Leitz Magnification Changer

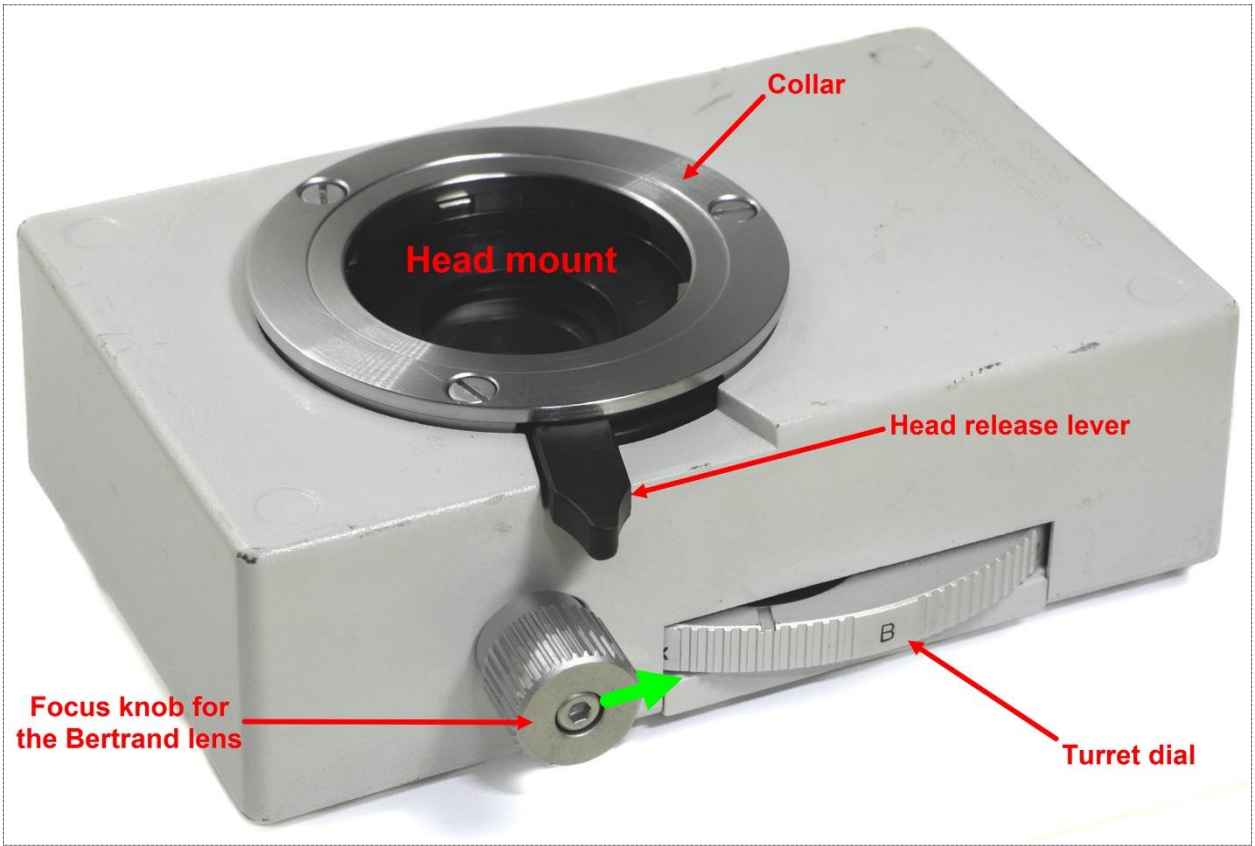

Figure 1: Leitz Magnification Changer, cat. no. 512 683, for Leitz microscopes with 160 mm mechanical tube length.

Figure 2: View of the Magnification Changer's bottom side with its 42 mm male dovetail mount.

Leitz Magnification Changer (Figure 1 and Figure 2) was Leitz' response to Zeiss' very popular and versatile Optovar magnification changer. The Leitz Magnification Changer, *Vergrößerungswechsler* in German, with cat. no. 512 683, is an optical accessory that allows the user to choose between four fixed magnification factors, 1.0x, 1.25x, 1.6x and 2.0x, and also a focusable Bertrand lens. It is designed for microscopes from the 160 mm mechanical tube length era. Its underside has a male 42 mm dovetail mount, while its upper side has a 42 mm female dovetail mount with the same head release lever as is found on the Leitz microscope stands from this era. Glass windows in both mounts protect the inside from dust. The Magnification Changer is supposed to be attached between the microscope stand's nosepiece and the microscope head.

In a similar way as in a typical phase contrast condenser, the Magnification Changer contains a five-position turret with detent stops for each of the five provided settings. To change between the settings the user simply turns the turret into the desired position as indicated by inscriptions along the edge of the turret dial (Figure 1.) The calculation of the microscope's resulting total magnification is straightforward, just include the Magnification Changer's magnification factor in the usual magnification equation, e.g., with a magnification factor of 1.25x, a 40x objective and a 10x eyepiece, the total magnification would be 40x · 10x · 1.25x = 500x. Because the angle of view is fixed and determined by the eyepiece, the microscope's field of view (by convention in mm units) instead becomes *reduced* by the magnification factor.

The Bertrand lens is used to observe the microscope objective's back focal plane, it is like a built-in phase telescope, but with the added convenience that it can be used without the need to swap back and forth between the regular eyepiece and the telescope eyepiece. It's most often used in polarizing microscopy to inspect interference patterns or in phase contrast microscopy to center and align the phase contrast rings. It is also quite useful for checking that the condenser's aperture diaphragm is properly set, for investigating defects (like dirt, delamination, or fungus) in objectives, and in some cases also for checking the centering of the illumination bulb. After the Bertrand lens has been positioned in the optical path (with "B" displayed on the turret dial as in Figure 1), then its focus can be adjusted with the knurled focus knob on the side of the Magnification Changer (Figure 1.) The focus knob pivots against a spring-load and must be pushed a few mm towards the turret dial (as shown by the green arrow in Figure 1) to engage with the Bertrand lens' focusing rack (Figure 8 and Figure 9) before the focus can be changed. If the focus knob is turned without the push nothing happens.

Scope

These maintenance notes describe the disassembly of the Leitz Magnification Changer to perform a few maintenance tasks. Here are some possible issues:

- Dirty optical surfaces (the protective glass windows in the upper and lower mounts, and also the external lens surfaces in any of the turret's five lens cases.)
- Sluggish or even stuck head release lever. The cause is typically aged, hardened grease.
- Sluggish focus mechanism for the Bertrand lens. The cause is typically aged, hardened grease.

Generally, the Magnification Changer however appears to be quite robust mechanically. The turning of the turret and the Betrand lens focusing tend to be smooth and problem-free even when the old grease clearly has degraded and become sticky.

Work Notes

1. Disassemble and clean the head release lever.

To access the inside of the Magnification Changer the head releasing mechanism must be disassembled and removed.

If the Magnification Changer has never been serviced, the head release lever (Figure 1) will probably be sluggish or even stuck.

Remove the three chromium plated M3x8 screws from the head collar (Figure 3) and remove the collar.

Below the collar sits the head release lever (made of brass) that moves the three small head clamps (Figure 4 and Figure 6.) The head release lever has a small pin that fits into one end of a spring. The other end of the spring is attached to the black base (Figure 5 and Figure 6.) The purpose of the spring is to push the lever to force the clamps to firmly hold any attached microscope head. Notice how the clamps are oriented (Figure 4 and Figure 6.)

Remove the head release lever and the three head clamps. The spring is difficult to remove from the base, so it is best to leave it where it is. Optionally, the black circular base (Figure 5 and Figure 6) can be left attached on the Magnification Changer, although removing it facilitates its cleaning. Note however that removing the base is required if you need to further disassemble the Magnification Changer. To remove the base, unscrew the three black M3x5 screws (indicated with orange circles in Figure 5) that hold it attached to the focus knob plate (Figure 7) just below.

Use white spirit to thoroughly clean off any old grease from the disassembled parts. Optionally, you could remove the dark tarnish (oxide layer) on the release lever (which is made of brass) by polishing it with a suitable metal polish (for example, Autosol or Peek.) After polishing wash the release lever with a brush and warm water with dish detergent – this is necessary to remove any remaining abrasives.

Figure 3: View of the upper side of the Magnification Changer.

Figure 4: View of the Magnification Changer's upper side after the collar has been removed.

Figure 5: View of the Magnification Changer's upper side after only the base has been left.

Figure 6: Exploded view of the disassembled head release mechanism parts.

2. Access the inside of the Magnification Changer.

Use a 2.5 mm hex (Allen) key to remove the M3x20 screw in the middle of the Bertrand lens focusing knob (Figure 1.) Remove the knob.

Remove the four self-tapping Philips screws from the bottom plate on the underside of the Magnification Changer (Figure 2.) Remove the plastic cover from the bottom plate. The turret with its five lens cases sits on a greased axle on the bottom plate and is held in place and covered by the focus knob plate (Figure 7 and Figure 8.)

Use a camera air blower to blow off any loose dust from the accessible optical surfaces. If required, use your preferred lens cleaning protocol to further clean any remaining dirt or film on the optics.

Figure 7: The Magnification Changer after the plastic cover has been removed.

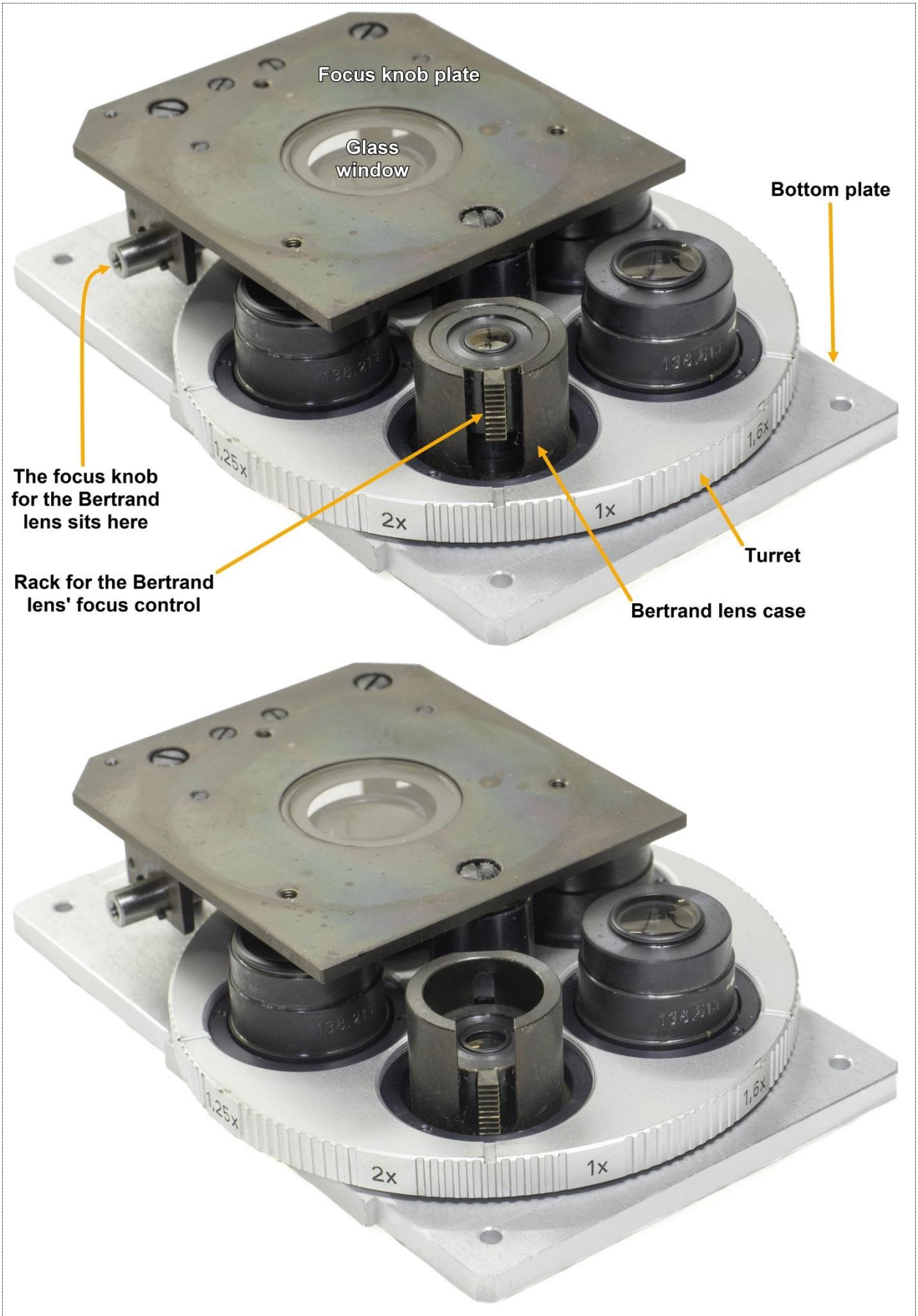

Figure 8: Oblique view of the Magnification Changer after the plastic cover has been removed. The only difference between the two images is that the Bertrand lens case is shown with different focus settings.

3. Disassemble the turret.

The turret must be removed from the bottom plate if you need 1) to clean either the lenses on the underside of the turret or the glass window in the bottom plate, or 2) to clean and regrease the turret's axle including the bearings, or 3) to clean and regrease the focus slide of the Bertrand lens case.

Remove the three black M3x4.5 screws (indicated with yellow circles in Figure 7) that hold the focus knob plate. Remove the focus knob plate. Be careful when collecting the three washers (Figure 9, but note that the washers may be different on different Magnification Changers) between the focus knob plate and the turret axle (Figure 11) below. The washers are greasy, and you need to protect the turret's lens cases from getting soiled.

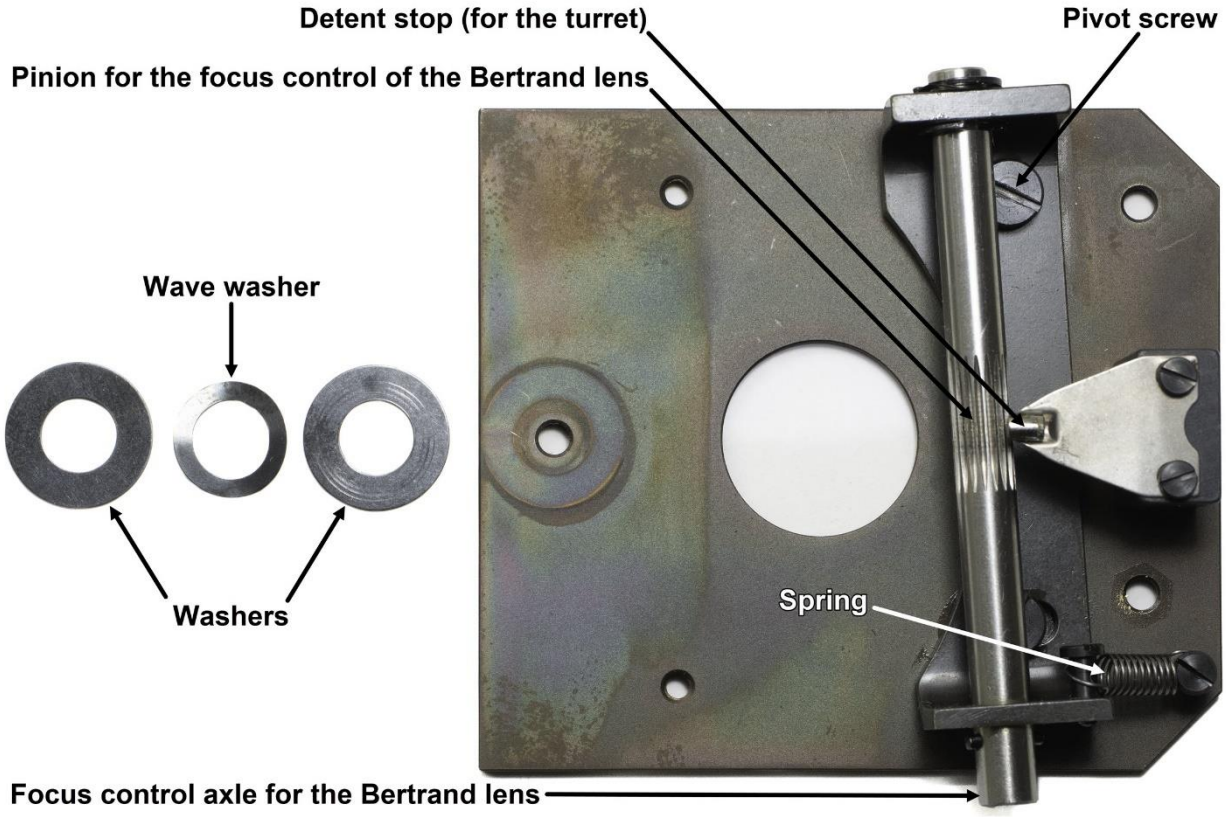

Figure 9: The underside if the focus knob plate.

The three washers in Figure 9 are well greased and comprise the plain bearing situated between the focus knob plate and the turret axle. The black steel wave washer (o.d. 12 mm, i.d. 8 mm, thickness 0.1 mm) is placed between two black regular washers (o.d. 15 mm, i.d. 7.5 mm, thickness 0.5 mm.)

On the underside of the focus knob plate (Figure 9), you will find the focus control mechanism for the Bertrand lens and a detent stop that ensures that the turret stops at exactly the proper centered positions. The mechanisms appear quite robust and should normally not need to be removed from the focus knob plate or disassembled. The detent stop has most probably been factory adjusted to stop the turret at its optimally centered positions, and this may be difficult to reproduce without the proper alignment tools.

As may be expected, the focus control mechanism (Figure 9) for the Bertrand lens only works when the turret is turned to put the Bertrand lens into the optical path. For focusing, the top of the Bertrand lens case can be moved vertically on a greased sleeve slide, as indicated in Figure 8. By pushing the Bertrand lens focus knob to the right (as the green arrow in Figure 1 indicates) the pinion (Figure 9) engages with the rack on the Bertrand lens case (Figure 8) and then by turning the knob the desired focus can be attained.

If the grease in the sleeve of the Bertrand lens case has aged and become so hard that it seriously hampers the focusing, then it may be necessary to clean and regrease the sleeve with fresh grease. I have actually not needed to do this, but here is what I believe would be required:

Figure 10: The Bertrand lens case on the turret.

Unscrew the black lead screw in the side of the Bertrand lens case (Figure 10) and pull out the case from the sleeve. Unfortunately the screw is difficult to reach with a regular, straight screwdriver because the turret axle is in the way. Either you will need to find an innovative way to release the screw with some improvised angled screwdriver (like a piece of sheet metal), or alternatively you will first need to remove the Bertrand lens case from the turret by removing the screws indicated with blue arrows in Figure 10. The latter alternative may however jeopardize any factory collimation of the Bertrand lens. Once the lead screw has been removed, pull up the Bertrand lens from the sleeve, thoroughly clean the sliding surfaces with white spirit and lightly regrease the slide (with, for example, Super Lube Multi-Purpose Synthetic Grease with Syncolon, NLGI Grade 2.) Push the lens case up and down in the sleeve several times to distribute the grease, wipe off any excess grease, and reattach the lead screw including any washers.

The detent stop mechanism is similar to what Leitz uses for their nose piece (objective) turrets. The detent stop (attached on the end of a flat spring, refer to Figure 9) snaps into the detent notches on the turret (Figure 11) to make sure that the lens cases always get properly aligned in the optical path.

The turret (Figure 12) sits on, and rotates around, the greased turret axle on the bottom plate (Figure 11.)

To remove the turret, grab it along the rim and turn it back and forth while carefully pulling it off from its axle. Remember to protect the lenses.

Left below the turret and resting on the bottom plate (perhaps parts of it will be sticking to the underside of the turret) you will find a ball bearing covered with old, gluey grease (Figure 13 and Figure 14.)

Figure 11: View of the turret sitting on the bottom plate's turret axle.

Figure 12: The turret with its five lens cases.

Figure 13: The bottom plate after the turret has been removed. Parts of the turret axle's ball bearing are now visible.

Figure 14: The components of the ball bearing that carries the turret. Starting from the bottom of the turret axle, and from the right side of the image:

- *Steel washer, o.d. 15.8 mm, i.d. 8.2 mm, thickness 0.6 mm*
- *Ball bearing retainer, transparent plastics, o.d. 17.9 mm, i.d. 7.9 mm, thickness 1.4 mm, containing 9 pcs of 2.0 mm steel bearing balls.*
- *Steel washer, o.d. 15.8 mm, i.d. 8.2 mm, thickness 0.6 mm*
- *Two black steel washers, each o.d. 16.0 mm, i.d. 8.2 mm, thickness 0.1 mm*

(Be aware that the washer configurations may be different on different Magnification Changers.)

Use white spirit to thoroughly clean off any old grease from the disassembled ball bearing components and from the turret axle.

If required, clean the lens surfaces of the turret's lens cases and the glass window in the Magnification Changer's bottom plate (Figure 13.)

4. Regrease the turret and reassemble the Magnification Changer.

Lubricate all ball bearing parts (Figure 14) with grease (for example, Super Lube Multi-Purpose Synthetic Grease with Syncolon, NLGI Grade 2) and assemble the parts over the bottom plate's turret axle. Starting from the bottom and up: 0.6 mm steel washer, the ball bearing retainer with all 9 balls, another 0.6 mm steel washer, and the two 0.1 mm black washers. Grease the turret axle. While turning the turret back and forth push it down over the axle as far as it goes. There will remain an approximately 1 mm gap between the bottom plate and the underside of the turret. Check that the turret rotates freely.

Grease the three black washers (Figure 9) and assemble them on the top of the turret axle (where the red "turret axle" arrow points in Figure 11.) The wave washer should be between the two regular washers. Check that the washers are centered over the turret axle and carefully place the focus knob plate (Figure 9) over the turret with the three screw holes aligned over the turret axle and the two brass spacers (Figure 11.) The alignment is easier to do if the focus knob plate's detent stop is engaged with one of the detent notches in the turret. Attach and tighten the three black M3x4.5 screws. Check that the turret still turns freely and stops as expected at the detent stops. Check that the Bertrand lens focusing works – this is best done with the focus knob temporarily attached to the pinion axle.

Attach the plastic cover using the four self-tapping Philips screws (Figure 2.)

Attach the black base to the upper side of the Magnification Changer using the three black M3x5 screws (Figure 5.) Make sure to have the base turned in the same way as indicated in Figure 5. The play in the screw holes allows the base to be adjusted laterally by approximately 1 mm – try to get the base properly centered before tightening the screws.

If you wish to lubricate the head release lever, then grease all sliding surfaces of the base, the brass lever, the three clamps, and the underside of the collar (Figure 6.)

Reassemble the head release lever and the clamps on the base. Check Figure 4 for getting the parts properly combined and make sure that the small pin on the lever is attached to the spring in the base. Attach the collar (with its three M3x8 screws) to hold the moving parts secured in place.

Reattach the Bertrand lens focusing knob to the pinion axle. It helps to guide the knob by putting a nail through the knob's screw hole and into the pinion axle's end. Once the knob has been pushed over onto the axle, remove the nail, and fasten the knob with the M3x20 hex screw.

Check that the head release lever works properly by attaching a suitable microscope head.

5. Checking and aligning the collar of the head mount.

(On first sight it may be confusing that the images in this subsection illustrate the head mount on a Labor-lux microscope rather than the head mount on the Magnification Changer. However, functionally these head mounts are identical.)

The dovetail mount on the underside of a Leitz micro-scope head has a very tight fit to the Magnification Changer's head mount, or more exactly, to the socket in the bottom of the head mount (Figure 15.) This is to ensure that the head always is steadily and reliably attached in the microscope's optical path.

Due to the narrow tolerances, the head's dovetail just barely fits through the collar and down into the head mount's socket. This means that the collar must be precisely aligned with the socket, otherwise the head will not be properly attached in the head mount. An

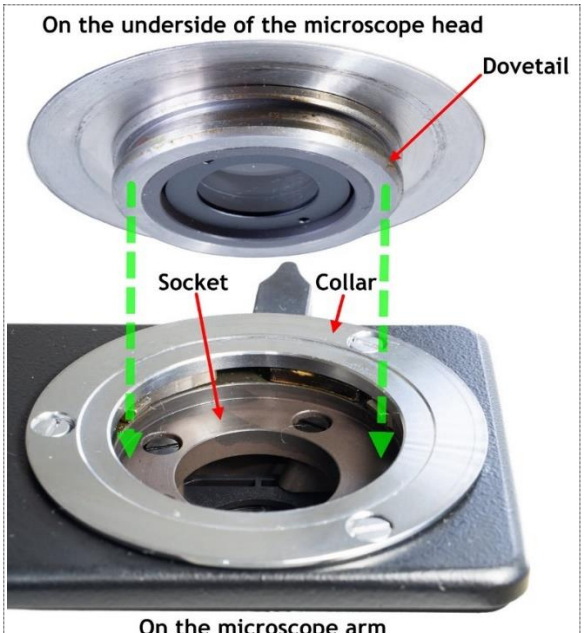

Figure 15: Head dovetail attaching to the head mount.

improper head attachment can be inconspicuous, why it is a good idea to visually check every time you attach a head to the Magnification Changer. Look from the side against a bright background to check that the head completely rests on the head mount's collar and that there is no gap visible anywhere between the head's underside and the collar (see Figure 16.)

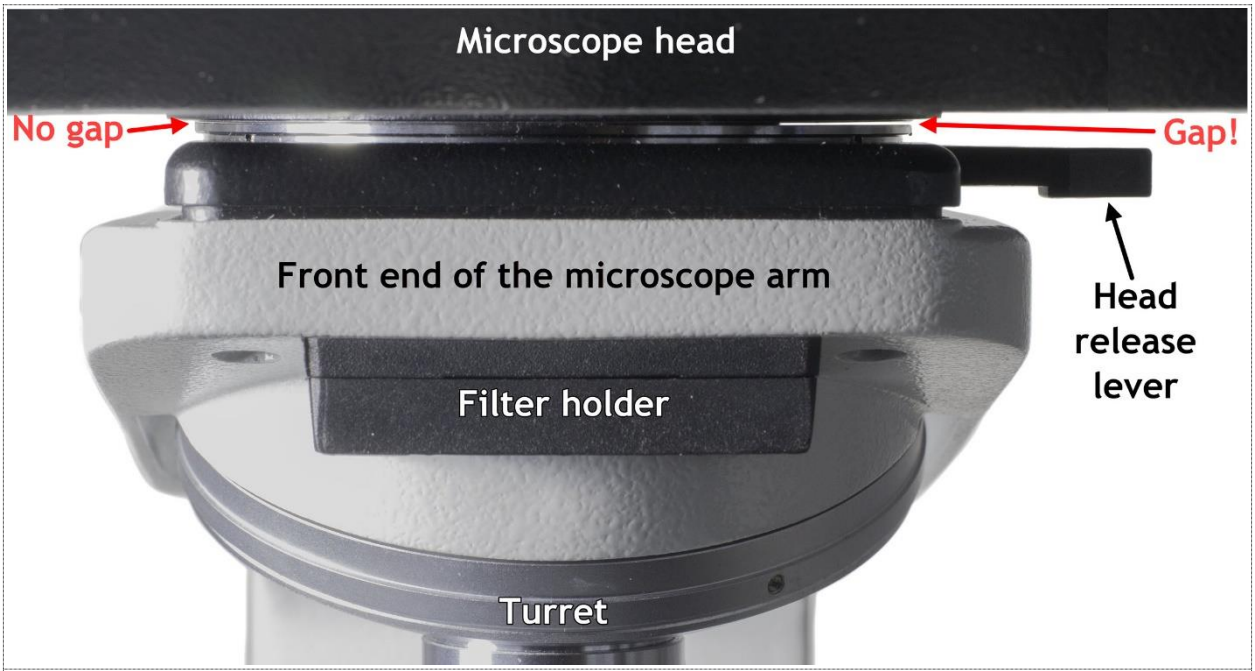

Figure 16: A small gap between the underside of the head and the collar of the head mount reveals that the head is not properly attached. The head in this image is slightly tilted.

If the head can't be attached to the Magnification Changer without there being a gap (which typically happens after the collar has been disassembled), the problem must be fixed by aligning the head mount's collar with the socket. The alignment is possible to do thanks to a small play in the collar's screw holes.

For the alignment it is a good idea to obtain an improvised alignment tool. To match the insides of the collar and the socket such a tool must be of a cylindrical shape with an outer diameter of exactly 42.0 mm. I have found that a 42 mm steel ball bearing (Figure 17) with a thickness of at least 12 mm makes a very good alignment tool, and it is not difficult to find (and inexpensive) on Amazon or eBay. The advantage with using a steel ball bearing is that ball bearings are manufactured to tight dimensional tolerances which ensures that the bearing snugly fits in the collar and in the socket.

An alternative alignment tool option is to use a piece of a 42 mm PVC pipe (Figure 18.) The disadvantage with a plastic pipe (or any other plastic alignment tool) is that it may not provide the diameter accuracy that is needed. If the pipe is slightly too thick to fit into the collar and the socket, then a 1-2 cm section at its end can be slightly sandpapered down until it fits. Wrap a 2 cm strip of sandpaper around the end of the pipe, hold the sandpaper between the thumb and the index finger and turn it back and forth to evenly reduce the diameter of the pipe's end. Remember to wash the pipe with water to remove any dust and wipe it dry before checking its diameter in the head mount. If, on the other hand, the pipe is slightly too thin, the diameter can be increased by evenly applying regular transparent office tape around the end. With a plastic pipe, it is also important to ensure that the end is cut precisely perpendicularly.

Figure 17: Improvised alignment tool: A 42.0 mm steel ball bearing (12 mm thick).

Figure 18: Optional improvised alignment tool: A PVC pipe with 42 mm (1.65”) outer diameter.

The collar alignment should be done after the head mount has been completely reassembled.

Start the collar alignment by barely loosening the three screws that attach the collar (Figure 1) – it should now be possible to move the collar sideways as far as the play in the screw holes allows, but the collar should still remain sitting rather tightly on the Magnification Changer.

Push back the head release lever (Figure 1) as far as it goes and keep holding it there to ensure that the head clamps (Figure 4 and Figure 6) are disengaged. Put the alignment tool all the way down into the bottom of the socket (Figure 21.) Thanks to the tight tolerances this forces the collar to align with the socket. Complete the alignment by tightening the three screws in the collar. Remove the alignment tool from the head mount and release the head release lever.

Figure 19: The “naked” head mount with the socket for the microscope head.

Figure 20: The head mount completely reassembled (except the collar screws.)

Figure 21: The head mount with the alignment tool (42.0 mm ball bearing) inserted.

Check that the head attaches properly to the head mount. Look from the sides to be sure that the head is completely seated on the head mount, particularly that there is no gap between the head and the collar (Figure 16.)

It is possible, albeit onerous, to align the collar with the socket without the help of an alignment tool by only using the microscope head. The problem is that for obvious reasons the collar screws can’t be tightened while the head is attached. The procedure would be to remove the head and initially only very lightly tighten the collar screws. Then the head is attached, which will force the collar into alignment. After gently removing the head, the collar screws can be fully tightened to preserve the alignment. The trick is to make the initial tightening of the collar screws just loose enough to allow the collar to move

sideways as much as is required to give place for the head, while at the same time the screws must be tight enough so the collar isn’t pushed out of alignment when the head is removed. It can be done, but it will probably require several trials to get the initial screw tightness just right.