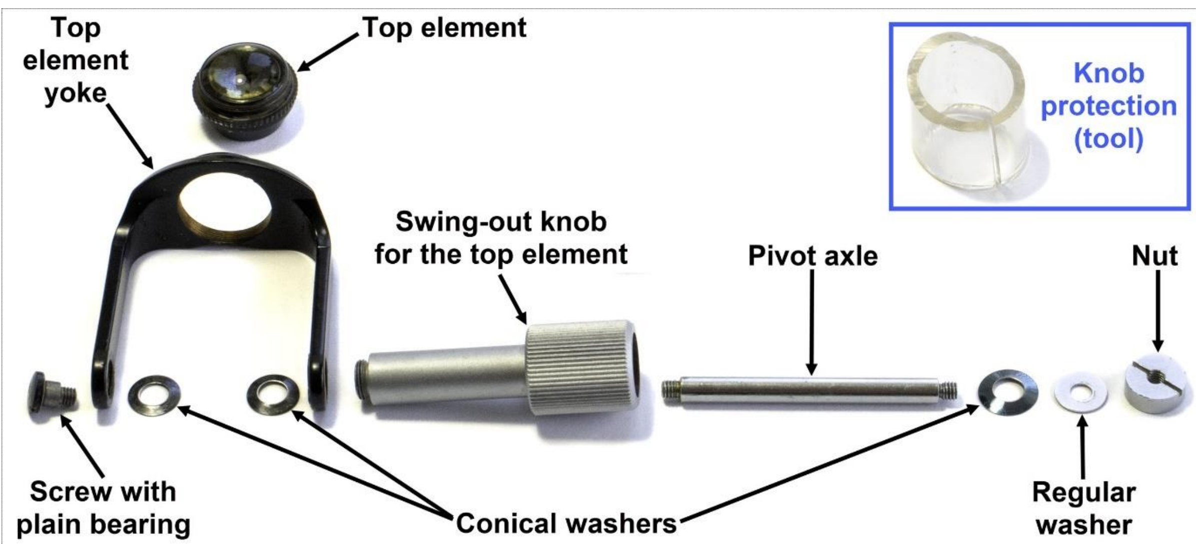


Figure 17: The swing-out top element disassembled.
The simple knob protection tool used for removal of the knob is shown in the blue frame

Use a screwdriver with a wide but very thin tip (make sure that the tip really reaches deep enough into the drive) to release and unscrew the nut from the end of the swing-out knob. Ideally one would use a screwdriver with a small indentation ground into the middle of the tip to allow some space for the tip of the pivot axle that sticks out slightly, but the nut appears to be fairly easy to loosen even with a normal, straight screwdriver tip.

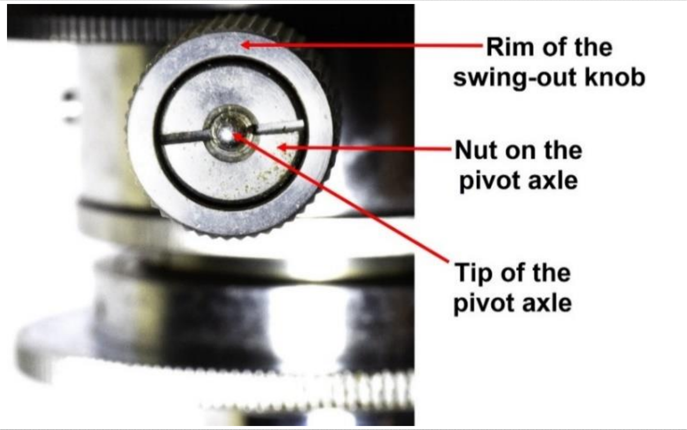


Figure 18: The outer end of the swing-out knob.

Depending on which of the pivot axle's threads is most stubborn you may release either the nut only, or the nut together with the pivot axle. Collect the black conical washer and the chrome plated regular washer that sit between the nut and the inside of the swing-out knob.

Some (but not all) Berek condensers have a very small grub screw (1.4 mm diameter) attached between the inner end of the swing-out knob and the end of one of the yoke legs (at the tip of the red arrow in Figure 19.) The purpose of the grub screw is to prevent that the swing-out knob accidentally releases from the yoke during routine microscope use.

If your condenser has that grub screw (look closely for it, it is very small and easy to miss!), remove it with a small watchmaker type screwdriver.

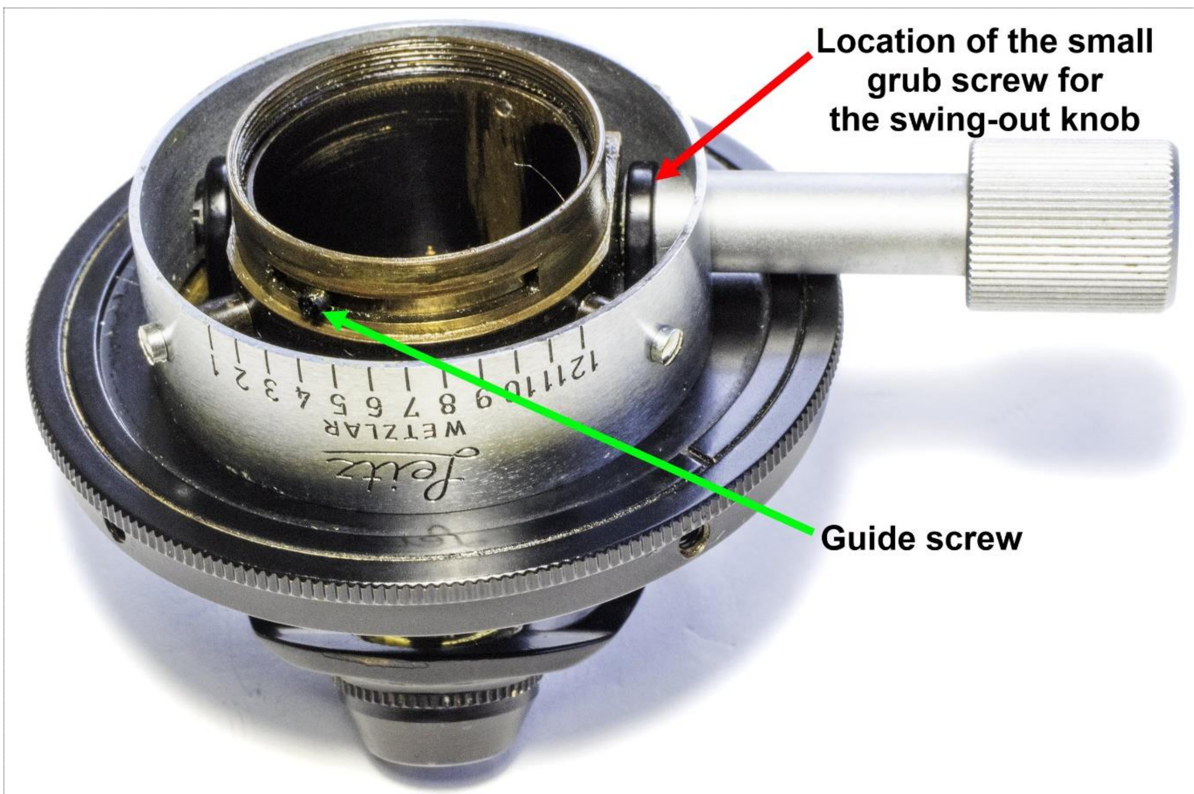


Figure 19: The aperture diaphragm block viewed from the bottom. The red arrow points to the spot where in some Berek condensers a very small grub screw can be found. (The condenser in this image didn't have the grub screw.) The green arrow points to one of the two guide screws that restrict the movement of the aperture diaphragm.

Unscrew and remove the swing-out knob. If the knob can't be removed with the fingers only, use combination pliers while taking care to protect the knob knurls from the pliers' teeth. A simple knob protection aid can be made by cutting off a short piece of a PVC hose [like the one within the blue frame in Figure 17.] Cut it up along one side and wrap it around the knob before gripping it with the pliers. The PVC hose is soft, but very rupture resistant.

If the pivot axle nut in your case was released from the pivot axle and left the axle attached to the aperture diaphragm block, then unscrew and remove the pivot axle. Pliers will probably be required. Protect the axle from being scratched by the pliers' teeth.

Remove the three small screws around the periphery of the condenser sleeve (Figure 1; two of the screws are also visible in Figure 19.) Remove the sleeve by turning it back and forth and pulling it down from the aperture diaphragm block.

Remove the black screw with the plain bearing (Figure 17) that holds the other yoke leg and pull out the now released yoke with the top element. Note that the screw drive is very narrow, so you will really need to ensure that your screwdriver fits properly into the drive. Don't lose the two conical washers that sit on the inside of the yoke's legs. You should now have the following parts disassembled (from the left side to the right side in Figure 17):

- A black, short screw with a plain bearing (i.e., a simple circular sliding surface) that attaches the yoke leg on the opposite side of the swing-out knob to the aperture diaphragm block. The plain bearing surface is lightly greased.
- Two black conical washers, each situated between the legs of the yoke and the aperture diaphragm block; o.d. 7.0 mm, i.d. 3.8 mm, thickness 0.2 mm, with the convex sides facing the yoke legs. The washers are greased.
- The black top element yoke (with attached top element.)
- The very small grub screw in the yoke locking the thread of the swing-out knob (the grub screw is not included in Figure 17, but indicated with a red arrow in Figure 19.)
- The swing-out knob for the top element. It attaches into the threads of the nearest leg of the top element yoke. The knob and its shaft are hollow and rotate around the greased pivot axle.
- The pivot axle that goes through the swing-out knob and is attached to the aperture diaphragm block. It is 39 mm long, with 3.5 mm diameter, and has threads in both ends. On one condenser I worked with the axle was symmetric, but on another condenser it wasn't – its condenser end was flat, while the nut end was rounded.
- One black conical washer, o.d. 8.0 mm, i.d. 3.9 mm, thickness 0.2 mm. It sits between the inside of the knob and the regular washer; the convex side of the washer faces outwards, i.e., towards the regular washer. The washer is greased.
- One regular washer. Apparently, it may be of different sizes in different condensers, but one washer had an o.d. of 8.0 mm, i.d. 3.9 mm, thickness 0.2 mm, another washer in another condenser was at an o.d. of 5.0 mm, i.d. 3.4 mm, thickness 0.2 mm. The washer sits just under the nut and is greased.
- Circular nut, with a screwdriver slot facing outward. Diameter 8 mm, thickness 3 mm.

7. Remove, clean, and reassemble the aperture diaphragm.

First a short description of how the aperture diaphragm works. The base plate of the aperture diaphragm is attached to the top of the aperture diaphragm block with three small, black grub screws (at the bottom of Figure 20, one of the screws is also visible in Figure 12.)

The 10 aperture diaphragm blades are anchored in the stationary base plate by small pivot pins in one end of the blades (Figure 20, Figure 21 and Figure 22.) The other ends of the blades also have pivot pins, but these sit in slots on the cylindrical aperture diaphragm actuator that is pressed against the aperture diaphragm (Figure 20 and Figure 22.) The actuator holds the diaphragm blades firmly in place only allowing them to move sideways as required to open and close the aperture diaphragm.

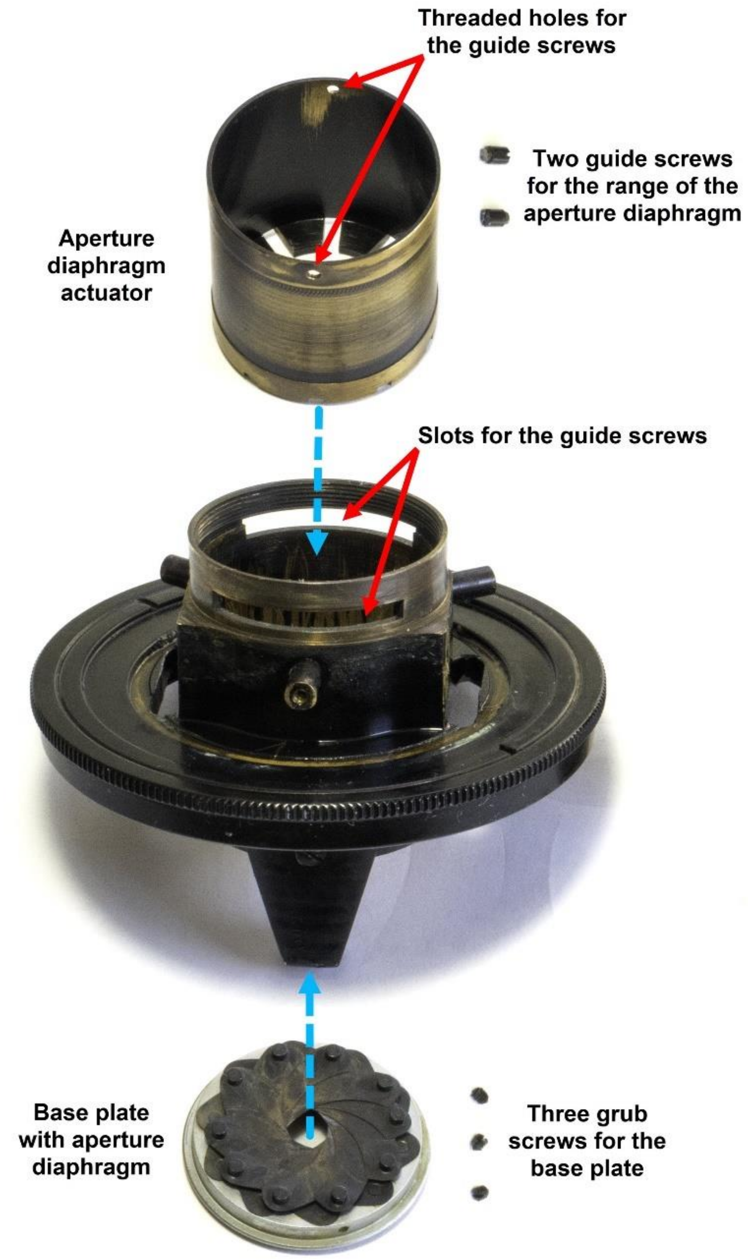


Figure 20: Disassembled parts of the aperture diaphragm block. Note that the aperture diaphragm block must be held upside down to keep the aperture diaphragm blades seated on the base plate.

The actuator's outside is greased, and it is turned by the aperture diaphragm lever to change the size of the aperture diaphragm opening. Two guide screws (Figure 20, and indicated with a green arrow in Figure 19) attached in the actuator move in slots (middle part of Figure 20) that restrict the rotation range of the aperture diaphragm. The heads of the guide screws stick out approximately 1.5 mm from the slots so they also can catch into two cuts on the ring that is a part of the aperture diaphragm control lever (Figure 23.)

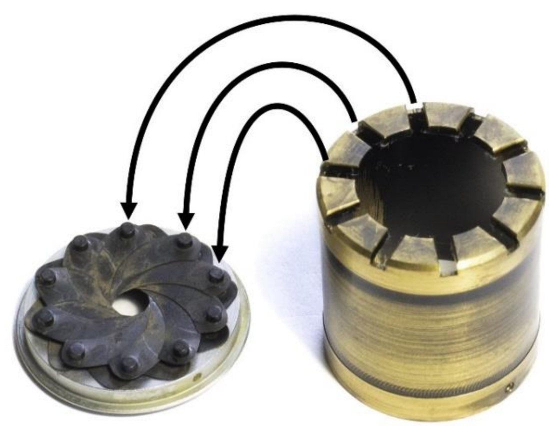
Now back to the work. We will describe two alternative approaches for cleaning the aperture diaphragm. The first method is a quick effort to release a stuck diaphragm by direct treatment with penetrating oil while it still sits attached in the block. The second method is more thorough and involves a partial disassembly of the aperture diaphragm before accessing and cleaning its parts. If your aperture diaphragm works well, you of course don't need to disassemble it and can skip this subsection.

a. Quick treatment of the aperture diaphragm with penetrating oil while left safely attached to the aperture diaphragm block.

If possible close the aperture diaphragm. Carefully apply penetration oil (WD-40, CRC 5-56, or similar) to the aperture diaphragm blades with the help of cotton swabs or wood sticks. Make the blades as wet as possible, but without allowing the oil to seep off from the blades. This is particularly important if the glass window still is attached to the base plate. Let the oil work for a few hours. Blot or wipe off excess oil and gently try to repeatedly open and close the diaphragm. Repeat the treatment at least two more times with fresh penetrating oil to further dissolve and remove any old, hardened grease. Close the aperture diaphragm fully and carefully wipe off as much as possible of the penetrating oil. 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 diaphragm repeatedly. Don't overdo the oiling!

b. Thorough cleaning of the aperture diaphragm after partial disassembly.

To physically access and clean the aperture diaphragm blades the actuator must be removed from the diaphragm. This leaves the diaphragm blades resting unsecured on the base plate. The blades will be kept in place only by gravity and by the pivot pins in the ends of the blades that sit in the holes in the base plate. Therefore, during work make sure that these pivot pins are not allowed to come loose from the base plate holes. If they come loose, you will face the tedious task to reassemble the entire aperture diaphragm again.

	
Figure 21: View on the underside of the aperture diaphragm block. The image shows the aperture diaphragm on the inside of the block.	*Figure 22: The aperture diaphragm blades anchored to the base plate (left side of the image) and the cylindrical aperture diaphragm actuator (right side of the image) The arrows show how the pivot pins on the blades fit into the slots at the end of the actuator.*

Start by turning the aperture diaphragm block upside down (as in Figure 20 and Figure 21.)

Remove the two guide screws that stick out of the slots in the block (Figure 20 and Figure 23.) This will release the aperture diaphragm actuator so it can be pulled out from the aperture diaphragm block.

Carefully pull out the actuator (Figure 20) to separate it from the diaphragm blades in the block. This is a critical operation because it is important to ensure that the aperture blades remain safely seated with their pivot pins in the holes of the base plate. If the aperture is greased, the blades may stick to the actuator; therefore, use a toothpick to gently push down on the blades to keep them undisturbed and safely resting on the base plate while the actuator is pulled out.

Still holding the aperture diaphragm block upside down, remove the three small black grub screws that hold the base plate attached to the top of aperture diaphragm block (Figure 12 and Figure 20.) Remove the base plate from the block by gently and carefully wiggling it and pulling it down. While doing this, make sure to keep the diaphragm blades safely seated in the base plate.

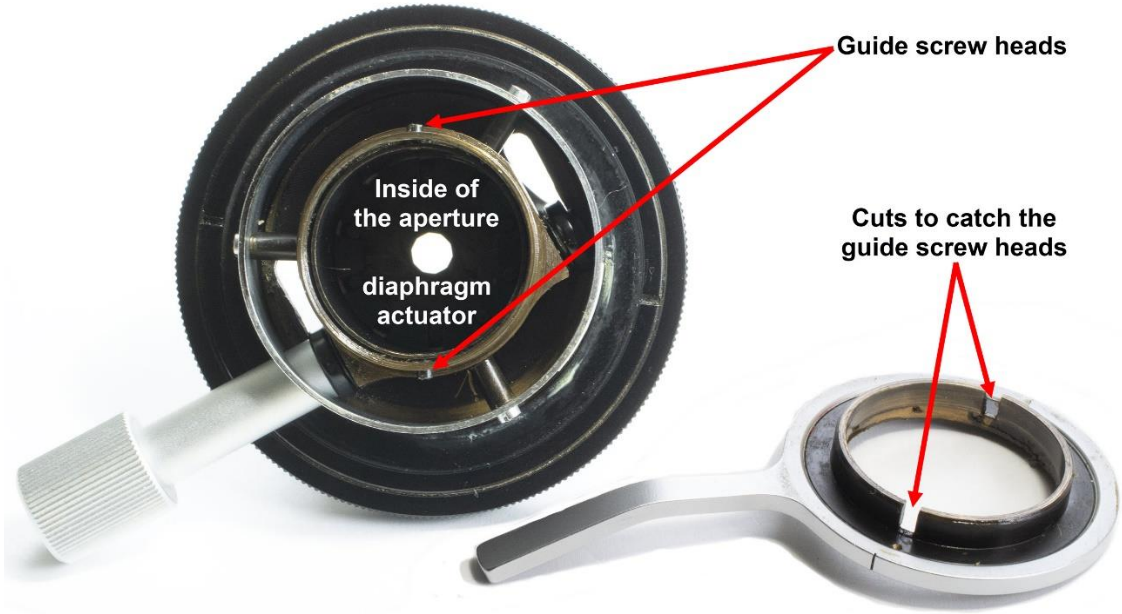


Figure 23: Illustration of the how the guide screws catch into the aperture diaphragm control lever.

Use a suitable petroleum-based solvent (e.g., white spirit) and cotton swabs or small pieces of cloth to clean the inside of the aperture diaphragm block and the entire actuator from old grease.

Put the base plate (if the glass window is stuck on the base plate, just leave it there as it is) with the diaphragm blades facing up in a small glass vial and cover it with cleaning solvent (e.g., white spirit). Let it sit in the solvent for a few hours occasionally rocking the vial slightly to move the solvent. Use a toothpick to carefully move the aperture blades slightly back and forth sideways but be careful not to let the blades come off from the base plate. Change to fresh solvent and continue the occasional rocking and moving of the aperture blades. Repeat with fresh solvent at least two more times (at least four more times if the glass window is left on the base plate) until all grease has been removed. Use tissue to blot the base plate and the diaphragm and allow the parts to dry completely. This can be facilitated by a final rinse in isopropanol which is more volatile and will speed up the drying.

Put away the base plate with the clean diaphragm blades in a safe place until it is time to put it back again into the aperture diaphragm block together with the actuator.

8. The top element stop.

The top element stop (Figure 3) determines the position of the top element when it is flipped up into the optical path. The stop is attached to the aperture diaphragm block with four screws, two from the outside of the block (Figure 24), and two from the inside (Figure 25.) The screws are difficult to remove, but that doesn't matter much as there really is no need to remove the top element stop for any of the work that we are doing. If you anyway insist on removing the stop, you will need to remove all four screws. The block has two holes cleverly placed to allow screwdriver access to the screws on the inside (Figure 25.) The screwdriver must have a long shaft to reach the screws through the holes in the aperture diaphragm block. Make sure that the tip of the screwdriver fits well into the screw drives.

Figure 24: The two outside screws that hold the top element stop (within green circles.)

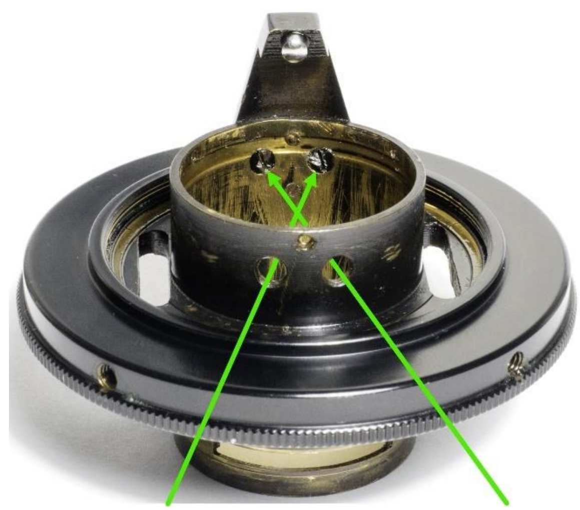


Figure 25: The two inside screws that hold the top element stop. The green arrows show how the screwdriver should go to access the screws.

9. Disassemble and clean the centering mechanism.

With most of the removable items gone from the aperture diaphragm block only the centering mechanism remains (Figure 25.) The centering mechanism is enclosed within a black casing and a cover (Figure 27.)

Figure 26: Flat tips on a camera lens spanner.

To access the centering mechanism the black, circular cover must be removed from the casing (Figure 27.) The removal requires a camera lens spanner (Figure 11) with flat tips (Figure 26) that fit well into the somewhat shallow slots on the cover (green arrows in Figure 27.) At manufacturing the centering mechanism was thoroughly greased, but today, 60 or more years later, the grease may be decomposed into a green mud-like mass with limited remaining lubricating capability. The cover sits in a wide thread and may be difficult to remove due to the degraded grease. Be very careful to avoid using too much force, the cover is made of soft brass and the slots are shallow which makes it very easy to slip and damage them. If the cover doesn't release easily try the following to loosen it:

Apply penetrating oil to the cover threads (the tips of the green arrows in Figure 27 indicate the location of the threads) and let the oil work a few hours or days. Attach the aperture diaphragm block by its knurled periphery in a vise where the jaws are covered with hard plastic to save the aperture diaphragm block from scratches. Carefully tighten the vise around the periphery of the block to give it a gentle squeeze, and then after a few seconds release the vise. Rotate the block 90° and give it another gentle squeeze. The idea is to force the stuck cover to release from the threads by very slightly deforming the circular casing of the centering mechanism. It must be done carefully because the casing is made of soft brass that easily bends or breaks.

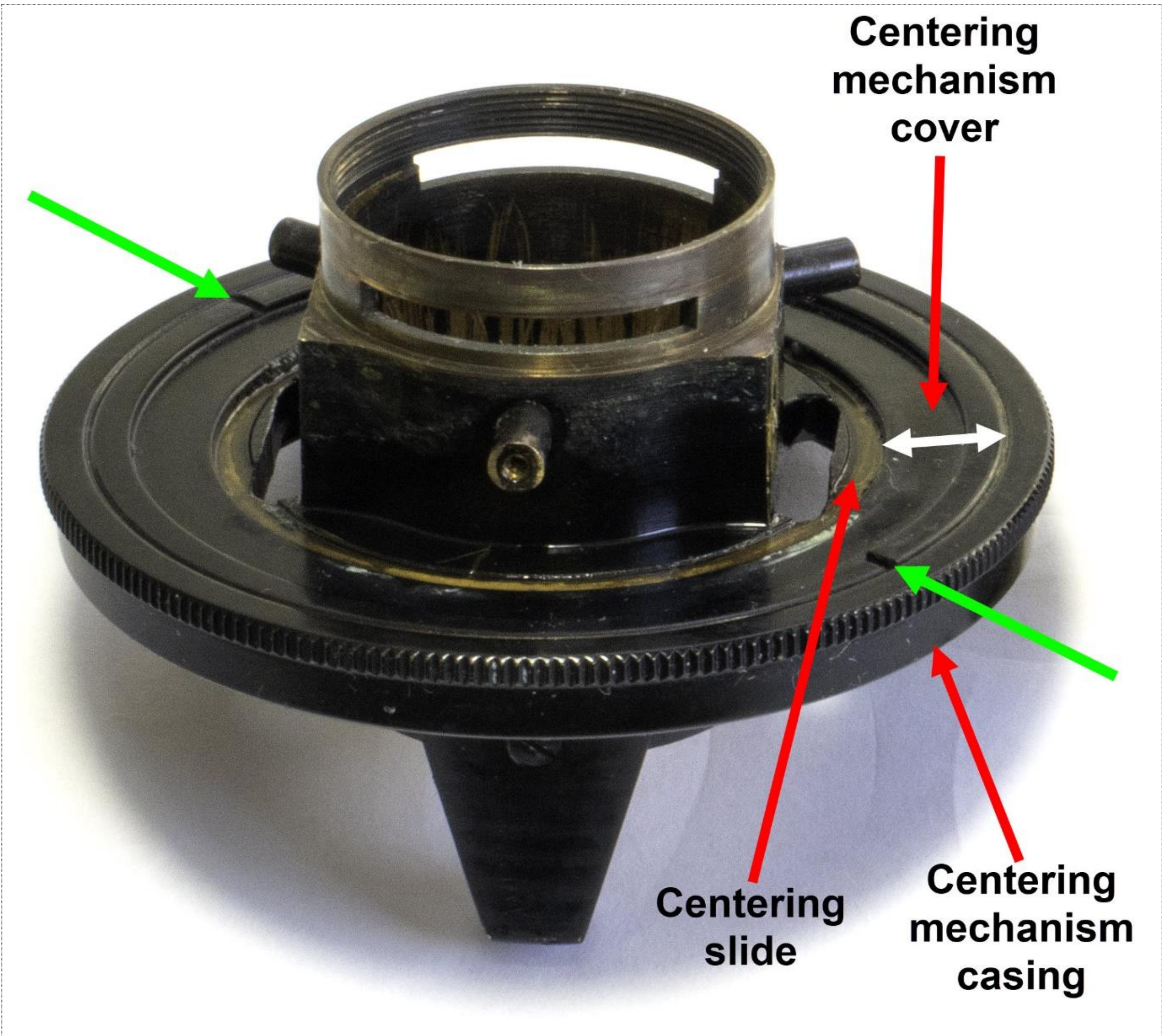


Figure 27: The aperture diaphragm block with the centering mechanism. The green arrows point to the slots for the camera lens spanner. The tips of the green arrows indicate the location of the thread slit between the cover and the casing. The white arrow indicates the width of the cover.

Release the cover with the spanner and unscrew it from the aperture diaphragm block. And again, recall that it is important that the spanner fits snugly into the slots on the cover and that the aperture diaphragm block is steadily supported. Avoid at any cost to slip with the spanner because that most probably will damage the slots.

If the cover still is stuck try to either 1) repeat the treatment of applying penetrating oil and squeezing the aperture diaphragm block in the vise, 2) use a small plastic hammer to lightly and many times knock on the top of the cover in the hope that the vibrations will release it from the thread, or 3) treat the aperture diaphragm block with alternating cold and heat by putting it in freezer for a couple of hours and then heating it to 50-70°C (120-160 °F) in an oven or with an electric heat gun.

Once the cover has been successfully unscrewed collect all parts of the centering mechanism (Figure 28 and Figure 30) and clean them with solvent. Be sure not to lose the small steel liners that are attached to the centering pushers (Figure 30 and Figure 31.) The green degraded grease is not always soluble in solvents, so it may need to be wiped or brushed off. As an optional last cleaning step, the parts may also be washed in warm water with detergent and then thoroughly dried.

Figure 28: The centering slide in the aperture diaphragm block after the cover has been removed.

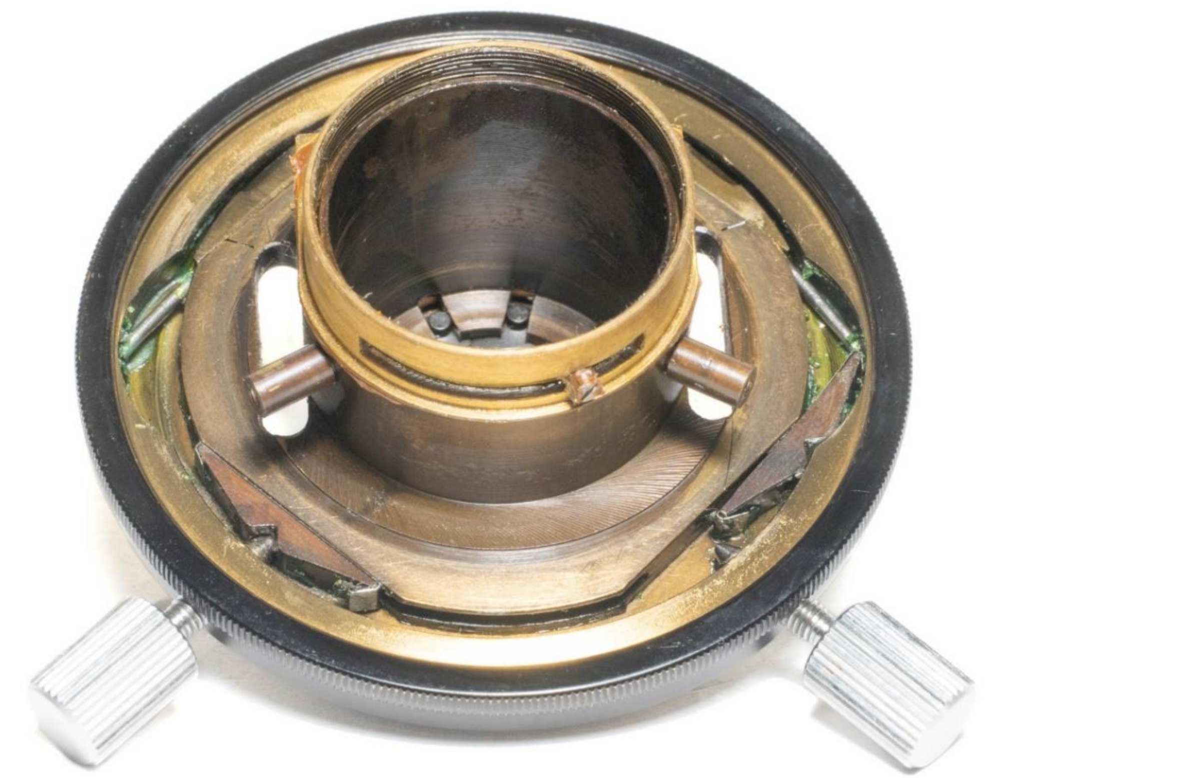


Figure 29: The centering slide demonstrating a mechanical failure. The left centering screw and pusher are intact, but the right pusher has slipped away from the left centering screw and become wedged in the slide. The slide is stuck.

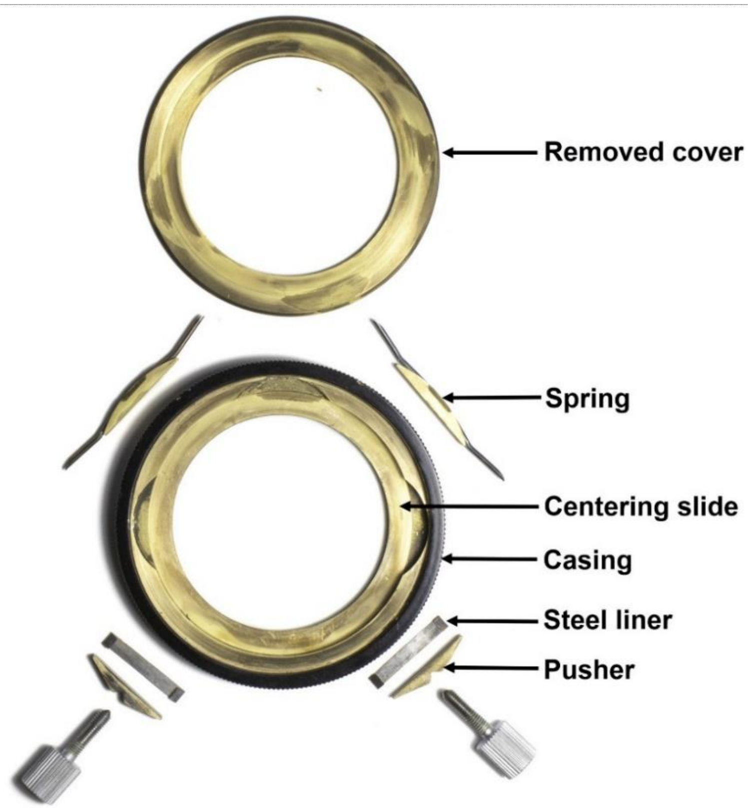


Figure 30: Exploded view of the centering mechanism (the condenser housing that moves in the slide is not included in the image).

Figure 31: Close-up view of the centering mechanism's pushers and steel liners. On the top the parts are separated, on the bottom the parts are assembled.

10. Grease and reassemble the centering mechanism.

Thoroughly grease the centering slide (Figure 30) of the casing. I have found that Mobilgrease 28 is a suitable grease for the centering mechanism.

Place the condenser housing on the centering slide making sure 1) that it is placed with the bottom side facing upward (as in Figure 28 and Figure 29), and 2) that it is correctly turned with the top element stop on the opposite side of the screw holes for the centering knobs (Figure 25.)

Attach the springs in the designated slots in the casing (Figure 28) and use a small screwdriver to force their steel pins into the slots along the inner edge of the slide. The springs should now push the condenser housing against the side of the slide where the centering knobs are.

Attach the centering knobs loosely to the centering casing – the tips should remain within the threads and should not stick out into the slide. Push the condenser housing along the slide away from the centering knobs to provide space for the pushers. Use forceps to put the pushers into that space. Be careful to include the steel liners and to align the pushers' dents with the tips of the centering knobs (Figure 28.) Tighten the centering knobs somewhat so the tips reach into the pushers' dents.

Apply grease on the upwards facing slide of the condenser housing, the springs, and the pushers.

Carefully attach the cover to the housing of the centering mechanism. Be sure that the cover catches the threads nicely. Don't force it, it may take a few attempts to get it right. Use the camera lens spanner (Figure 11 and Figure 26) to tighten the cover only very lightly. Wipe off excess grease. Use the centering knobs to check that the centering mechanism works properly.

11. Return the aperture diaphragm into the aperture diaphragm block.

Skip this subsection if you used the quick procedure (subsection 7.a) for cleaning of the aperture diaphragm, or if you didn't need to clean it at all.

At manufacturing of the Berek condenser the outside of the actuator (Figure 20 and Figure 22) was greased. We will however not apply grease on it when the aperture diaphragm block is reassembled. This simplifies the assembly, it eliminates any future problems with grease aging and contamination, and even without grease the aperture diaphragm will still move quite easily and smoothly.

For the first part of the following work make sure to hold the aperture diaphragm block upside down. This is to ensure that the diaphragm blades with the help of gravity remain seated in the base plate (Figure 20.)

Attach the three very small, black grub screws (Figure 20) along the edge on the top of the block. Only attach them deep enough so they sit in the threads but without allowing the tips to stick out on the inside. Be aware that the screws are brittle and that the threads in the block are made of brass and consequently easily damaged.

Check that the diaphragm blades on the base plate are not sticking outside of the rim of the base plate. If necessary, use a toothpick to move their loose ends inward. Be careful so the stationary ends of the blades are not pulled out of their slots in the base plate.

From below, push the base plate with the diaphragm blades into the top of the block. Hold it attached to the block with the fingers, so it doesn't fall out. (Remember to keep holding the block upside down all the time.) Lightly tighten the grub screws so they hold the base plate attached and it doesn't fall out from the block.

Use a clean wooden toothpick to push the loose ends of the diaphragm blades very carefully and incrementally outwards as far as it goes to open the diaphragm fully. Be careful so the stationary ends of the blades are not pulled out of their slots in the base plate. When all blades are in their maximally opened position the upward facing pivot pins on the blades should be evenly spaced. Slowly push the actuator (Figure 20) down into the block while 1) aligning the holes for the guide screws so they are somewhere within the slots for the guide screws (Figure 20), and 2) aligning the diaphragm blade pivot pins with the slots in the bottom of the actuator. Now try to get every pivot pin to lock into a corresponding actuator slot – it may be necessary to very slightly (fraction of a millimeter) rotate the actuator back and forth to catch all pivot pins. Once all pivot pins have caught in the slots let the actuator rest on the diaphragm. Attach the two guide screws through the slots in the block and into the actuator. Now the actuator is locked to the aperture diaphragm and the aperture diaphragm block may safely be turned into any position.

Recall that the slots for the guide screws are designed to protect the aperture diaphragm by limiting its range, or particularly how far it can be closed. Forcing the diaphragm to close beyond this limit could damage the blades. We will now adjust the diaphragm for this limit.

This time, keep holding the aperture diaphragm block in its normal position, i.e., with the base plate facing up. Loosen the three base plate grub screws just enough to release the base plate. With the base plate loose again be careful not to allow it to lift off from the aperture diaphragm block – that would mess up the aperture diaphragm blades. The base plate should only be allowed to rotate while remaining firmly seated on the top of the block. Rotate the actuator and the base plate as required to simultaneously 1) set the aperture diaphragm into its maximally closed position [i.e., as closed as possible without jeopardizing the blades, the opening should be less than 1 mm] and 2) get the actuator rotated counterclockwise [as viewed from above] as far as is allowed by the guide screws. Once completed, carefully tighten the grub screws around the base plate so they hold the base plate safely attached to the top of the block.

This adjustment of the aperture diaphragm range can also, if required, be performed retrospectively on a fully assembled Berek condenser.

In the case that the glass window has been stuck on the base plate (Figure 12), and if its underside is dirty, this is a good time for accessing and cleaning it. Open the aperture diaphragm fully and clean the window by reaching through the underside of the aperture diaphragm block using cotton swabs wetted with a suitable lens cleaning solution. Avoid getting cleaning solution into the aperture diaphragm. Cleaning the outside of the window can wait until the condenser has been completely assembled.

If you wish to apply oil to the aperture diaphragm, then now is the right time to do that. Close the aperture diaphragm fully. Wet a cotton swab with a high quality, non-drying oil and dab it carefully and sparsely on the aperture diaphragm blades from the underside of the block. Spread the oil evenly over the blades by opening and closing the diaphragm repeatedly. Don't overdo the oiling!

12. Grease and reassemble the yoke and the swing-out knob on the aperture diaphragm block.

Apply grease on the area around the screw holes on the aperture diaphragm block that will hold the yoke attached, and also apply some grease to the inside of the yoke legs just around the holes in the legs. Put one of the conical, black washers (Figure 17) over the screw hole on the side of the block where the screw with the plain bearing (Figure 17) will go. Let the washer's convex side face outward, i.e., toward the yoke leg. Attach the yoke so the leg with the smaller hole will be just above the screw hole with the washer and then attach the screw with the plain bearing. Tighten the screw.

Push the other conical washer in the slit between the other side of the aperture diaphragm block and the other yoke leg. The convex side of the washer should again face toward the yoke leg.

Put the condenser sleeve (Figure 1) over the aperture diaphragm block with the hole for the swing-out knob aligned above the screw hole for the pivot axle. Attach the sleeve to the block with the three chrome plated screws (two of these screws are visible in Figure 19.)

Screw the pivot axle (Figure 17) into its screw hole in the side of the aperture diaphragm block making sure that the conical washer still is between the block and the yoke leg. Tighten the pivot axle with pliers while protecting the axle from being scratched. Apply a thin layer of grease along the entire pivot axle, push the swing-out knob (Figure 17) over it, and finger tighten the knob into the threads in the yoke leg.

If applicable for your Berek condenser, attach the tiny grub screw (Figure 19) that locks the swing-out knob's thread to the yoke. If your Berek condenser didn't have the grub screw, then tighten the swing-out knob solidly with your fingers.

Apply grease to the washers that should sit in the end of the swing-out knob and put them into the knob over the tip of the pivot axle – first the black conical washer with its convex side facing outward, and then the chrome plated washer (Figure 17.) Attach the circular nut (Figure 18) and tighten it moderately with a screwdriver with a wide and very thin tip. Check that the yoke freely swings out and in.

13. Reattach the aperture diaphragm control lever to the aperture diaphragm block.

Apply grease (Mobilgrease 28 is suitable) along the outer edge at the bottom of the aperture diaphragm block (the green arrows in Figure 32.) This is the slide for the aperture diaphragm control lever.

Push the aperture diaphragm control lever into its place over the greased edge. The lever's ring has two cuts that should catch over the guide screw heads sticking out from the aperture diaphragm actuator (Figure 23 and Figure 32.) Check that the index on the side of the lever is adjacent to the scale on the condenser sleeve. Check that the lever moves smoothly, and that the aperture diaphragm works properly. For now, the lever is only loosely attached to the aperture diaphragm block – it will be safely locked in its place once the field diaphragm unit has been attached.

We will now turn our attention to the field diaphragm block that we in subsection 4 above separated from the aperture diaphragm block.

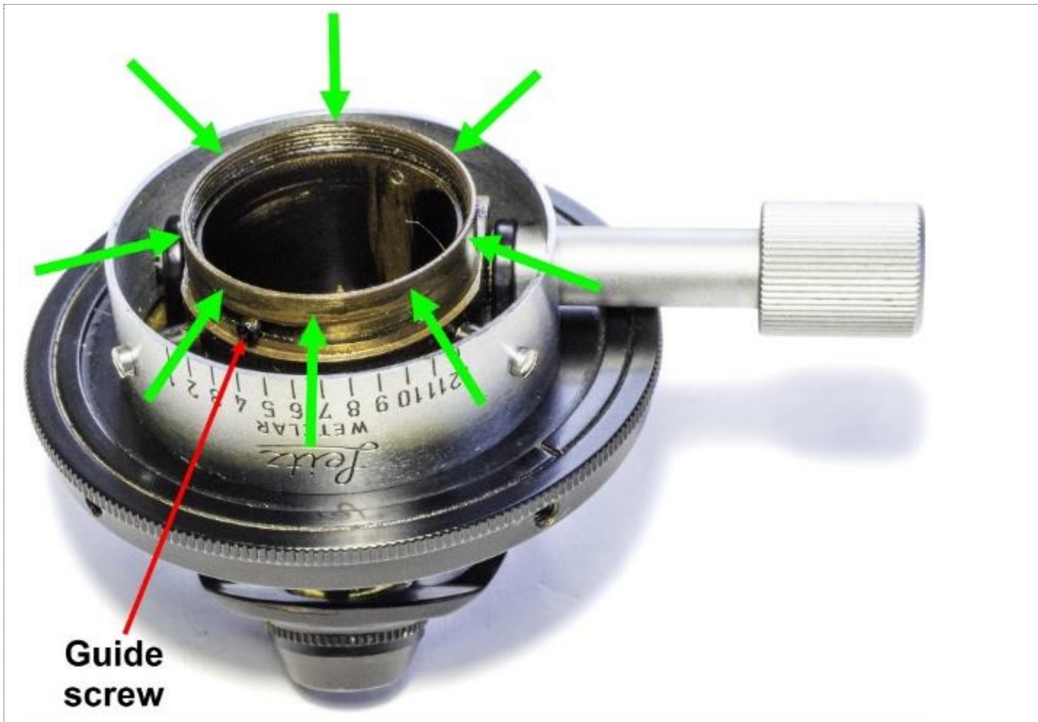


Figure 32: The underside of the aperture diaphragm block. The green arrows indicate the outer edge that should be greased before the aperture diaphragm lever is attached.

14. The field diaphragm block

The field diaphragm block (Figure 33 and Figure 34) has two components that may require maintenance: The upper collector lens may be dirty, and the field diaphragm may be sluggish or stuck.

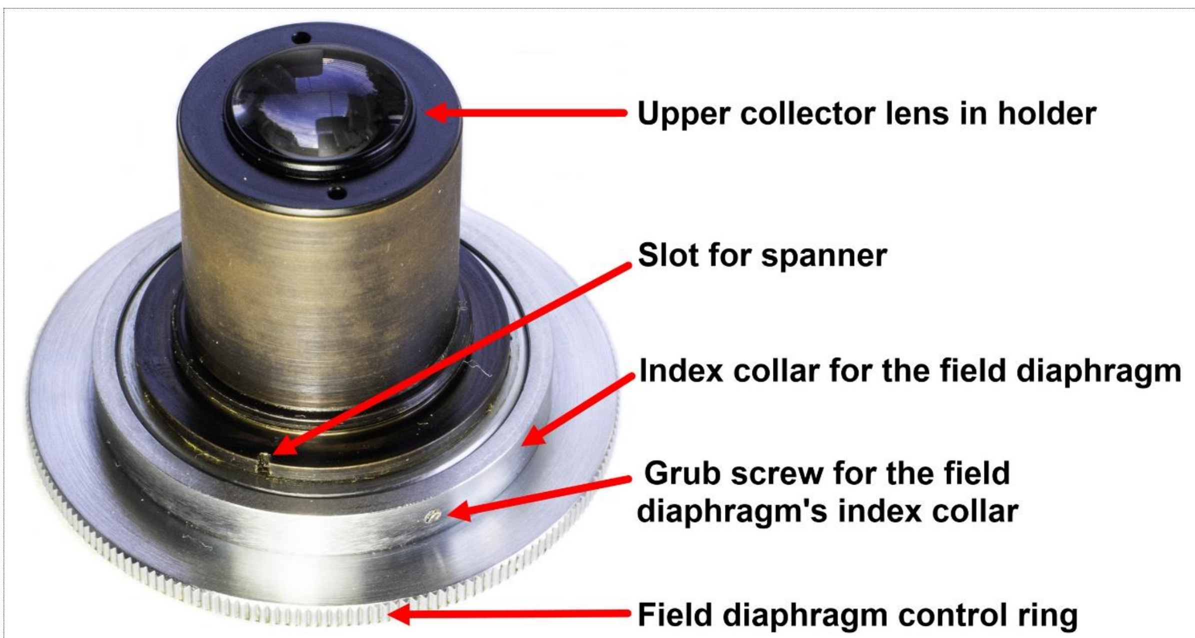


Figure 33: The field diaphragm block.

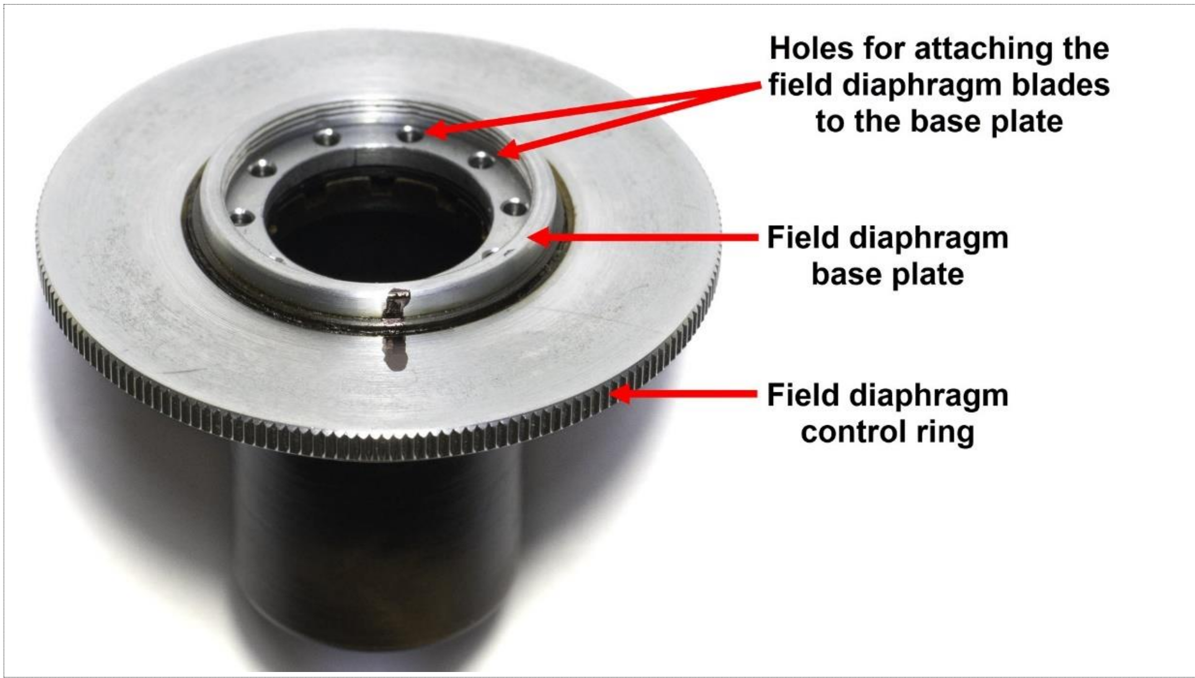


Figure 34: The underside of the field diaphragm block.

15. Remove and clean (if required) the upper collector lens on the field diaphragm block.

The upper collector lens in its black metal holder may need cleaning. Its upper surface can easily be cleaned while it is attached to the top of the field aperture block, but to access the lower side for cleaning the lens must be removed (Figure 35.) Remove the lens by unscrewing it with a face pin spanner (Figure 10) that fits into the holes on the top of the black lens mount (Figure 33), but be careful not to scratch the convex lens surface with the spanner. Clean the lens surface(s) as required using your preferred lens cleaning protocol.

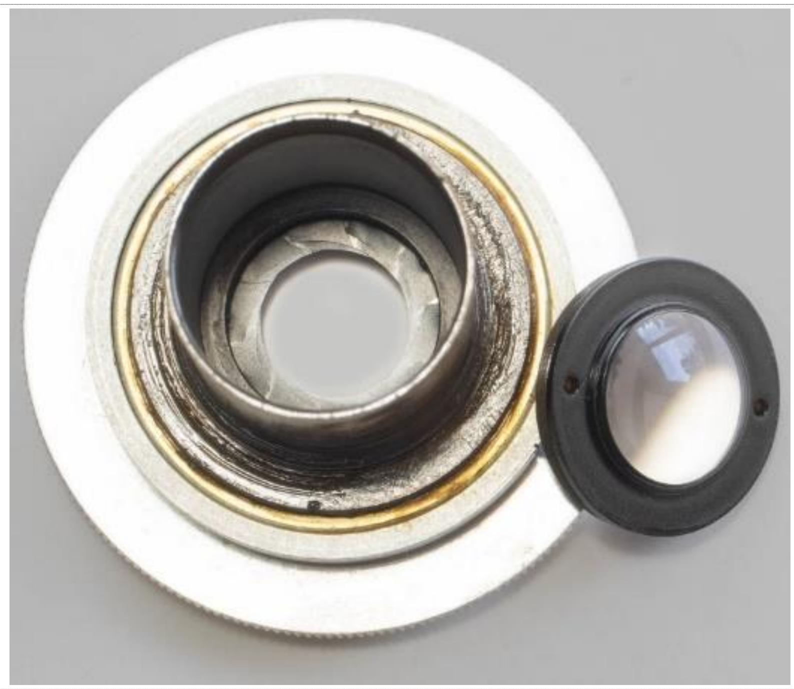


Figure 35: The field diaphragm block viewed from above after the upper collector lens has been removed.

16. Clean the field diaphragm.

Skip this subsection if the field diaphragm works as expected and moves smoothly.

Make sure that the upper collector lens has been removed as described above.

The index collar (the right item in Figure 36) has an index bar along the side (Figure 2) that indicates the opening of the field aperture against a scale on the condenser sleeve (Figure 1 and Figure 2.) After releasing a black grub screw in the collar's side, the collar can be turned to adjust the index bar position vs. the scale to appropriately reflect the field diaphragm opening (with a maximally closed field diaphragm the index bar should point to the scale number 1.)

Figure 36: The field diaphragm block after the index collar has been removed.

Use a 1.0 mm watchmaker type screwdriver to loosen the small grub screw and remove the index collar (Figure 36) from the field diaphragm block.

With the collar out of the way, the guide screw for the field diaphragm that was hidden under the collar becomes accessible (Figure 36 and Figure 37.) Remove the guide screw and then remove the field diaphragm control ring by unscrewing it from the underside of the field diaphragm block. The spanner slots in the rim of the field diaphragm block (Figure 33) are not needed for our purposes.

This leaves us with the field diaphragm block containing nothing else than the field diaphragm in its brass enclosure (the left item in Figure 37.)

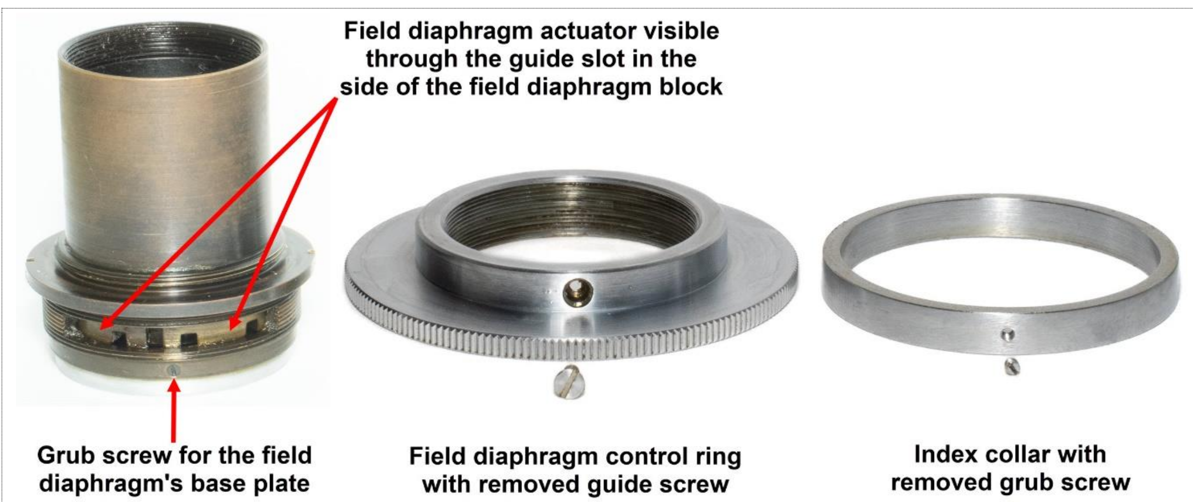


Figure 37: The field diaphragm block after the index collar has been removed.

The field diaphragm has 10 diaphragm blades, like the aperture diaphragm. The base plate (Figure 34 and Figure 39) that is attached to the bottom of the field diaphragm block is the stationary anchoring point for the diaphragm blades. The other ends of the diaphragm blades are held by the 10 slots on the underside of the brass actuator (the middle item in Figure 40.) The actuator rests in a greased ledge in the inside of the field diaphragm block and can be turned back and forth thereby determining the opening of the field diaphragm. Parts of the actuator can be seen through the guide slot on the side of the block (Figure 37) and by peeking down through the upper end of the block (Figure 38.)

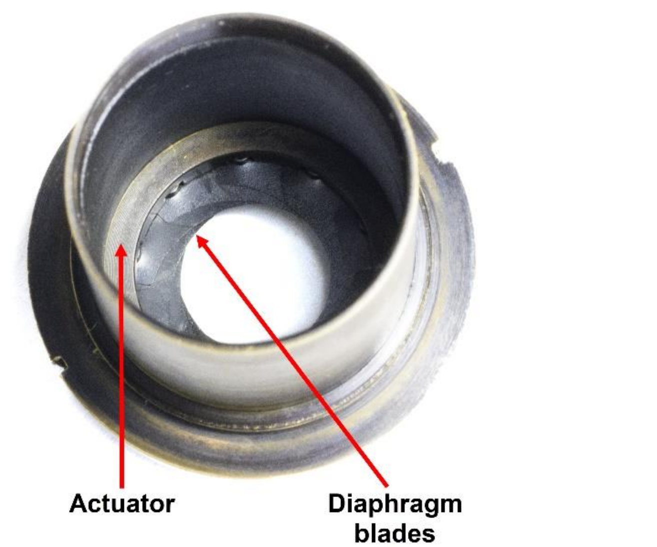


Figure 38: View down through the top of the field diaphragm block. The backside of the actuator and parts of the diaphragm blades can be seen.

Figure 39: The field diaphragm's base plate after it has been removed from the field diaphragm block. The diaphragm blades are loosely resting on the base plate.

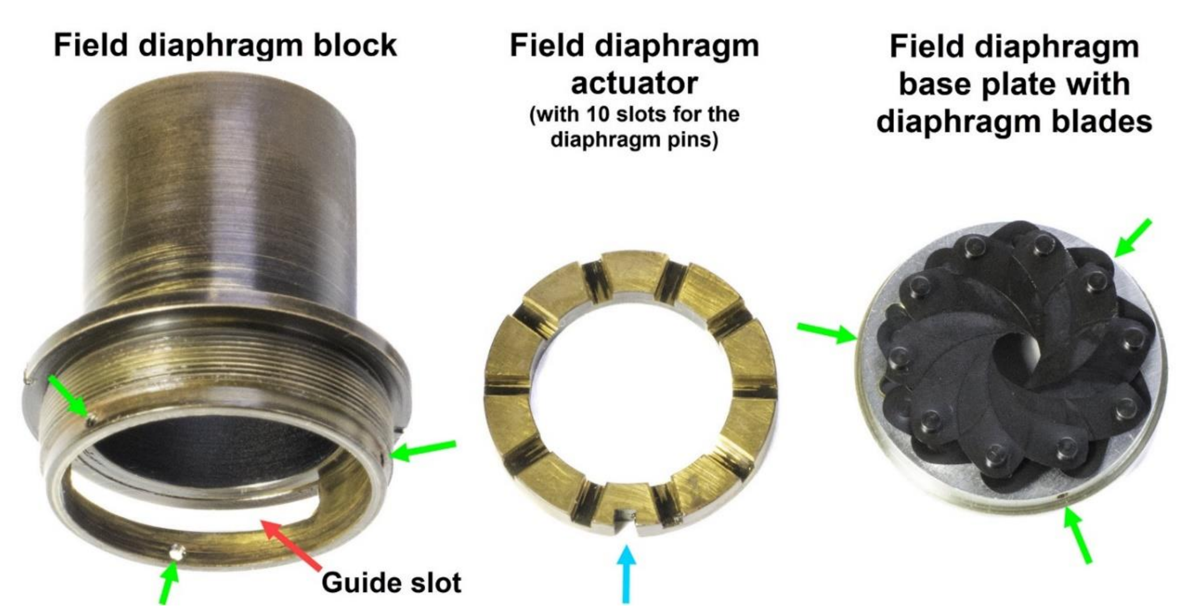


Figure 40: The field diaphragm after (partial) disassembly.

Green arrows: Locations for the grub screws that attach the base plate to the field diaphragm block.
Blue arrow: The indentation for the tip of the guide screw (in the field diaphragm control ring.)

The guide screw (Figure 36 and Figure 37) in the field diaphragm control ring goes through the guide slot (Figure 37 and Figure 40) in the field diaphragm block with the screw tip reaching down into an indentation (Figure 37 and Figure 40) in the side of the actuator. The screw tip forces the actuator to move along with the control ring as the ring turns. The guide slot protects the diaphragm blades by limiting the turning range of the actuator.

Similarly to the aperture diaphragm, we will describe two procedures for cleaning of the field diaphragm. The first method is an effort to release a stuck diaphragm by direct treatment with penetrating oil while it still sits attached in the field diaphragm block. The second method is more thorough and laborious as it involves a partial disassembly of the field diaphragm before accessing and cleaning its parts.

a. Quick treatment of the field diaphragm with penetrating oil while left safely attached in the field diaphragm block.

If possible close the field diaphragm. Carefully apply penetration oil (WD-40, CRC 5-56, or similar) to the field diaphragm blades with the help of cotton swabs or wood sticks. Make the blades visibly wet. Let the penetrating oil work for a few hours. Blot or wipe off excess oil and gently try to release the stuck diaphragm by putting a wooden toothpick through the guide slot and into the actuator's guide screw indentation and move the actuator back and forth. If the diaphragm still is stuck, apply fresh penetrating oil, and let it work for a longer time. Once the diaphragm moves, repeat the treatment at least two more times with fresh penetrating oil to further dissolve and remove any old, hardened grease. Close the field diaphragm and use dry cotton swabs to carefully wipe off as much as possible of the penetrating oil. Wet a cotton swab with a high quality, non-drying oil and dab it carefully and sparsely on the diaphragm blades. Spread the oil evenly over the blades by opening and closing the field diaphragm repeatedly. Don't overdo the oiling!

An alternative "quick cleaning" procedure is to dissolve the hardened grease by soaking the entire field diaphragm block in solvent.

Put the field diaphragm block with the field diaphragm into a glass jar and cover the diaphragm end with a solvent with good grease dissolving power (e.g., white spirit.) Let the solvent work for a couple of hours or days, as required, and occasionally gently try to get the actuator to move as described above. With this approach, not only any grease on the diaphragm blades will be removed, but also the grease on the actuator. Once the diaphragm moves freely, repeat the solvent soaking with fresh solvent at least two more times. Let the block and diaphragm dry completely - adding a last soaking with isopropanol will shorten the drying time. As desired, leave the diaphragm "dry" (unoiled), or lightly oil the diaphragm blades as described above.

b. Thorough cleaning of the aperture diaphragm after partial disassembly.

Most probably the "quick treatment" as described above will be good enough to get your field diaphragm in working condition. If not, then here follows the "thorough" procedure.

To physically access and clean the field diaphragm blades the field diaphragm must be removed from the field diaphragm block. In the removed field diaphragm, the actuator will sit loosely on top of the diaphragm blades and the field diaphragm's base plate. Removing the actuator from the blades on the base plate will leave the blades resting unsecured on the base plate. The blades will be kept in place only by gravity and by the pivot pins in the ends of the blades that sit in the holes in the base plate. Therefore, during work, make sure that the pivot pins are not allowed to come loose from the base plate holes. If they come loose, you will face the tedious task to reassemble all blades properly again onto the base plate.

Start by opening the field diaphragm fully by pushing with a toothpick in the actuator's guide screw indentation (green arrow in Figure 41.) Turn the aperture diaphragm block upside down as in Figure 41. Use a 1.0 - 1.2 mm screwdriver to remove the three grub screws around the rim of the block (Figure 40 and Figure 41) that hold the base plate attached. But don't remove the base plate! Hold the base plate with one finger so it doesn't fall out of the block and place the block on the table with the base plate down. You should now be able to see the actuator's back side in the inside of the block (Figure 38.) Use two wood sticks to push down on opposite sides of the actuator to keep it joined with the diaphragm and steadily resting on the table surface, and then carefully pull up the block only, so it releases from the diaphragm and can be removed. Done properly this should leave the intact field diaphragm on the table (Figure 43.)

Remove the actuator by carefully lifting it up from the diaphragm while holding down the diaphragm blades with toothpicks so they remain resting on the base plate (Figure 44.)

Figure 41: View on the underside of the field diaphragm block (brass) with the base plate (chromium-plated) facing upward.

Blue arrow: Points to one of the three grub screws that hold the field diaphragm base plate.
Green arrow: Points to the guide screw indentation in the side of the actuator.
Yellow arrow: The guide slot in the field diaphragm block.

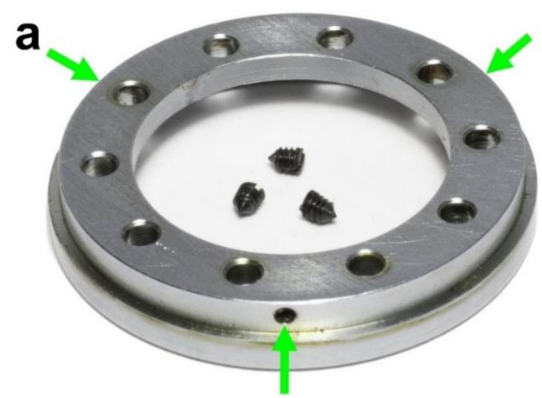


Figure 42: The underside of the field diaphragm base plate with the diaphragm blades removed.

The arrows point to the locations of the receiving depressions for the three grub screws that hold the base plate attached to the field diaphragm block.

Figure 43: The field diaphragm after the field diaphragm block has been removed. The diaphragm blades (not visible because the diaphragm is fully open) are between the actuator and the base plate.

Figure 44: The field diaphragm after the actuator has been removed.

Carefully put the base plate with the diaphragm blades into a glass jar and cover it all with a solvent that has good grease dissolving power (e.g., white spirit.) Let the solvent work for a couple of hours or days, as required. Gently poke the diaphragm blades with a toothpick and try to move their loose ends back and forth sideways to let the solvent penetrate, but be careful not to let the pins of the stationary ends of the blades come off from the base plate. Once the diaphragm blades appear to move freely, repeat the solvent soaking with fresh solvent at least two more times. Let the block and diaphragm dry completely - adding a last soaking with isopropanol will shorten the drying time (Figure 45.)

Figure 45: The field diaphragm base plate and blades after solvent soaking and drying.

Figure 46: The field diaphragm after the sleeve has been attached.

Figure 47: The field diaphragm after the diaphragm blades have been moved outward as far as possible within the PVC sleeve.

Carefully open up the PVC sleeve (Figure 9) described in section Some Special Equipment and attach it around the rim of the base plate just on top of the flange (Figure 46 and Figure 48.) Be careful not to disturb the diaphragm blades. The stiff PVC sleeve should lightly pinch around the base plate, so it doesn't fall off easily. Properly attached the sleeve will have the same inner diameter as the field diaphragm block which greatly helps when the actuator is reattached over the diaphragm blades. The sleeve also prevents the diaphragm blades from accidentally spread too far outward.

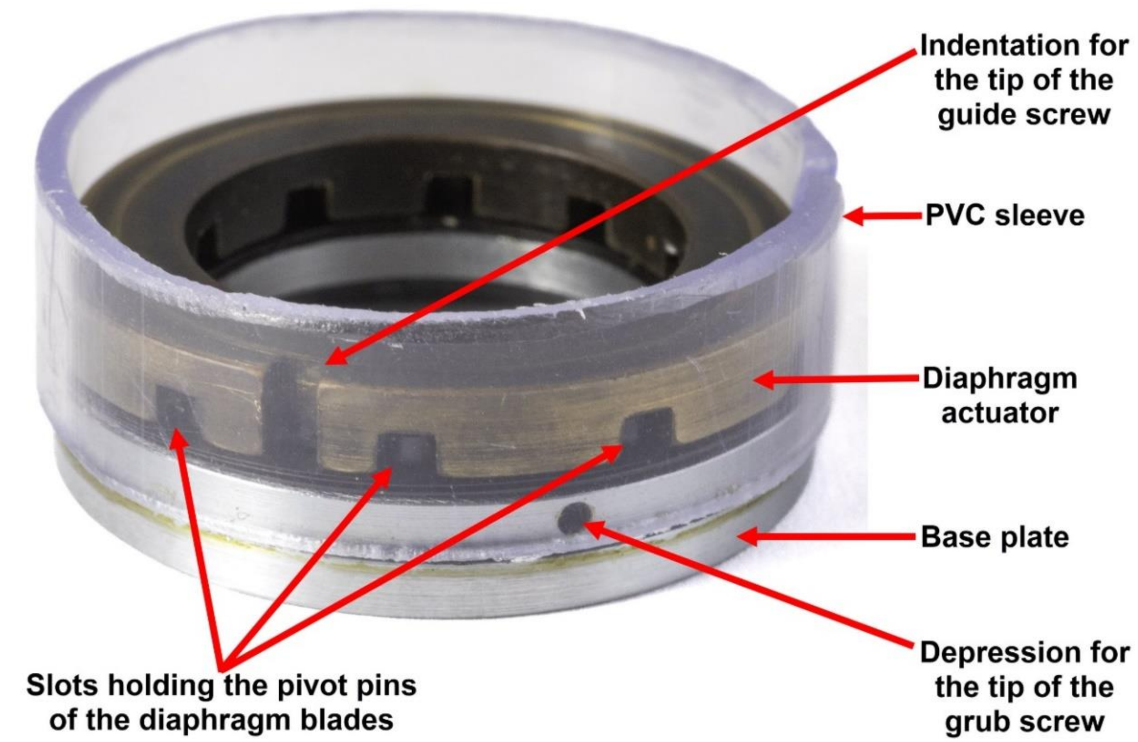


Figure 48: The field diaphragm with the PVC sleeve attached.

Use a toothpick to carefully push the loose ends of the blades outward as far as possible against the PVC sleeve (Figure 47.) The sleeve will keep the blade ends evenly distributed so all upward facing pivot pins neatly will fit onto the corresponding slots in the actuator.

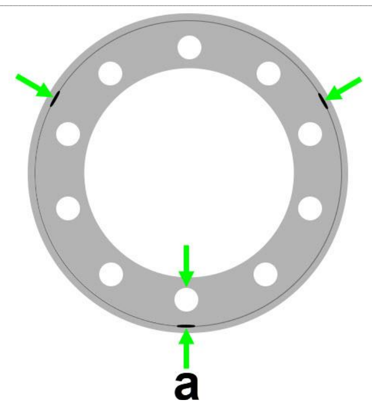


Figure 49: The field diaphragm base plate (without the diaphragm blades.)

The three arrows on the outside point to the three depressions for the grub screws.

Figure 50: This grub screw depression is <u>not</u> adjacent to any pivot pin hole.

NOTE: For clarity the diaphragm blades are not included in these images – you should however <u>not</u> remove the blades from the base plate.

Figure 51: This grub screw depression is adjacent to one of the pivot pin holes. This is depression "a".

The actuator can however not be attached haphazardly onto the blades; of the 10 possible ways to attach it over the blade pins, only one is the correct position. The reason is that the built-in diaphragm range limiter involving the guide slot in the field diaphragm block (Figure 40 and Figure 41) and the guide screw (Figure 36) requires that the base plate and the actuator are properly oriented vs. the guide slot in the field diaphragm block.

Recall that along the periphery of the base plate there are three small depressions (Figure 42 and Figure 49) for the tips of the three grub screws that hold the base plate attached to the field diaphragm block. For the correct orientation of the base plate we need to identify the single depression that is exactly adjacent to one of the holes for the diaphragm blade pivot pins (Figure 50 and Figure 51) – let's call this depression "a". Use a marker pen to mark the location of this depression on the side and on the underside of the base plate.

Put the base plate with the PVC sleeve still attached on the table with the diaphragm blades facing upward. Check that the loose ends of all blades are pushed as far as possible against the sleeve as in Figure 47 – this corresponds to a fully open diaphragm. Put the actuator with its slots facing down lightly on top of the blades (without disturbing them) with the actuator rotated so its guide screw indentation (Figure 40) is adjacent to the second base plate pivot pin hole counter-clockwise from the base plate's "a" depression (Figure 52.) Attach the actuator so all slots on the underside catch the pivot pins of the diaphragm blades. In the case that your PVC sleeve is too narrow to comfortably allow you to join the actuator with the diaphragm blades, you can try to carefully remove the PVC sleeve before attaching the actuator.

Carefully remove the PVC sleeve from the field diaphragm (Figure 53.)

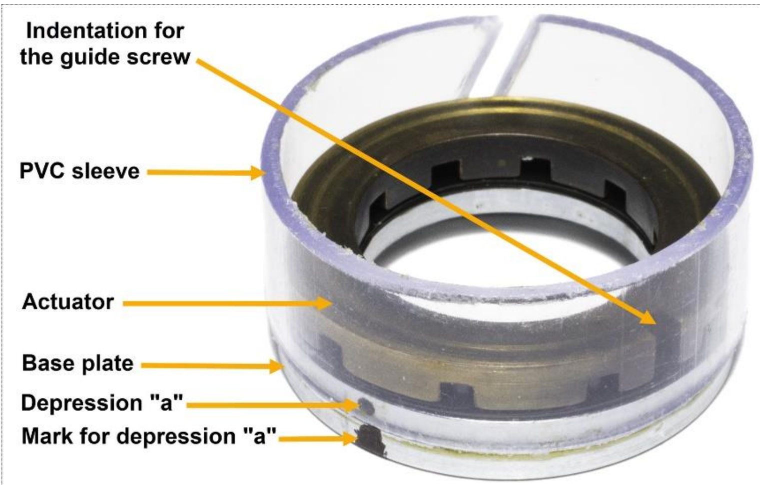


Figure 52: The field diaphragm after the actuator has been reattached. The image shows where the actuator's guide screw indentation should be positioned two pivot pin holes counterclockwise from depression "a"

Figure 53: The field diaphragm after the PVC sleeve has been removed. The actuator is correctly aligned with the base plate.

Attach the field diaphragm block over the field diaphragm's base plate – position it so the actuator's guide screw indentation is visible through the guide screw slot in the block (Figure 54.)

Hold the base plate with one finger so it doesn't fall out of the field diaphragm block and turn the block upside down so the diaphragm side faces upward (Figure 55.) Until the base plate is secured with the three grub screws make sure that the base plate all the time safely rests in its place in the block. If it slips off, the diaphragm blades will come loose and require tedious realignment and reattaching.

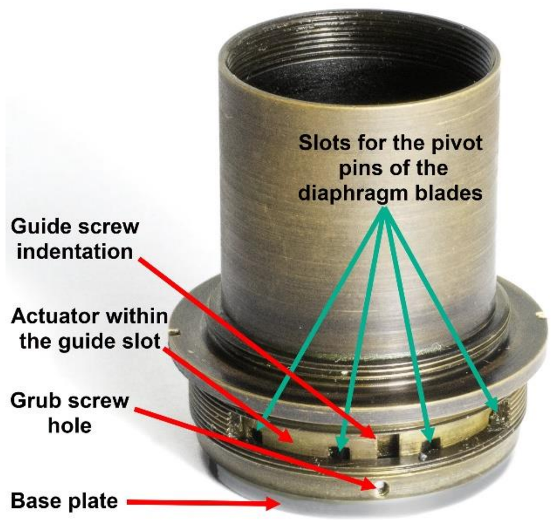


Figure 54: The field diaphragm just after the field diaphragm block has been attached over it.	*Figure 55: The field diaphragm block after the base plate has been properly aligned.*

Put a toothpick into the actuator's guide screw indentation (Figure 55) and push on the actuator to turn it counterclockwise, i.e. to the right, toward the end of the guide slot. Because the diaphragm already is fully open the actuator will also force the base plate to turn with it. (Make sure that the base plate remains seated on the block.) When the guide screw indentation comes close to the right end of the guide slot look into the grub screw hole above the guide slot (Figure 55) to see when one of the grub screw depressions in the base plate will appear just below the hole. This is the correct position for the base plate on the field diaphragm block - it ensures that the field diaphragm's range will remain only within safe limits.

To be sure that the diaphragm is correctly assembled, compare it with Figure 55 and check that the following criteria are fulfilled:

- The field diaphragm should be fully opened,
- the actuator's guide screw indentation should be almost all the way counterclockwise within the guide slot,
- the base plate's depression "a" should be at the 2 o'clock position when you are facing the guide slot, and
- one of the base plate's grub screw depressions should be visible through the block's grub screw hole that is facing you.

Secure the base plate to the block with the three black grub screws. Don't overtighten, the screw tips dig down quite reliably into the holes in the base plate.

Use a toothpick in the actuator's guide screw indentation to turn the actuator back and forth within the confines of the guide slot to check that the field diaphragm's range is appropriate (particularly so it is protected from damage by forcing it to close too far) and that the diaphragm moves smoothly.

If desired, lightly lubricate the diaphragm blades and the actuator with a high quality, non-drying oil. Spread the oil evenly by repeatedly opening and closing the diaphragm.

17. Reassemble the field diaphragm block.

Lightly grease (with, for example, Mobilgrease 28) the thread of the field diaphragm control ring (Figure 33, Figure 36 and Figure 37) and screw it onto the field diaphragm block as far as it goes (but don't tighten it.) Look into the control ring's hole for the guide screw and slowly unscrew the control ring until you see the indentation in the actuator's side through the screw hole. Attach the guide screw so its tip reaches all the way into the indentation. Turn the control ring to check that the diaphragm opens and closes as expected.

Put the index collar over the field diaphragm control ring (Figure 33, Figure 36 and Figure 37), attach the small shiny grub screw, and tighten it only very lightly. The index collar will later be adjusted against the diaphragm scale on the condenser sleeve (Figure 2.)

Reattach the upper condenser lens to the top of the field diaphragm block (Figure 33 and Figure 35.) Finger tightening it is good enough, there is no need to use a spanner.

18. Recombine the field diaphragm block with the aperture diaphragm block.

Screw the field diaphragm block into the bottom of the aperture diaphragm block. It may help to grease the thread lightly. Put the pins of a face pin spanner (Figure 10) steadily into any two holes situated on opposite sides on the bottom of the field diaphragm's base plate (Figure 14) and carefully tighten the field diaphragm block to the aperture diaphragm block. Don't overtighten. Check that the aperture diaphragm lever moves freely.

19. Reassemble the entire condenser.

Close the field diaphragm as far as it goes, loosen the small grub screw on the index collar (Figure 33), turn the collar (without changing the field diaphragm) so its index bar is adjacent to the number "1" on the condenser sleeve's diaphragm scale, and tighten the grub screw.

Put the dovetail mount (Figure 1 and Figure 15) over the top of the condenser. Make sure it is turned correctly: The slanted sides of the mount should face upward, and the small distance screw on one of the rounded sides of the mount should face in the opposite direction of the centering knobs. Lightly grease the thread on the dovetail mount locking ring (Figure 15) and attach it over the mount. Use a face pin spanner (Figure 10) to carefully tighten it while checking that the mount remains correctly aligned. The dovetail should be solidly attached so it doesn't come loose during normal use of the condenser, but avoid overtightening.

Lightly grease and attach the centering screws/knobs (Figure 1) to the condenser.

Attach the lower collector lens to the condenser. Finger-tighten the lens.

If required, clean the protective glass window (Figure 12) and attach it to the condenser. Light finger-tightening it is adequate.

Attach the top element (Figure 1 and Figure 3) to the yoke.

Appendix: Disassemble and Clean the Top Element

It is possible to inspect the lens surfaces that are out of direct physical reach on the inside of the top element (Figure 3) by inspecting them from the outside using a stereo microscope. By moving the focus down below the top element's top surface first the underside of the upper lens can be inspected and then further down the upper side of the lower lens. The illumination strongly affects the visibility of any contamination or defects, try to illuminate from the bottom through the top element as well as from above, and vary the illumination angles.

After inspecting the inner lens surfaces you will need to decide whether they are clean enough as they are, or if they need cleaning.

I have only worked with six Berek condenser's so far (all purchased used and with unknown history), but it seems that it is not uncommon that the inner lens surfaces are covered with a hazy film, or small droplets (a bad case is illustrated in Figure 56), or they may even show signs of growth of mold. The good news is that the top element consists of two halves that are joined by a thread and therefore the inside lens surfaces may become accessible for cleaning (Figure 57.) The not so good news is that the halves may be difficult or even impossible to take apart without damage. Of the six mentioned Berek condensers only one top element could be disassembled by hand, four could be opened after some struggling with pliers, while the last top element remained stuck – trying hard to release it I only managed to damage it beyond repair. Here are a few factors that work against us:

- Oil and perhaps other unknown fluids may have penetrated into the thread between the top element halves. After many years these fluids may have hardened or dried into a resin- or glue-like residue.
- The top element is manufactured from brass which is a soft metal prone to bruising, deformation, and damage.
- It is <u>very difficult</u> to get a good grip with pliers around the only 1 mm wide rim (indicated by "A" in Figure 57) of the upper top element half.

Try first to unscrew the top element halves with your fingers only. Avoid touching any of the outer lens surfaces. A piece of a thin rubber mat (available in kitchen utensil shops and used to open cans with tight screw lids) around the conical part of the upper top element half can help you to get a firmer finger grip.

Next step up to escalate the efforts is to use pliers to get a good and safe grip around the top element halves, and then try to unscrew the halves without damaging them. It is now important to protect the top element from the sharp teeth of the pliers. Regular metal pliers will almost inevitably lead to damage. Some pliers are available with jaws that are lined with half-hard plastics, like polyethylene, polypropylene, or nylon – I have however found these unsuitable because the plastic tends to slightly deform and slip off from the very narrow (1 mm) rim of the top element's upper half. A better option would be to use combination pliers that are made of <u>hard</u> plastics. Unfortunately, such pliers are more difficult to find. If you have a choice, pick a small size, pick one that is as thin as possible, and make sure that the shape of the jaws and teeth appear suitable for the task. Preferably you should use two of these pliers, one to grip around the rim "A" (see Figure 57) and the other to grip around the knurled edge "B";

you could alternatively use steel pliers for the latter if you can manage to line the jaws with something that reliably will protect the brass from damage.

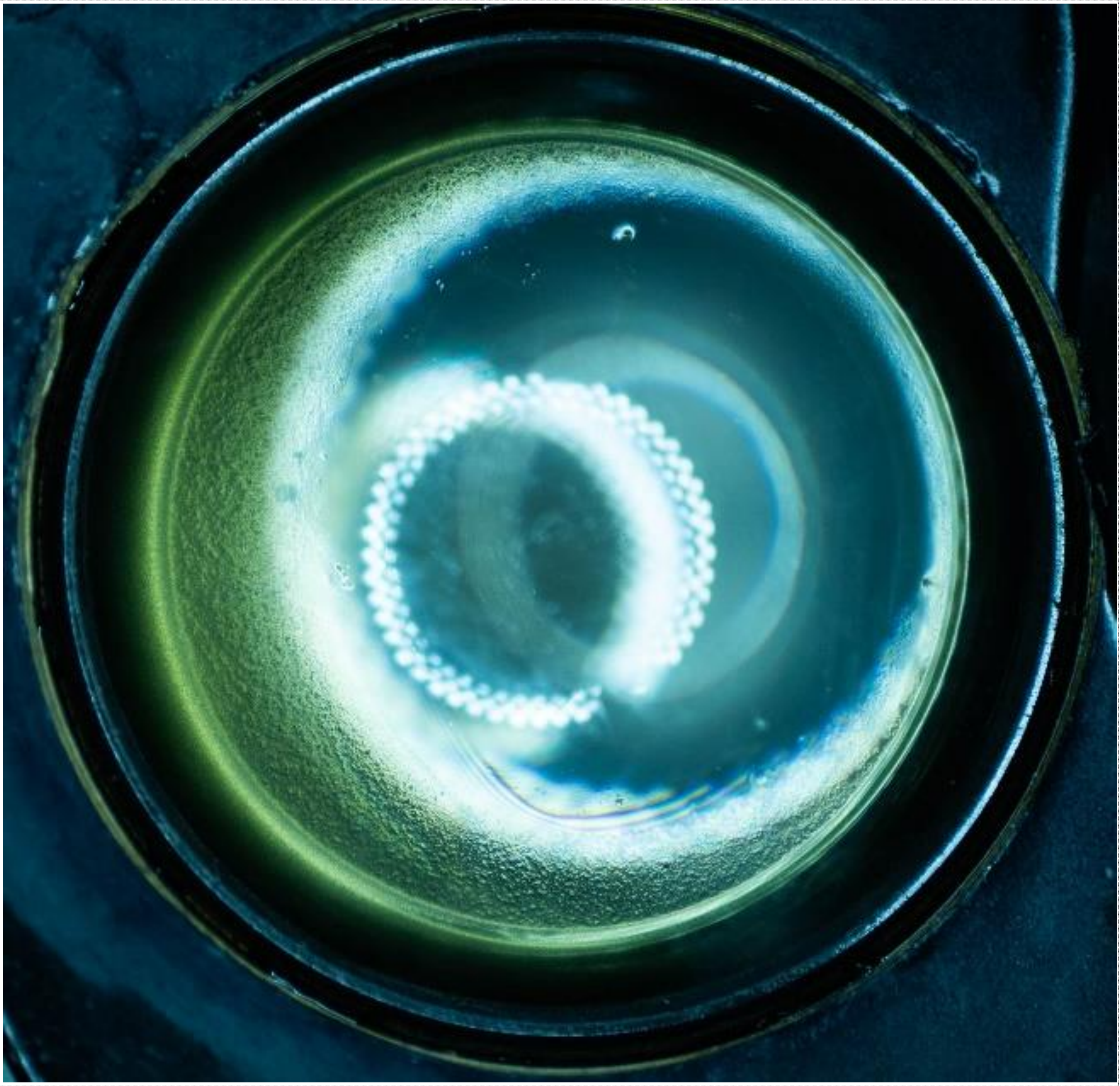


Figure 56: A stereo microscopic view of one of the top element's inner lens surfaces. The stereo microscope is focused below the upper lens' outer surface into the top element internals. The green crater-like structures along the left side look like a film of a contamination of unknown origin, perhaps penetration by immersion oil.

The bright dotted circles are artifacts due to reflections of the circular LED illumination.

For an improved grip (and protection) snugly apply an approx. 2 mm wide strip of double-sided tape around the rim (indicated by "A" in Figure 57) of the top element's upper half. Use one of the hard plastic pliers to firmly hold around the rim, use the other plastic plier to grip around the knurled edge of the lower half, and with steady hands try to release and unscrew the halves. Be very careful to avoid slipping, the pliers around the rim "A" of the upper half are particularly difficult to keep firmly attached. It helps to press the pliers against each other. And, above all, protect the lens surfaces from scratches.

If the halves still are stuck your only options are to either give up, or to proceed with alternative (and probably more brutal) methods until you either succeed or damage the top element.

Once the top element halves are separated clean the released threads with cotton swabs wetted with solvent. Proceed by cleaning the inner lens surfaces with cotton swabs wetted with lens cleaning solution or a suitable solvent (for example, isopropanol.)

Wait one day before reattaching the top element halves to be sure that all traces of the lens cleaning solution/solvent have evaporated.

Figure 57: How the top element can be separated into two halves.

A = 1 mm wide rim of the top element's upper half. The diameter of the rim is 14 mm.
B = Knurled edge of the top element's lower half. The diameter of the knurled edge is approx. 15 mm.
S = Slit that separates the top element's two halves.

References

A very nice general read with praise for the Berek condenser on page 20:
The Excellent Leitz Microscopes with Black Enamel Finish, by Overney, N., and Overney, G., (2011)

Two interesting threads in Internet fora (the latter is in German) about Berek condensers:
https://www.microbehunter.com/microscopy-forum/viewtopic.php?t=9002
https://www.mikroskopie-forum.de/index.php?topic=7076 (in German)

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