Leitz Ortholux XY-Stage Maintenance Notes

The “black era” Leitz Ortholux microscopes were manufactured from approx. 1937 to 1974. Although all Ortholux microscopes (except the later Ortholux II) look similar from the outside, Leitz’ ongoing product development/improvement efforts led to several design differences through the years.

Scope

These maintenance notes describe the disassembly, cleaning, greasing and reassembly of the XY-stage of a 1947 Ortholux microscope, i.e., a rather early-stage model before coaxial stage controls were introduced.

XY-Stage Introduction

The older XY-stage model (manufactured until approx. 1950) described in these maintenance notes has separate controls for X and Y axis movements (Figure 1 and Figure 2.) The stage has linear ball bearings for the Y axis movement (forward-and-backward) and a quite long slide for the X axis movements (side-ways). Ball bearings have much less friction resistance than slides, so to equalize the feelings of the X and Y axis stage movements one should consider making the ball bearing more sluggish while facilitating the slide movements as much as possible. This can be accomplished 1) by selecting a medium to high viscosity grease for the ball bearings and a very low viscosity grease for the slide, and 2) by using a high viscosity grease for the Y axis pinion axle and a medium viscosity grease for the X axis pinion axle.

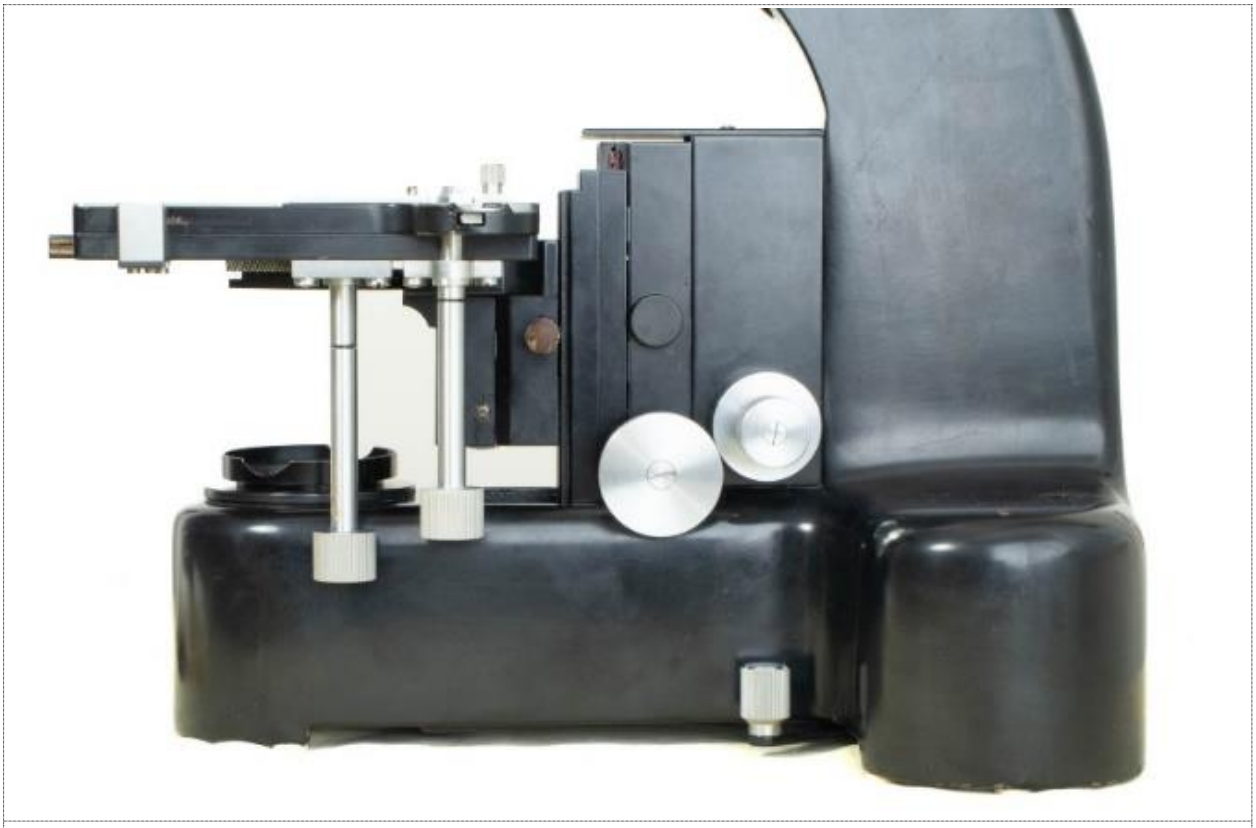

Figure 1: Microscope base with the stage.

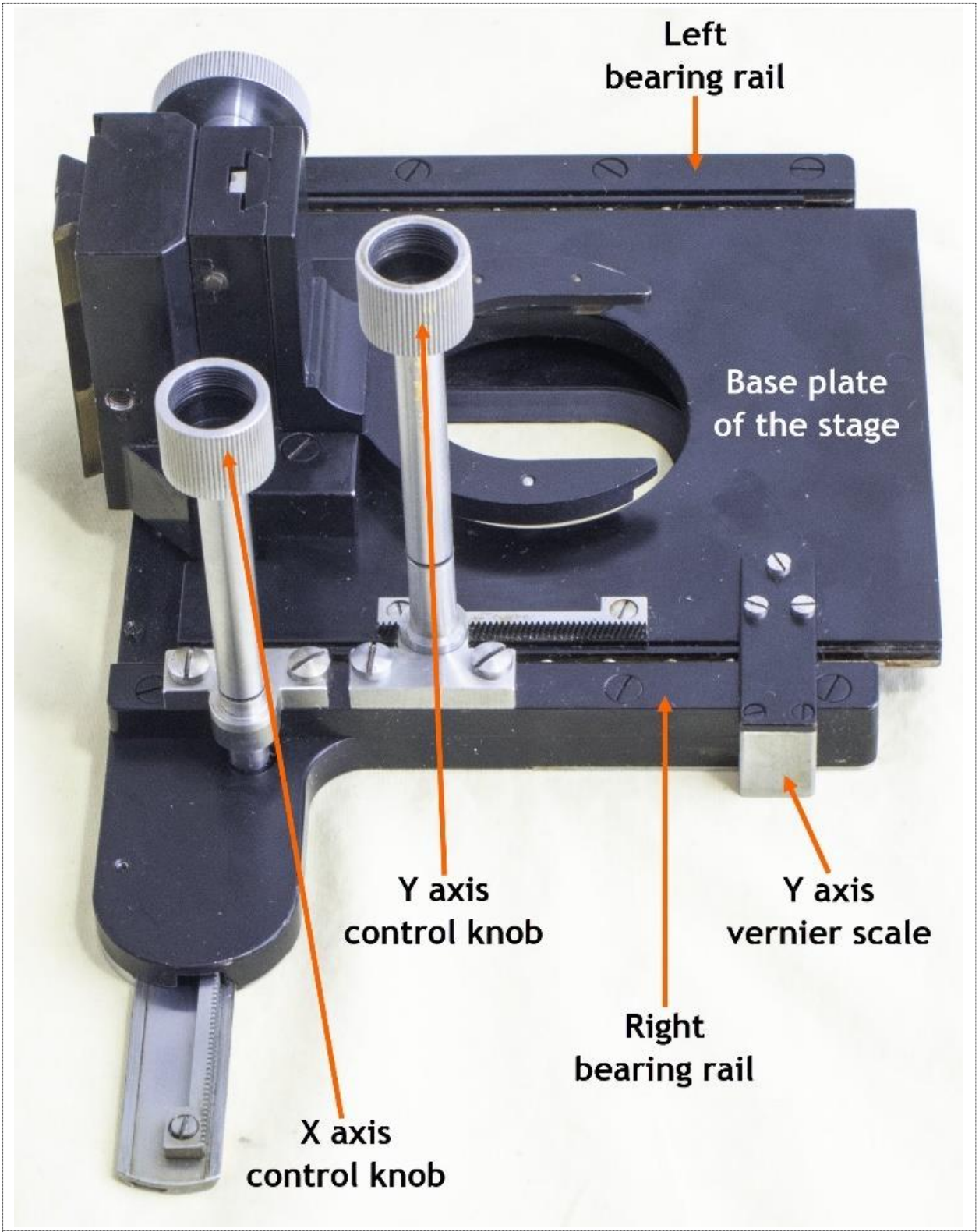

Figure 2: XY-stage (view of its underside).

Grease

The various greases used are described in the notes. Feel free to use other greases of your preference.

Control knobs

Control knobs from the Leitz black era microscopes are usually made of nickel or chromium plated brass. After many years of service, the knurled circumferences of these knobs have often caught and accumulated dirt, sweat and fat from the user's fingers. After the knobs have been removed, they can be cleaned by soaking in warm water with dishwashing detergent and brushing along the grooves with a hard toothbrush. It the knobs are still attached to the microscope cleaning becomes more difficult but can be accomplished by wrapping the knob circumferences in cloth strips wetted with water and detergent, and subsequent brushing in the direction away from the microscope. Never use a steel brush to clean these knobs - the plating is sensitive to scratches.

Remove the XY-stage from the microscope

Loosen the stage clamp screw and remove the stage assembly (which includes the condenser holder) from the microscope's dovetail.

Remove both object glass clamps from the stage by loosening the locking screws and sliding the clamps sideways and off the stage.

Turn the stage upside-down and remove the Y axis vernier scale (Figure 2).

Remove, clean and grease the stage controls

Remove both stage controls from the stage (Figure 2) by taking out the screws that attach the controls to the stage (Figure 3). Then the controls can simply by lifted out from their racks.

Disassemble both controls by first using a screwdriver to remove the slotted nuts (Figure 4) that sit approx. 5 cm down within the control knobs' hollow shafts. The pinion axles will probably not release immediately, but instead be stuck in the shafts. To release them, carefully heat the lower end of the shaft with an electric heat gun, then insert a small steel rod with an approximate diameter of 4 mm (e.g., an old scrapped 5/32" drill bit) into the knob end of the shaft and tap the rod carefully with a small hammer.

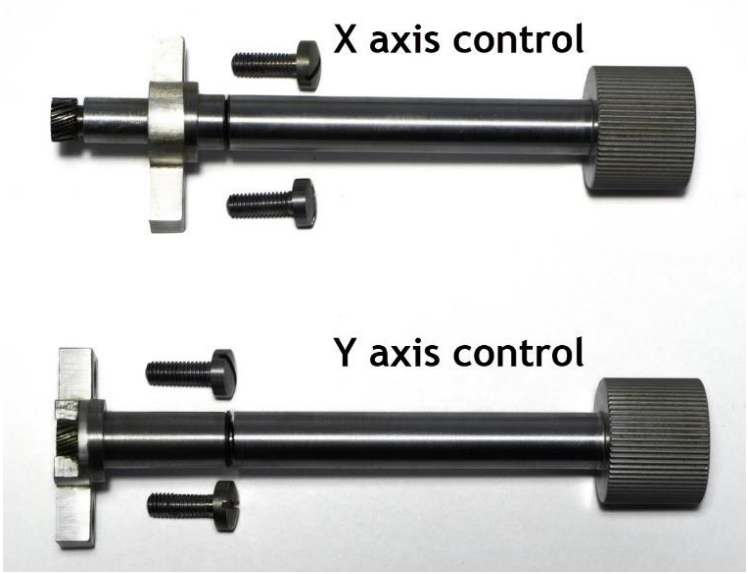

Figure 3: The stage controls after removal from the stage.

Collect all pieces (Figure 5; tapered pinion axle, control holder, one or two washers, control knob, slotted nut) and clean them with solvent (e.g., white spirit) to remove old grease. Even after solvent cleaning the crevices between the pinion teeth may still have some remaining deposits. If that is the case, scrape off the deposits with a steel needle (a magnifier is quite helpful for this), soak the pinion axle in warm water with dish detergent (an ultrasonic cleaning bath would be ideal), scrub the pinion teeth with an old hard toothbrush, and allow the axle to dry.

Figure 4: Close-up of the slotted nuts.

Figure 5: The stage controls taken apart.

Apply grease on the tapered pinion axle and the washer(s). Use a somewhat viscous grease – the thickness of the grease in the controls will help to determine the degree of resistance in the stage movements. I choose to use the moderately viscous Super Lube Multi-Purpose Grease with Syncolon (NLGI grade 2) for the X axis control and the highly viscous NyoGel 767A for the Y axis control. Stick the greased pinion axle through the control holder (which functions as a plain bearing). Add the washer(s) and wipe off any excessive grease left on the axle. Holding the axle firmly pressed into the control holder, slip the axle into the control knob's hollow shaft, and through the knob end of the shaft attach the slotted nut to the pinion axle's thread. Hold the pinion tight (perhaps wrapped in a piece of cloth to save your fingers) and tighten the nut. Make it enough tight so the axle doesn't slip in the knob shaft (i.e., with no axial play) during routine microscope use, but don't overdo it.

If the stage control shows any axial play, it should be remedied by adding one or two thin spring washers, either Belleville (conical dish) washers, or alternatively curved or wave spring washers.

Don't yet attach the stage controls to the stage.

Clean, grease and reassemble the Y axis ball bearings

Place the stage with the underside facing up as in Figure 2. Remove the left ball bearing rail (that's the rail on the opposite of the side where the controls are) after completely taking out the four main screws (facing upwards in Figure 2) and loosening the three lateral tension screws (with the large heads) by 1-2 mm. The three lateral tension screws determine the lateral pressure ("squeeze") applied over the Y axis ball bearings. Retrieve the bearing balls (10 balls with 4.1 mm diameter) and the brass bearing retainer. Carefully lift off the stage's base plate and retrieve the corresponding bearing parts from the other (right) side. (The rail on this side doesn't need to be removed from the base plate.) Soak all 20 balls and both retainers in strong solvent (e.g., white spirit) and clean them with a piece of cloth wetted with the solvent. Wipe the bearing balls dry with a lint-free microfiber cloth (don't use paper towels – they leave a lot of tiny paper fibers on the surface of the balls.) The surfaces of the brass retainers will probably be tarnished by dark oxidation deposits. These deposits don't hamper the function but may optionally be removed by a polishing agent (e.g., Autosol) or a very fine sandpaper – be sure to thoroughly remove any remaining abrasives after polishing.

Also thoroughly remove any old grease from all four bearing races.

Use some support to tilt the stage sideways (roughly 45°) so the side where the controls are (the right side) is lower than the opposite side (the left side), but with the right bearing still horizontal. Apply fresh grease (Super Lube Multi-Purpose Grease with Syncolon) on all four bearing races. Apply the same grease to both sides of one of the brass bearing retainers. Make sure that the retainer holes get some grease – this will help to hold the bearing balls in place during assembly. Press the retainer into the grease approximately in the middle of the bearing race on the right bearing rail. The grease will hold the retainer in place. Using forceps place the 10 bearing balls into the retainer holes. This is somewhat tricky as the retainer holes are facing partly sideways, but the grease will help to keep the balls in place. Use a pointed toothpick to push each of the balls to the bottom of the retainer holes – this ensures that the balls stick and don't fall out too easily, and also aligns the retainer properly with the race groove.

Carefully align the bearing race of the stage's base plate against the race with the freshly added bearing balls and push them together. This step is somewhat critical because it is important that the races join with proper alignment and with all bearing balls properly seated. Once joined, don't allow the races to separate - if they separate, some of the balls will most probably dislodge and force you to reposition the retainers and balls. Thanks to the tilted stage, gravity will help to hold the bearing tight.

Next, apply the same grease to both sides of the other brass bearing retainer. As before, make sure that the retainer holes get some grease. Press the retainer into the grease approximately in the middle of the base plate's left bearing race. Use forceps to place the remaining 10 bearing balls into the retainer holes and use a pointed toothpick push them to the bottom of the holes.

Carefully slip the race of the left bearing rail against the left race of the base plate - the space is somewhat limited by the three lateral tension screws which still should remain loosened by 1-2 mm. And again, once attached, don't allow the bearing to separate. Use the four corresponding screws to attach the left bearing rail to the stage. Don't fully tighten the screws, leave them just barely loose. The screws should be tight enough to hold the rail attached to the base plate without play, but still loose enough so it can slide slightly sideways for the adjustment of the tension over the bearing. Now tighten the three lateral tension screws but leave them just barely loose. At this stage the bearings can't separate anymore because they are kept in place by the 7 screws. Successively tighten the three lateral

tension screws until the Y axis slide is tight without shearing. The lateral tension screws determine the tightness over the bearings; the Y axis movement should be smooth but must at the same time be completely free from play. Don't hesitate to redo this a few times, if necessary; it is a trial-and-error exercise. Once the lateral tightness feels good, fully tighten the remaining four screws to finally secure the left bearing rail to the stage.

Clean, grease and reassemble the X axis slide

Put the stage on the table with its specimen side facing up, like in Figure 6.

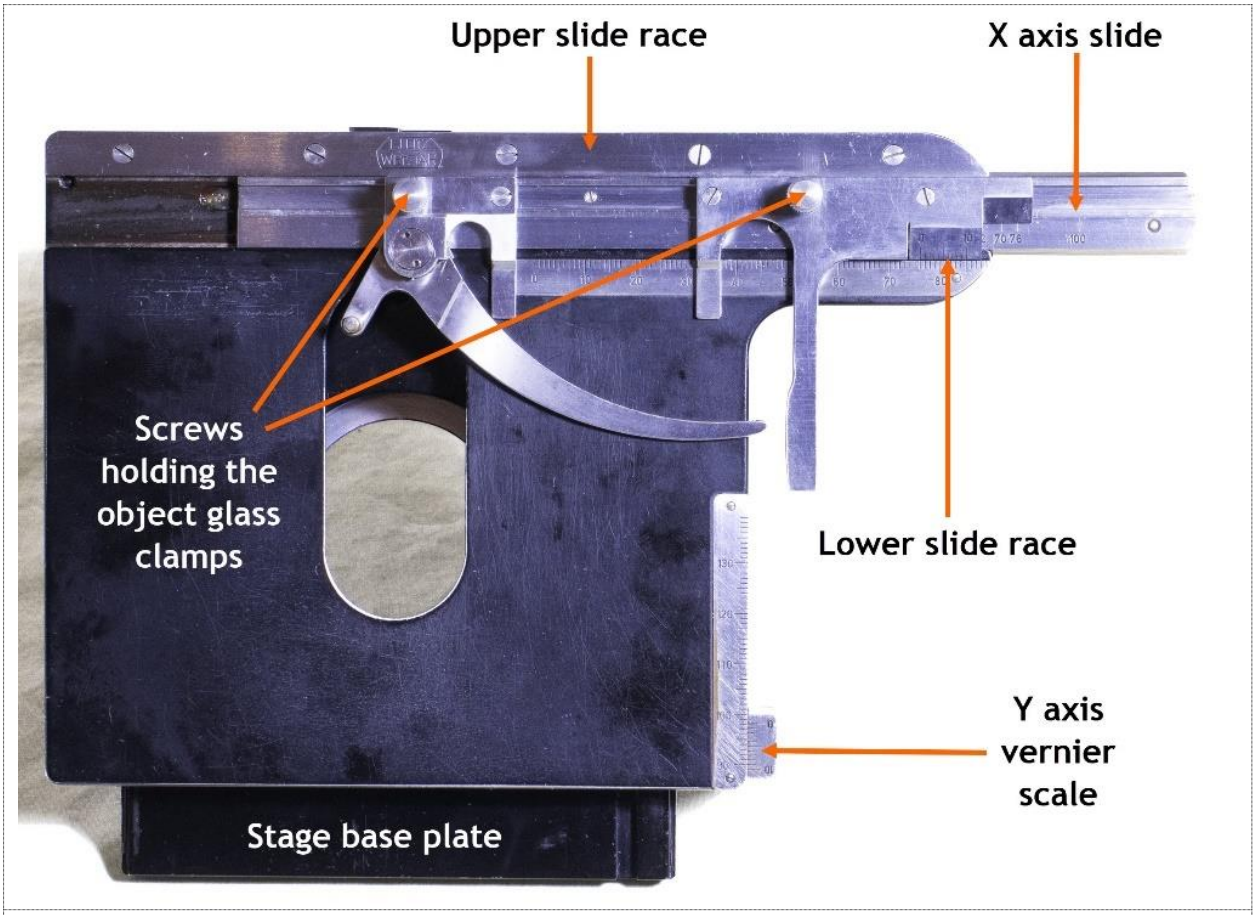

Figure 6: XY-stage (view of the top).

The object glass clamps should already have been removed. Remove the five screws that hold the upper slide race and remove the race. Remove the X axis slide; its underside has a rack and a range limiting arrangement so some wiggling may be needed to release it. If any of the stage's shiny nickel or chromium plated surfaces appear tarnished, they can be carefully polished with a piece of cloth or cotton swabs wetted with a suitable metal polish (for example, Autosol.) Be sure to remove any remaining abrasives by cleaning with isopropanol.

Clean all available surfaces with solvent and let the parts dry. Apply low viscosity grease (Mobilgrease 28) on all sliding surfaces. Apply Super Lube Multi-Purpose Grease with Syncolon to the rack on the underside of the slide. Reassemble the slide and the upper slide race. Check that the slide moves lightly.

Attach the stage controls

Attach first the X axis control to the stage with the two corresponding screws, but keep the screws slightly loose, leave them at the point just before they start to tighten. During adjustment of the tightness between the rack and the pinion we will take advantage of the play in the control holder's screw holes. Push the control holder with your finger against the rack (assuming that the screws mentioned above are not too tight), and then turn the knob to move the X axis stage back and forth as much as it goes. The fit through the entire range should be tight enough to avoid play, but not too tight. To much tightness is indicated by the knob getting a jerky feeling when turned, particularly at the endpoints of the stage movement. Vary your pressure on the control holder, keep turning the knob all the way back and forth, while successively tightening the screws. Give the screws a final tightening once it feels satisfactory.

Proceed with the Y axis control by first applying Super Lube Multi-Purpose Grease with Syncolon to the rack that is attached on the underside of the base plate. Continue with the same alignment and attachment procedure as was done above with the Y axis control.

Reattach the Y axis vernier scale to the stage using the three corresponding screws. Before final tightening of the screws align the two scales so they are close but without rubbing against each other.

Reattach the object glass clamps by pushing them onto the small slide on top of the X axis slide (don't grease this small slide!) Position the clamps as desired on the slide and lock them in by tightening the locking screws.

Comment on the object glass clamp

I found two interesting issues (Figure 7) on the object glass clamp belonging to the stage I worked with , both related to what appears to be normal wear after many years of intense service. A rather thin metal stop on the spring-loaded object glass clamp had broken and become bent. As a result, the moving arm got a more closed resting position than originally designed. It's not a critical flaw, and could probably be fixed in the hands of a skilled fine mechanic. The other issue is an indentation on the inside of the clamp arm. It was obviously created by routine wear against thousands of object glass corners. As a temporary fix I filled the hole with steel reinforced epoxy putty (J-B Weld SteelStik) and filed and sanded it down to be as close as possible to its original shape. A more permanent repair could probably be attempted with something like silver brazing. If a thinner arm could be accepted, grinding could be used to eliminate the hole while still retaining the arm's curvature.

When checking the status of a used microscope, inspecting the wear of the clamp arm could be a useful indicator of how much the microscope has been used through its lifetime.

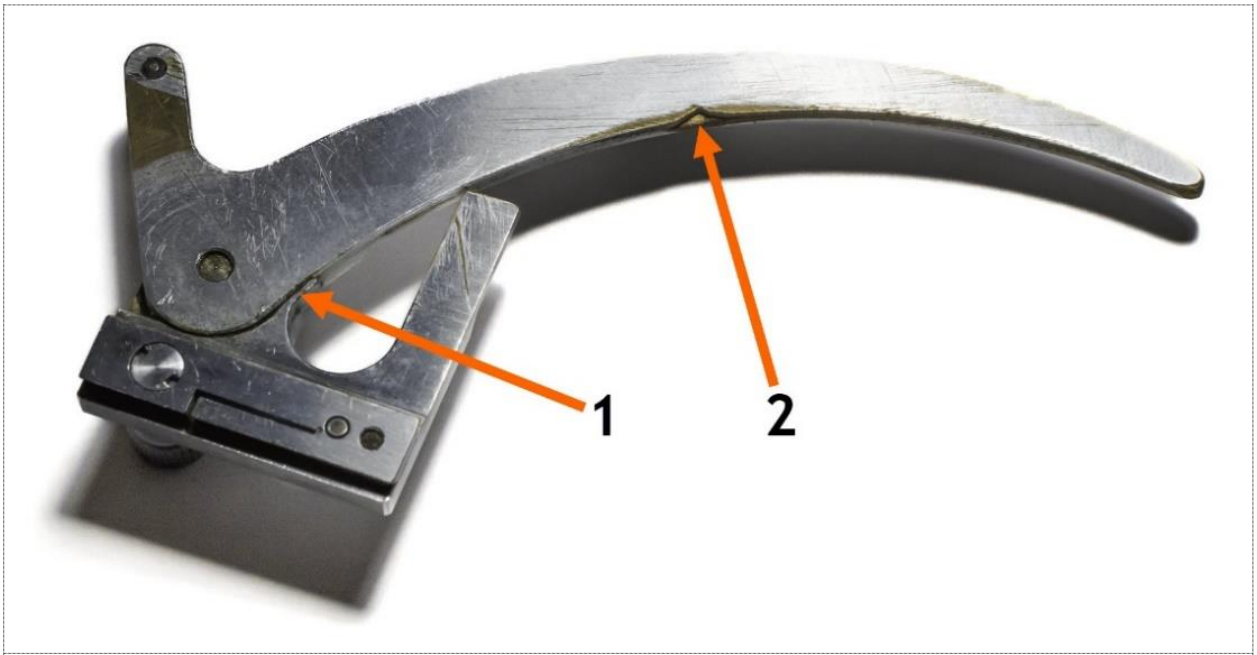

Figure 7: Underside of the object glass clamp showing two defects that indicate long time use:
1. Broken/bent metal stop allowing the clamp to collapse towards a more closed resting position.
2. Indentation due to abrasion wear against sharp object glass corners.

Figure 8: The underside of another even more worn object glass clamp.