

# Complete Teardown, Cleaning, and Reassembly of the Olympus BH-2 Coaxial Focus Mechanism

(Revision 2)



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## Introduction

The microscopes in the Olympus BH-2 line (BHS, BHSU, BHT, and BHTU) have largely been replaced in the professional and clinical world, due to their advancing age and the lack of repair parts from Olympus. A great many of these microscopes were produced in their day, and because of this are they readily available on the used market for very reasonable prices. Thanks to their excellent build quality and solid optical performance, these scopes are now very popular with hobbyists, providing an affordable, high-quality alternative to the Chinese-made scopes prevalent today. One problem that might be encountered when purchasing one of these scopes is that the focus action may be stiff, due to the decades-old grease in the coaxial focus mechanism. This document describes the complete teardown and re-lubrication of the coaxial focus mechanism in an Olympus BHTU stand. Since the various BH-2 stands share the same coaxial focus mechanism as the BHTU, this document should allow a hobbyist with reasonable mechanical abilities to service any of these microscope stands.

## A Caution Regarding Stiff Focus Mechanisms

Avoid turning the fine-focus knobs on any BH-2 microscope stand whose coarse-focus mechanism feels abnormally stiff. Turning these knobs when there is excess resistance in the mechanism, such as may be caused by dried grease, puts high stresses on the plastic drive gears in the fine-focus mechanism, and these can be damaged if these stresses are too high.

## Left and Right Side Designations

Throughout this document, references are made to the left and right sides of the microscope frame. These designations are from the perspective of the equipment operator; the tension-adjustment knob is on the right-hand side and the pre-focus stop collar and condenser height knob are on the left-hand side.

## Tools and Supplies Needed

The following tools and supplies will be needed to complete the teardown, cleaning, and reassembly of the coaxial focus mechanism in a BH-2 microscope stand:

- Allen wrenches or drivers: .050", 1/16", 1.5mm, 2.5mm (two are needed), and 3mm
- Cleaning solvents (see recommendations below)
- Electric heat gun (item 3 of Appendix 2)
- LocTite® 242 blue thread locker (item 7 of Appendix 2)
- LocTite® 222 purple thread locker (item 8 of Appendix 2)
- Lubricant (see recommendation below)

- Pliers, tongue-and-groove
- Pliers, tongue-and-groove, soft jaws (item 4 of Appendix 2)
- Screwdriver set, JIS (item 5 of Appendix 2)
- Screwdriver, slotted, 3mm
- Tweezers, fine tipped
- X-Acto® knife

## Recommended Lubricant Type

Plastilube® Brake Grease (item 2 of Appendix 2) is recommended for use in the BH-2 coaxial focus mechanism. Plastilube® Brake Grease is a heavy grease which will remain stable and serviceable for many years to come.

## Recommended Solvents

Some sort of solvent will be needed to clean the old grease from the various mechanical parts. Solvents that can be used are acetone, diethyl ether, heptane, hexane, mineral spirits, turpentine, and xylene. Regardless of which solvents are chosen, make sure that adequate ventilation is present during the cleaning process, and that any necessary personal protective equipment is utilized to minimize exposure. Consult the MSDS sheet before using any unfamiliar solvents. Many of the solvents listed above are flammable, and their vapors may represent an explosion hazard if mishandled. Whichever solvents are chosen, be sure to follow all manufacturer's instructions and safety precautions.

**Painted Surfaces:** Many solvents will damage the finish of painted surfaces. Isopropyl alcohol or 409 cleaner may be safely used to clean most painted surfaces.

**Metal Parts:** The solvents listed above are generally compatible with the various unpainted metal parts. If unsure, minimize the exposure time with the solvents by not soaking the parts any longer than necessary to loosen the old grease.

**Plastic Parts:** Many solvents will dissolve or damage plastic parts. Be careful when cleaning the focus knobs and the pre-focus lock collar, to prevent damage from solvents. Minimize the time that the cleaning solvents are in contact with plastic parts (i.e., do not soak them in the solvent), and test for solvent compatibility by applying a small amount to an inconspicuous place, such as inside a knob, first. Never use xylene to clean nylon parts, as xylene dissolves nylon. Isopropyl alcohol and trichloroethylene will cause swelling of nylon due to solvent absorption. The list of solvents generally considered safe for nylon includes acetone, diethyl ether, heptane, mineral spirits, naphthalene, and turpentine.

## Cleaning Grease from Parts

When cleaning old grease from the various parts, submerge the part in the solvent (if possible) and allow it to soak for a sufficient time for the grease to dissolve to the point where it can be scrubbed off with a stiff brush, or wiped away with a tissue or rag wetted with the solvent. The solidified grease (resembling green wax) between the teeth of the gears and of the focus-rack, although stubborn, can be removed by scraping it out with the tip of a toothpick or tweezers, following a sufficient soak in the solvent.

## Electric Heat Gun

An electric heat gun is an absolute necessity for servicing BH-2 microscopes. Heat is ideal for loosening old grease to free stuck or stubborn mechanisms, and also for softening the glues and thread-locking adhesives used throughout these microscopes. *Do not try to service your BH-2 stand without a suitable heat gun.* Stripped fasteners will be the result if you ignore this warning.

## Label Parts for Identification and Reassembly

There are many small parts that make up the BH-2 coaxial focus mechanism. It is critical that these be bagged and tagged as they are removed to prevent them from getting lost, and to facilitate their proper identification during reassembly.

## Remove the Accessories from the Stand

Before beginning the teardown, remove all the major components from the microscope stand (i.e., AC power cord, condenser, x-y stage, eyepieces, viewing head, objectives, and nosepiece, if applicable). This will make the stand easier to maneuver and will prevent inadvertent damage to these components during the teardown and reassembly process. Be sure to protect these components from dust and damage while they are not installed on the stand.

## Protect the Exposed Mounting Dovetails

Once the accessories have been removed from the stand, cover the top of the microscope arm (i.e., the exposed mounting dovetails for the viewing head and nosepiece, if applicable) with a clean plastic bag and secure this with a rubber band or adhesive tape to keep dust out (see [Figure 1](#)). This is especially important on BHSU and BHTU stands which have an optical correction lens located just below the viewing head to correct for the difference in tube length introduced with the reversed nosepiece.



Figure 1 – Protect the top of the arm from dust

## Remove the Lamp House

Remove the lamp house from the rear of the microscope base. The lamp house simply plugs into the base and can be removed by grasping it and pulling it straight back. Set the lamp house aside to prevent damage. Do not touch the halogen lamp with your fingers, as oils from your skin may cause premature failure of the bulb. If the bulb is accidentally touched, clean it with isopropyl alcohol.

## Remove the Substage Condenser Carrier

Adjust the condenser height knob on the left-hand side of the substage condenser carrier to raise the condenser mount to the top of its range of travel. Rack the focus block on the stand to its lowest position using the coarse-focus knobs. Loosen the Allen-head lock screw securing the substage condenser carrier to the sliding focus block, using a 3mm Allen wrench or driver (see [Figure 2](#)).

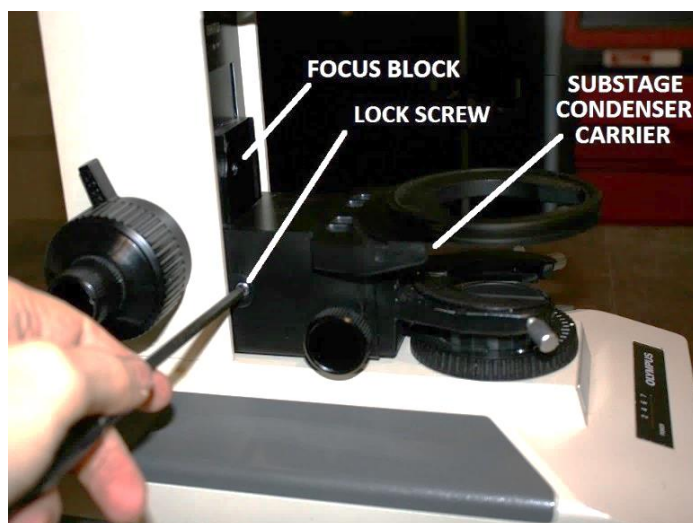


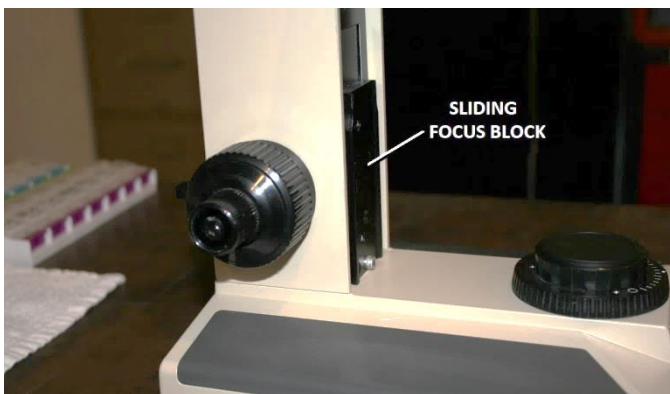
Figure 2 – Loosen substage condenser carrier lock screw

With the lock screw loosened, grasp the substage condenser carrier and lift it straight up to remove it from the sliding focus block (see [Figure 3](#)).



**Figure 3 – Lift and remove the substage condenser carrier**

[Figure 4](#) shows the microscope stand with the substage condenser carrier removed from the sliding focus block.



**Figure 4 – Substage condenser carrier removed**

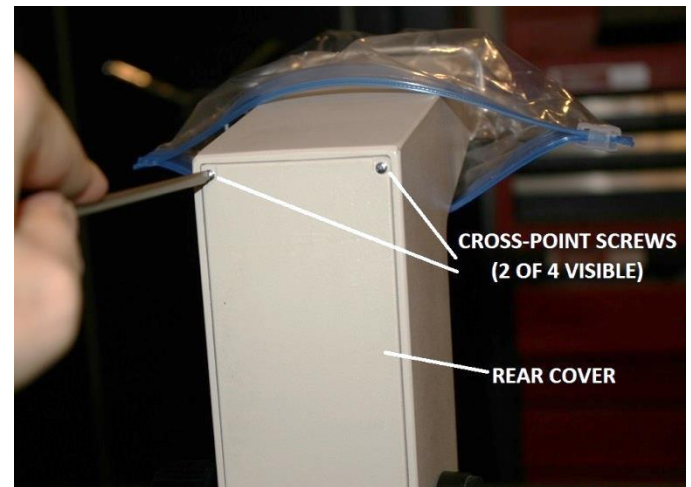
Place a suitable dust cap over the exposed field lens to protect it from dust, debris, and physical damage (see [Figure 5](#)).



**Figure 5 – Protect the field lens with a dust cap**

## Remove the Rear Cover

Using a suitable JIS screwdriver, remove the four small, cross-point screws securing the rear cover to the stand and remove the rear cover, to gain access to the gearbox and focus rack within (see [Figure 6](#)).



**Figure 6 – Remove rear cover from the back of the arm**

## Remove the Gearbox

Rack the sliding focus block to its lowest position using the coarse-focus knobs, to prevent the focus block from dropping unexpectedly when the gearbox is removed. Using a 2.5mm Allen wrench or driver, remove the four Allen-head screws and washers securing the gearbox in place on the frame (see [Figure 7](#)) and remove the loose gearbox (see [Figure 8](#)).

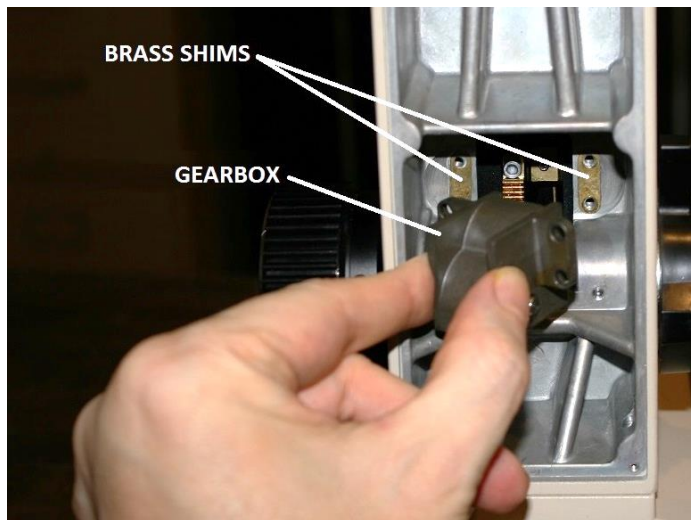


**Figure 7 – Remove screws and washers holding gearbox**

There should be two brass shims present between the mounting flanges of the gearbox and the frame. These shims may come out stuck to the gearbox, or they may remain stuck to the frame (see [Figure 8](#)). It may be tempting to leave these in place, since they may seem to be stuck in place, but be sure to remove them both



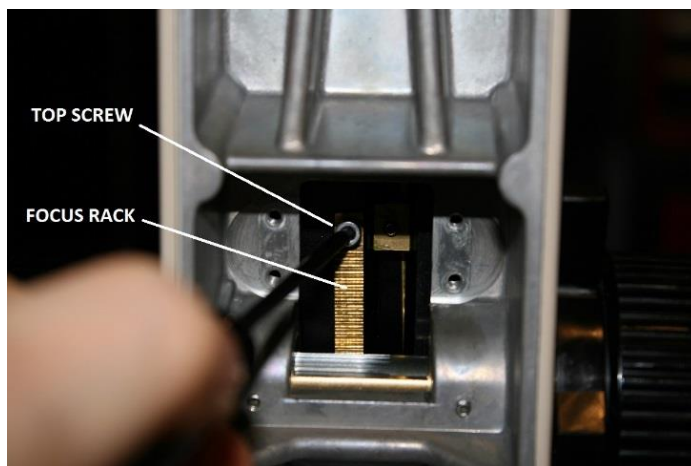
and place them someplace safe so that they do not fall out and get lost at some point during the repair.



**Figure 8 – Remove the loose gearbox and the brass shims**

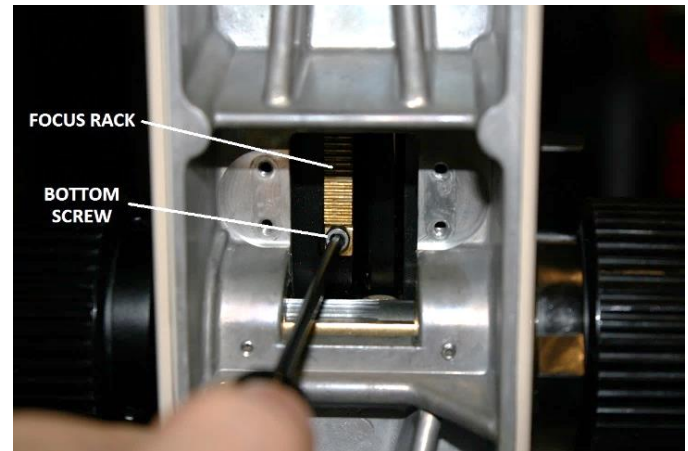
### Remove the Focus Rack

Now that the gearbox and the two accompanying brass shims have been removed, the next step is to remove the brass focus rack from the back side of the sliding focus block. With the sliding focus block positioned at its lowest point, use a 2.5mm Allen wrench or driver to remove the Allen-head screw securing the top of the brass focus rack to the focus block (see [Figure 9](#)).



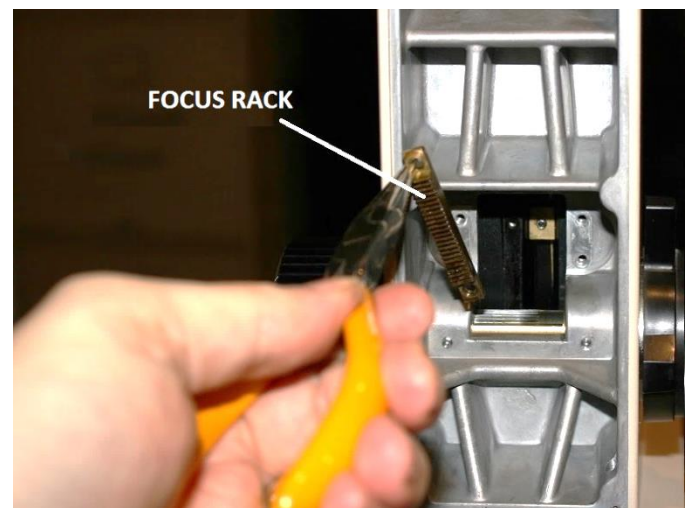
**Figure 9 – Remove the top screw holding the focus rack**

Once the top screw has been removed, reach around to the front of the frame with one hand and raise the sliding focus block to its uppermost position, such that the bottom screw securing the focus rack can be accessed. Hold the sliding focus block in this position and use a 2.5mm Allen wrench or driver to remove the bottom rack screw (see [Figure 10](#)).



**Figure 10 – Remove bottom screw holding the focus rack**

Carefully remove the (now loose) brass focus rack using tweezers or needle-nose pliers (see [Figure 11](#)).



**Figure 11 – Remove the loose focus rack**

### Check the Focus Block for Freedom of Motion

With the gearbox and focus rack removed, the sliding focus block should now move freely. Raise and lower the focus block by hand, and note the feel of this movement. The focus block should slide freely, without any noticeable stiffness or binding. Raise it to the top and release it. It should drop quickly, without any significant lag. Smooth, free action of the sliding focus block is critical to the focus performance of the microscope stand, since the mechanical design of the coaxial focus mechanism relies on gravity to eliminate the effects of the mechanical backlash inherent in the rack-and-pinion gearing mechanism. If the sliding focus block movement is too stiff, it will cause an apparent hysteresis effect in the fine-focus knobs (i.e., there will be a noticeable lag before the focus changes when the fine-focus knobs are reversed). If the action of the sliding focus block is unacceptable, it will need to be

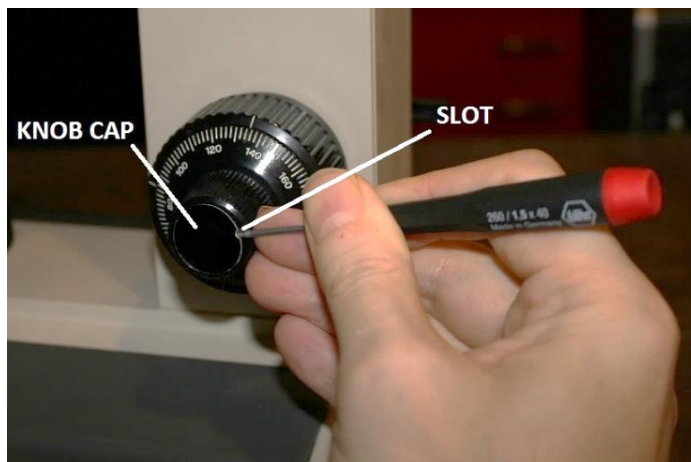
disassembled, cleaned of old grease, and reassembled with fresh grease. The procedure for doing this repair is beyond the scope of this document. Refer to the [Complete Teardown, Cleaning, and Reassembly of the Olympus BH-2 Sliding Focus Block](#) document for detailed instructions on how to accomplish this.

### Remove the Fine-Focus Knob Caps

Before the screws securing the fine-focus knobs to the fine-focus shaft can be accessed, the end caps on both knobs must first be removed. These caps are held in place with adhesive on the back surface of the caps. To remove the knob caps, insert the tip of a tweezers or the tip of a small screwdriver into the notches in the caps and gently pry the caps free from the knobs (see [Figure 12](#)). Be careful when doing this, so as to not bend or damage the knobs caps while prying them free.

If the adhesive does not release with moderate prying force on the knob caps, use gentle heat from a heat gun to soften the adhesive holding them in place, or squirt isopropyl alcohol into the notches using a syringe or a small dropper and allow the alcohol to soften the adhesive for a bit before attempting to remove the knob caps.

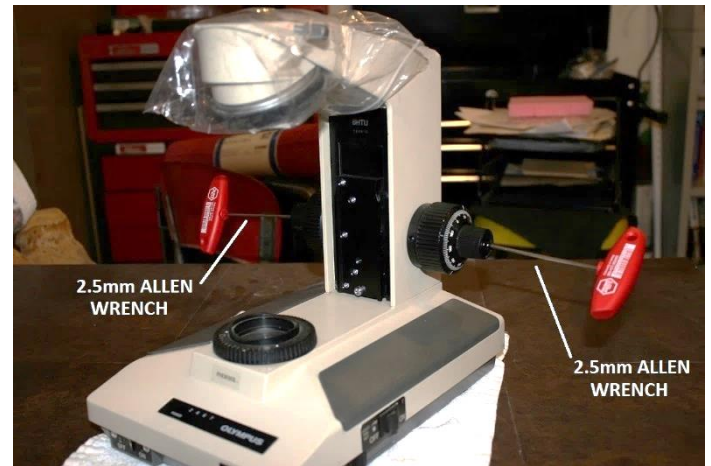
Once you have removed the knob caps, be sure to place them someplace where dust and debris will not foul the exposed adhesive on the back surfaces.



**Figure 12 – Remove the caps from the fine-focus knobs**

### Remove the First Fine-Focus Knob

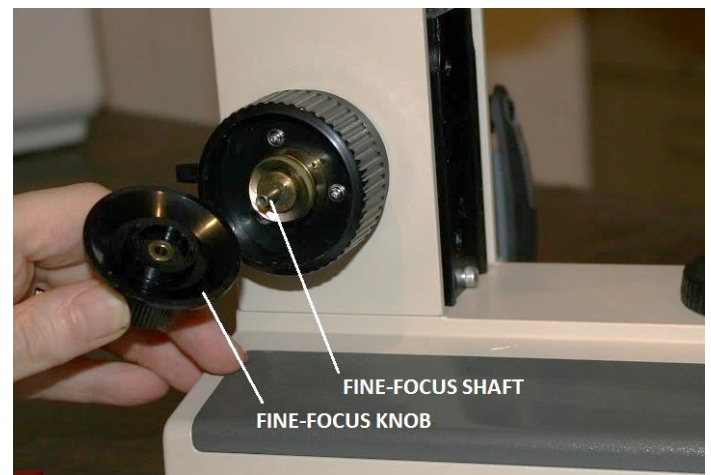
Obtain two 2.5mm Allen wrenches or drivers and insert one into each of the screws securing the fine-focus knobs to the fine-focus shaft (see [Figure 13](#)).



**Figure 13 – Insert Allen drivers in screws in knobs**

Hold the Allen tool in the right-hand knob stationary, while turning the tool in the left-hand knob counter-clockwise, to loosen one of the screws. Only one of the two screws will loosen, and it doesn't particularly matter which one does<sup>1</sup>. Remove the screw that comes loose, along with its accompanying lock washer.

If the screw in the left-hand knob comes loose, pull the left-hand knob free of the shaft (see [Figure 14](#)).

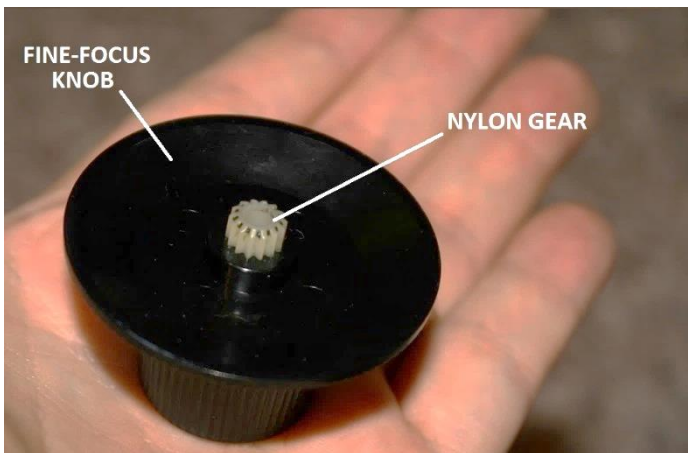


**Figure 14 – Remove the fine-focus knob from the shaft**

If instead the screw in the right-hand knob comes loose, hold the right-hand fine-focus knob stationary and simultaneously pull and rotate the left-hand fine-focus knob, until the left-hand knob, with attached fine-focus shaft, pulls free of the back of the right-hand focus knob. Once this happens, remove the right-hand fine-focus knob by pulling it straight out, without rotating it while doing so. This is necessary to prevent damaging

<sup>1</sup> Note that, unless stated otherwise, the various images in this document show the disassembly and reassembly that results when the left-hand screw loosens.

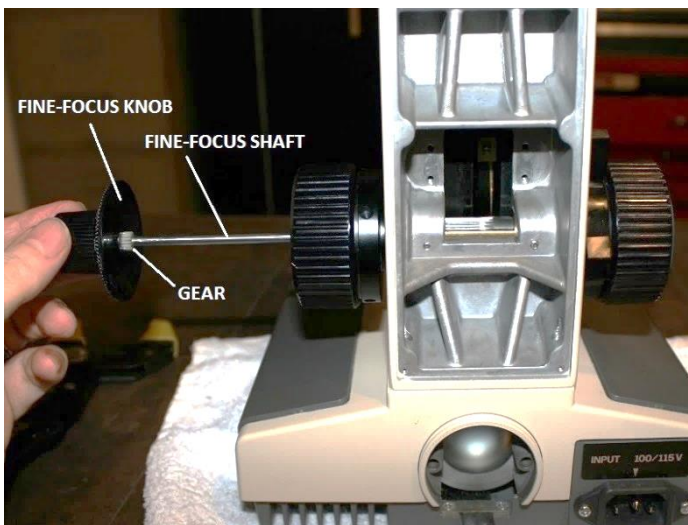
the nylon gear pressed into the back of the knob (see [Figure 15](#)).



**Figure 15 – The gear in the back of the fine-focus knob**

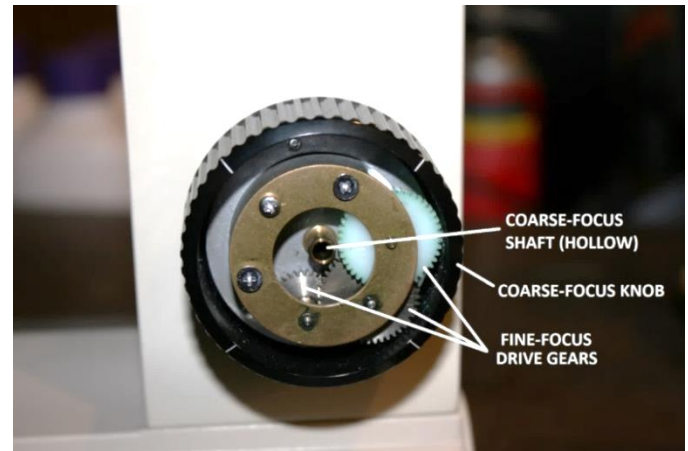
### Remove Fine-Focus Shaft and Second Knob

Grasp the fine-focus knob on the opposite side from which the knob was just removed and pull straight out (see [Figure 16](#)) until the fine-focus knob and attached shaft are free of the hollow coarse-focus shaft.



**Figure 16 – Withdraw the fine-focus shaft (right side)**

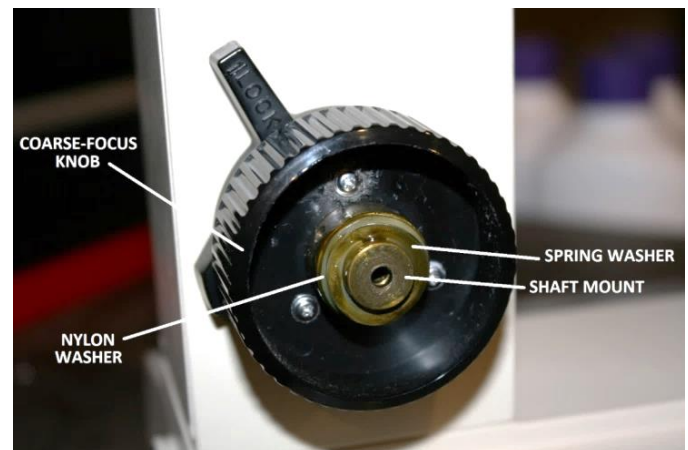
[Figure 17](#) shows a view of the fine-focus drive gear cluster that is located within the right-hand coarse-focus knob. The small nylon gear that is pressed into the back of the right-hand fine-focus knob (see [Figure 15](#)) meshes with this gearing, and because nylon gears are somewhat fragile, you must always exercise caution when installing or removing the right-hand fine-focus knob, to prevent damage to these gears.



**Figure 17 – A view of the fine-focus drive gear cluster**

### Remove the Fine-Focus Thrust Washers

[Figure 18](#) shows the two fine-focus thrust washers that are located beneath the left-hand fine-focus knob. These consist of a curved-disk spring washer, which sits on top of a nylon washer, which in-turn sits on the shoulder of the brass shaft mount. These two washers will be visible once the left-hand fine-focus knob has been removed. Although these washers are normally found in position over the shoulder of the brass shaft mount (see [Figure 18](#)), if you don't find them there, look inside the fine-focus knob which was removed from the left-hand side.



**Figure 18 – A view of the fine-focus thrust washers**

Remove the curved-disk spring washer from the nylon washer first, and then remove the nylon washer from the shoulder of the brass shaft mount. The spring washer will come out easily, but the nylon washer may be somewhat stubborn, due to the presence of dried grease beneath it. If this proves to be the case, use gentle heat and a sharp X-Acto® knife to separate the nylon washer from the shoulder of the brass shaft mount (see [Figure 19](#)). Be careful when applying heat

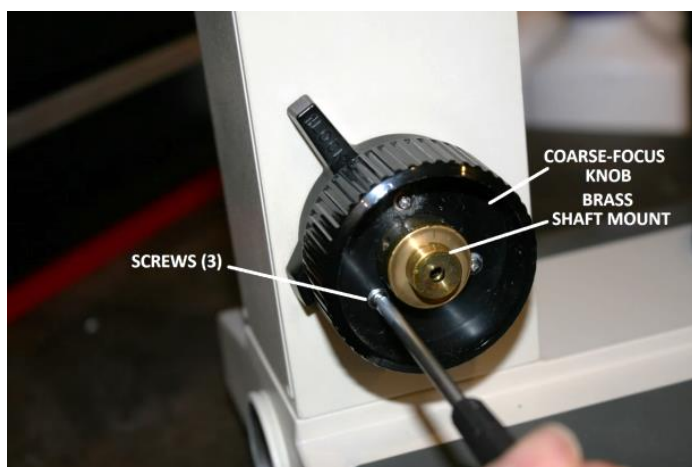
here, so as to not melt or deform the plastic knob or the nylon washer.



**Figure 19 – Remove the nylon thrust washer**

### Remove the Left-Hand Coarse-Focus Knob

Using a suitable JIS screwdriver, remove the three cross-point screws securing the left-hand coarse-focus knob to the brass shaft mount (see [Figure 20](#)). Note that these screws can be stubborn, and it is easy to strip the heads while trying to remove them. To improve the odds of loosening these screws without damaging the heads, apply gentle heat with a heat gun (don't melt or deform the plastic knob), and then seat the screwdriver bit in the three screw heads and lightly tap the screwdriver handle, to try to break the screws loose before removing them. Be careful and do not break the plastic knob while doing this.



**Figure 20 – Remove screws holding the coarse-focus knob**

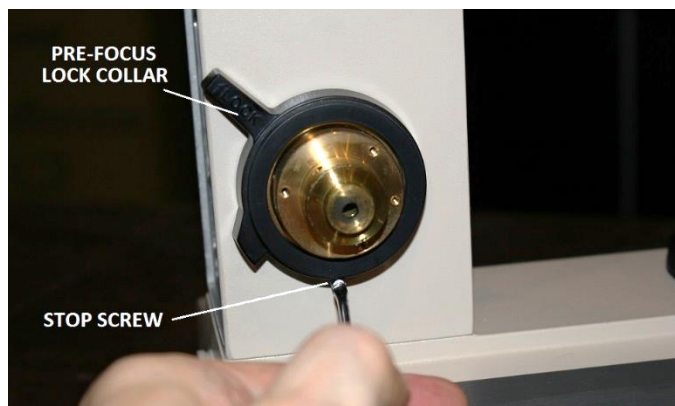
Once these three screws have been removed, pull the left-hand coarse-focus knob free of the brass shaft mount and remove it (see [Figure 21](#)).



**Figure 21 – Remove the coarse-focus knob**

### Remove Stop Screw for Pre-Focus Lock Collar

The slotted stop screw beneath the pre-focus lock collar needs to be removed before the plastic lock collar can be removed. This stop screw is staked in place with adhesive, and it is best to soften this adhesive with heat before removing it. Be careful when applying heat to the stop screw. Heat the stop screw while minimizing heat exposure to the plastic stop collar, to prevent the stop collar from melting or deforming. Use a baffle of some sort to shield the stop collar from the heat gun, if necessary. Once the slotted stop screw has been heated, use a small (3mm) slotted screwdriver to loosen and remove the stop screw (see [Figure 22](#)).

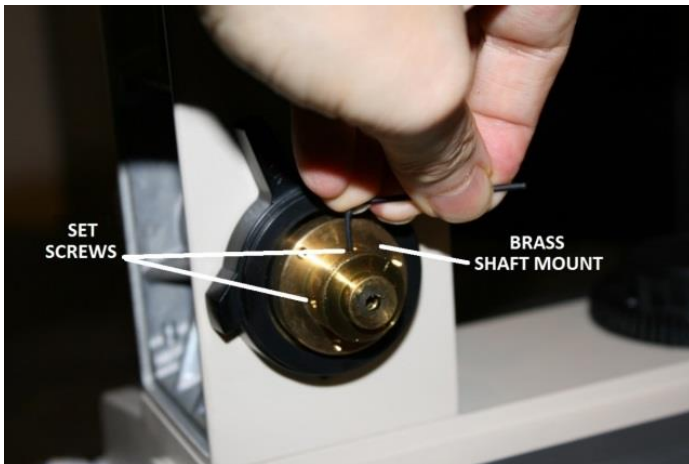


**Figure 22 – Remove the stop screw for the lock collar**

### Disassemble the Pre-Focus Stop Mechanism

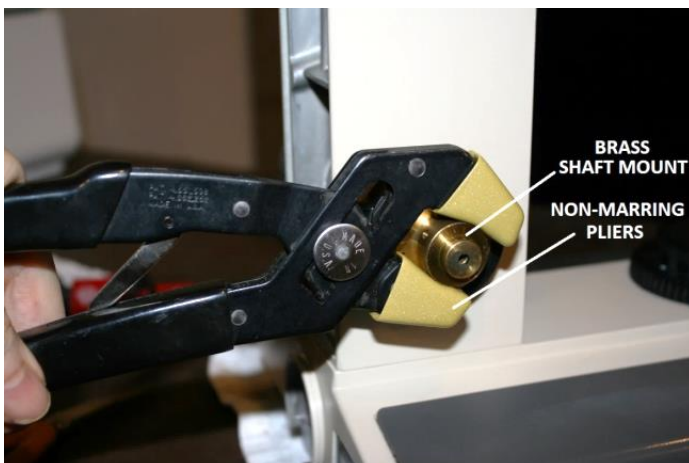
To disassemble the pre-focus stop mechanism, the brass shaft mount on the left-hand side needs to be removed from the coarse-focus shaft. Apply heat to the brass shaft mount, to loosen the adhesive holding the two perpendicularly oriented set screws in place. Be careful to not deform or melt the plastic stop collar when heating the brass shaft mount. Using a 1.5mm Allen wrench or driver, loosen and remove the two

perpendicular set screws securing the brass shaft mount (see [Figure 23](#)). If the fit of the 1.5mm Allen tool seems loose, try a 1/16" Allen tool.



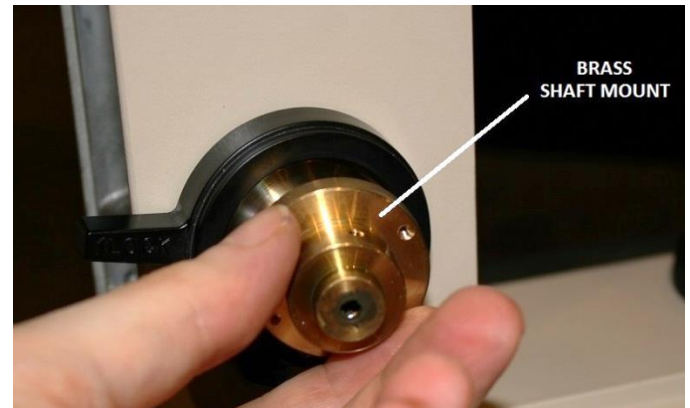
**Figure 23 – Loosen set screws holding brass shaft mount**

After both set screws have been removed from the brass shaft mount, rotate the pre-focus lock collar counter-clockwise to release the pre-focus stop. This is necessary to minimize the possibility of damaging the coil spring under the brass shaft mount while loosening and removing the brass shaft mount. After the pre-focus stop has been released, grasp the brass shaft mount with non-marring pliers to hold it stationary (see [Figure 24](#)). While holding the brass shaft mount stationary with the non-marring pliers, rotate the coarse-focus knob on the right-hand side counter-clockwise to loosen the brass shaft mount from the coarse-focus shaft. It may be necessary to apply gentle heat to the brass shaft mount first, to soften any dried grease that may be holding the brass shaft mount to the coarse-focus shaft.



**Figure 24 – Hold the brass shaft mount stationary**

While holding the brass shaft mount stationary with the non-marring pliers, rotate the coarse-focus knob on the right-hand side counter-clockwise until the brass shaft mount fully disengages from the threaded coarse-focus shaft (see [Figure 25](#)) and remove it, being careful to disengage the stop screw on the back from the coil spring first. Do not allow the brass shaft mount to rotate during this step, or the coil spring could be damaged if for some reason the pre-focus lock mechanism is not spinning freely.



**Figure 25 – Remove the brass shaft mount**

The coil spring and a nylon washer should both be visible once the brass shaft mount has been removed from the coarse-focus shaft (see [Figure 26](#)). If the nylon washer is not present on the shoulder of the coarse-focus shaft, look for it inside the bore of the brass shaft mount. Remove the loose coil spring. The nylon washer will be removed after the lock collar has been removed.



**Figure 26 – Spring and nylon washer under shaft mount**

Loosen and remove the pre-focus lock collar by rotating it counter-clockwise until it comes free (see [Figure 27](#)).



**Figure 27 – Loosen and remove the pre-focus lock collar**

Use gentle heat to loosen the dried grease, and then remove the nylon washer using an X-Acto® knife with a sharp blade (see [Figure 28](#)).



**Figure 28 – Remove the nylon washer with X-Acto® knife**

Remove the (loose) rotating lock ring from within the threaded lock ring (see [Figure 29](#)).



**Figure 29 – Remove the rotating lock ring**

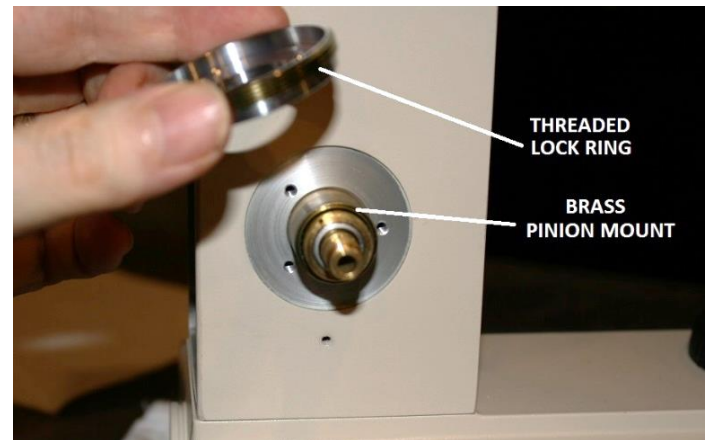
The removal of the threaded lock ring in the next step is optional. This piece may be left on the stand and

cleaned of old grease in place, if desired. The details of removal are shown for the sake of completeness.

Apply heat with a heat gun to soften the adhesive staking the three flat-head screws, and using a suitable JIS screwdriver, remove these screws securing the threaded lock ring to the frame (see [Figure 30](#)). Remove the threaded lock ring from around the brass pinion mount (see [Figure 31](#)).



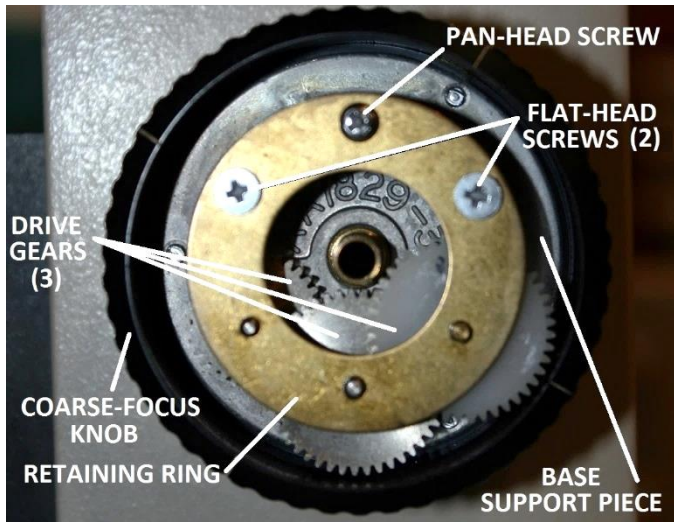
**Figure 30 – Remove screws holding the threaded lock ring**



**Figure 31 – Remove the threaded lock ring**

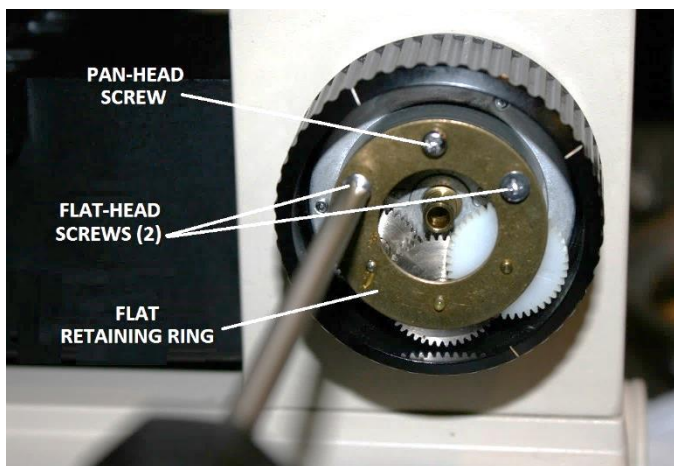
### Disassemble the Fine-Focus Drive Gear Cluster

There are three fine-focus drive gears that make up the fine-focus drive gear cluster. These are located within the right-hand coarse-focus knob. They are held in place by the base support piece on the bottom and by a flat brass retaining ring on the top (see [Figure 32](#)). These gears are driven by the small pinion gear that is pressed into the back of the right-hand fine-focus knob (see [Figure 15](#)).



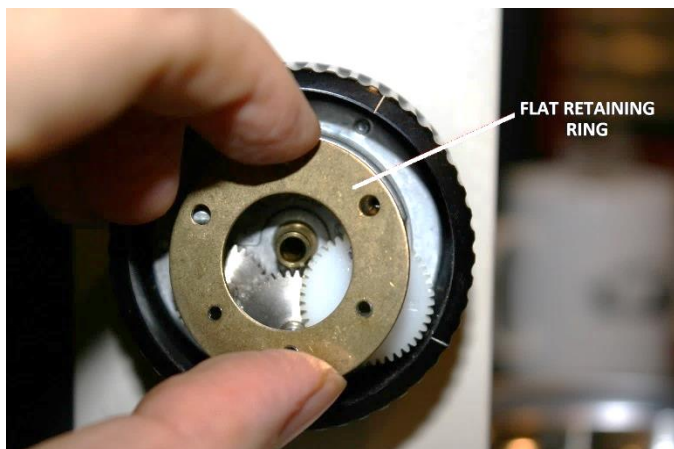
**Figure 32 – The fine-focus drive gear cluster**

Using a suitable JIS screwdriver, remove the two flat-head screws (on the left and right sides) and the single pan-head screw (in the middle) holding the flat retaining ring in position (see [Figure 33](#)).



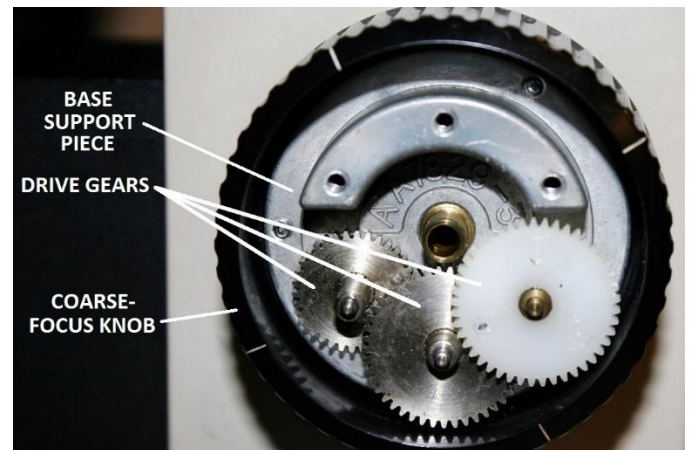
**Figure 33 – Remove three screws holding retaining ring**

Remove the flat retaining ring holding the gears in place (see [Figure 34](#)).



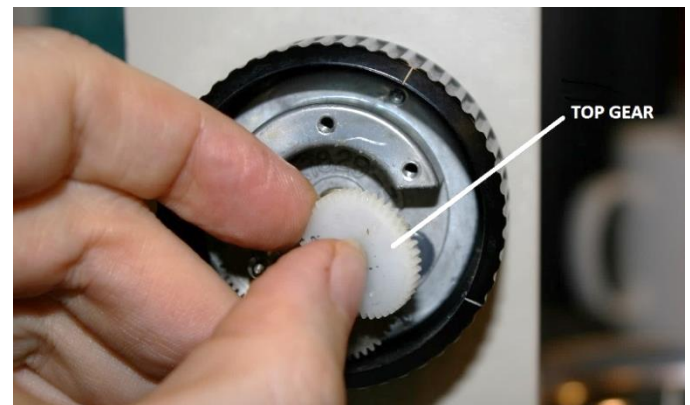
**Figure 34 – Remove the flat retaining ring from gears**

Once the flat retaining ring has been removed, the three gears may then be removed (see [Figure 35](#)).



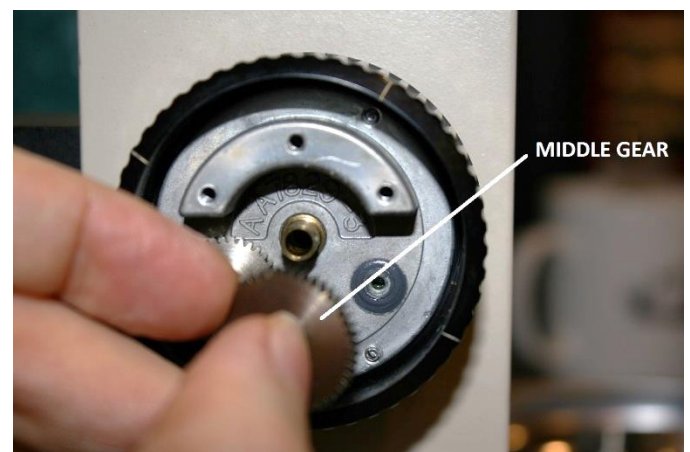
**Figure 35 – The flat retaining ring has been removed**

Remove the top (right-most) drive gear first (see [Figure 36](#)).



**Figure 36 – Remove the top (right-most) gear**

Next, remove the middle drive gear (see [Figure 37](#)).



**Figure 37 – Remove the middle gear**

Finally, remove the bottom (left-most) drive gear (see [Figure 38](#)).



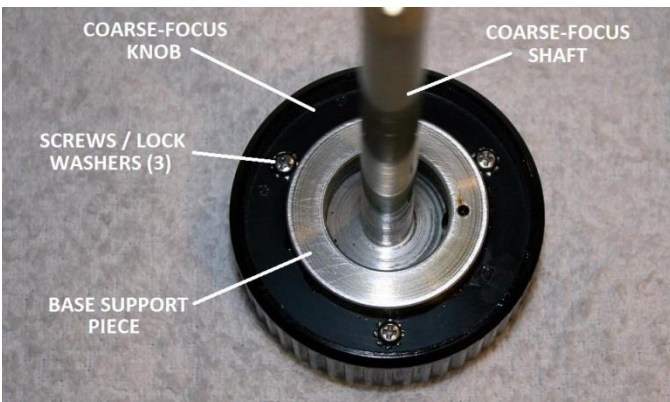
**Figure 38 – Remove the bottom (left-most) gear**

Clean the grease from the three gear holes in the base support piece and from the pins of all three gears.

Note: The base support piece is attached to the coarse-focus knob via three JIS screws and star lock washers, as shown in the rear view of the coarse-focus knob in [Figure 39](#). Removal of the base support piece is not required for this procedure, but [Figure 39](#) is included here for the sake of completeness.

The coarse-focus shaft threads into the back of the base support piece, and is staked in place with adhesive. Do not remove the coarse-focus shaft from the base support unless absolutely necessary.

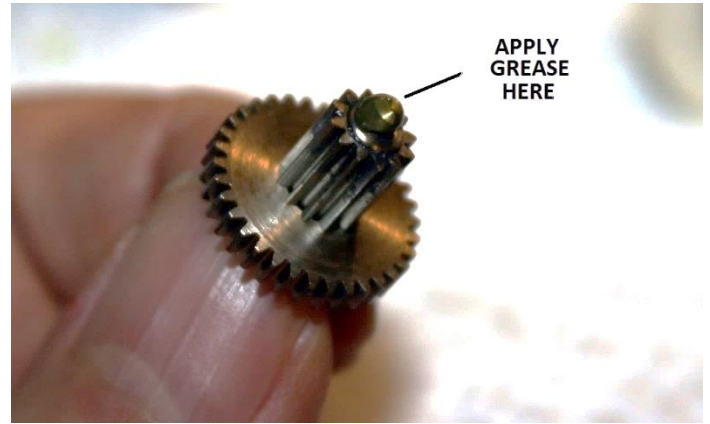
If it ever becomes necessary to remove the coarse-focus shaft, be sure to first soften the adhesive by thoroughly heating the bonded pieces, after removing the plastic knob. When gripping the coarse-focus shaft during removal, be careful not to scuff or flatten the shaft.



**Figure 39 – Rear view of the coarse-focus knob**

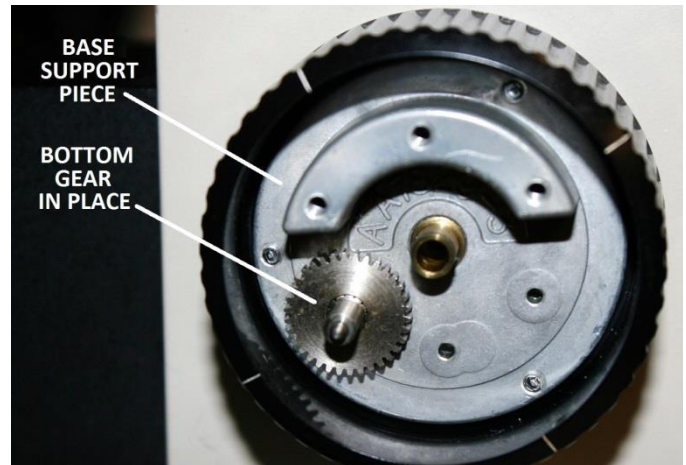
### Reassemble the Fine-Focus Drive Gear Cluster

Apply fresh grease to the lower pin of the bottom (left-most) drive gear (see [Figure 40](#)).



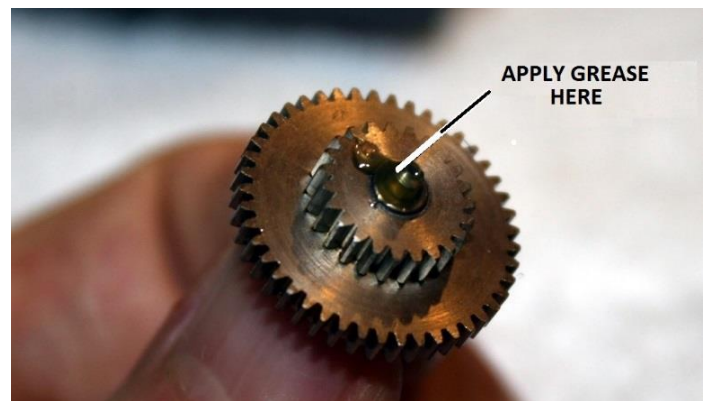
**Figure 40 – Grease lower pin of bottom (left-most) gear**

Place the bottom drive gear in the left-most position in the base support piece (see [Figure 41](#)).



**Figure 41 – Place bottom (left-most) gear in position**

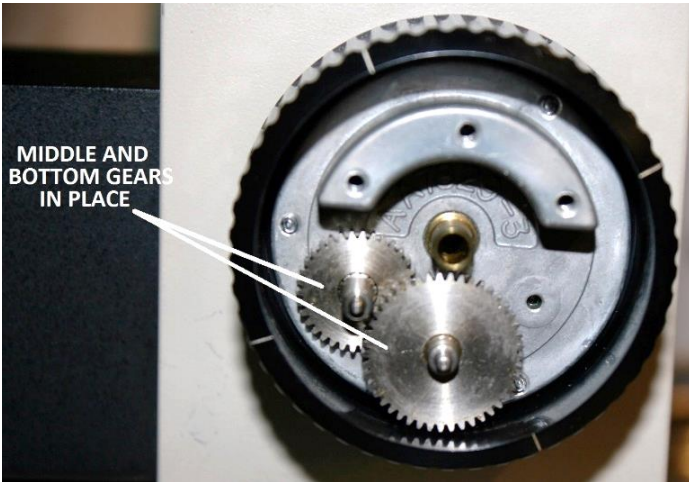
Apply fresh grease to the lower pin of the middle drive gear (see [Figure 42](#)).



**Figure 42 – Grease the lower pin of the middle gear**

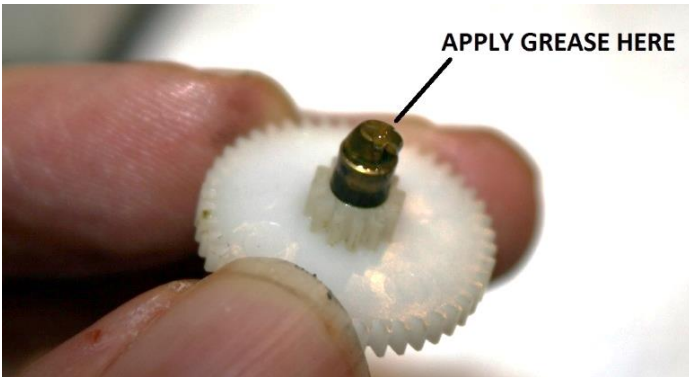
Place the middle drive gear in the center position in the base support piece (see [Figure 43](#)).





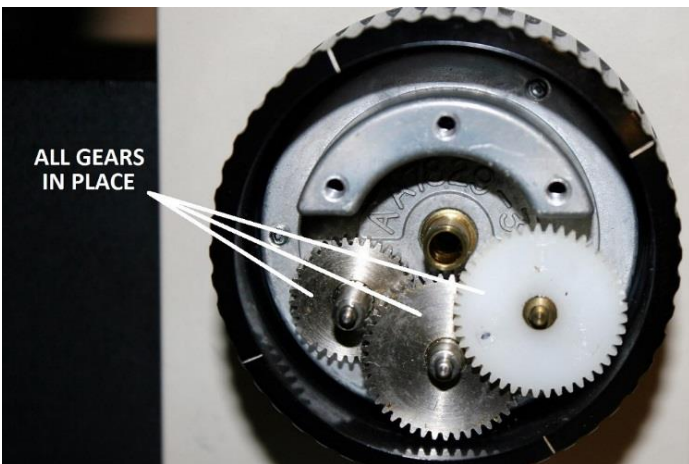
**Figure 43 – Place the middle gear in position**

Apply fresh grease to the lower pin of the top (right-most) drive gear (see **Figure 44**).



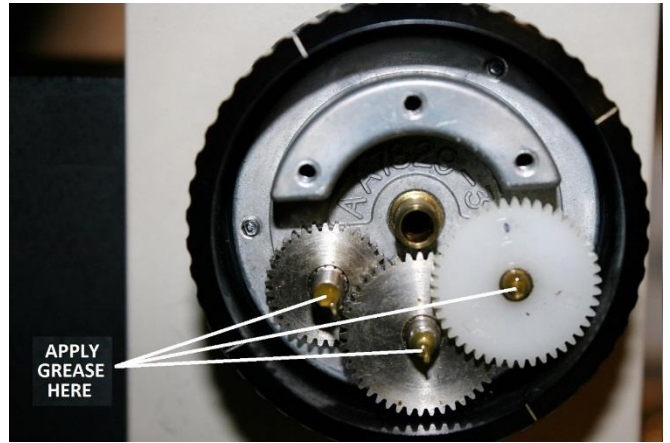
**Figure 44 – Grease the lower pin of top (right-most) gear**

Place the top drive gear in the right-most position in the base support piece (see **Figure 45**).



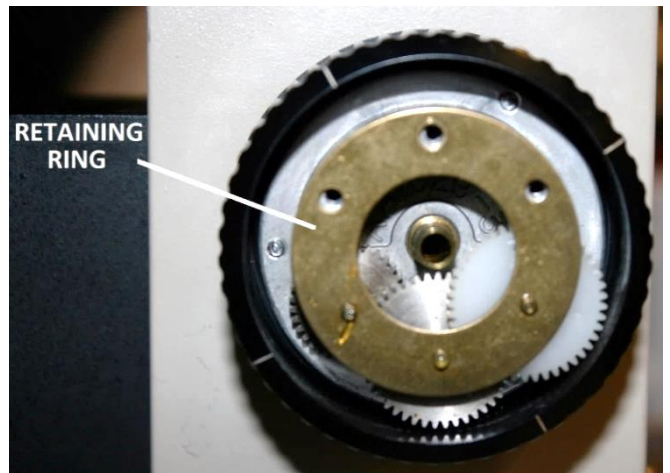
**Figure 45 – All three drive gears are now in place**

Apply fresh grease to the top pins of all three drive gears (see **Figure 46**).



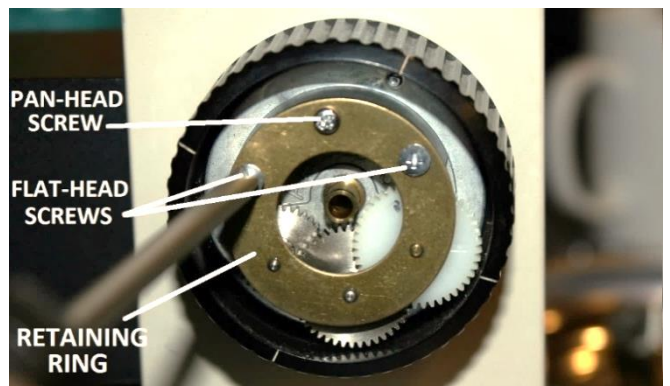
**Figure 46 – Grease the top pins of all the gears**

Clean the old grease from the flat retaining ring and place the ring in position over the three drive gears. Orient the retaining ring with the three small holes towards the bottom and over the pins on the gear tops (see **Figure 47**).



**Figure 47 – Flat retaining ring in position over gears**

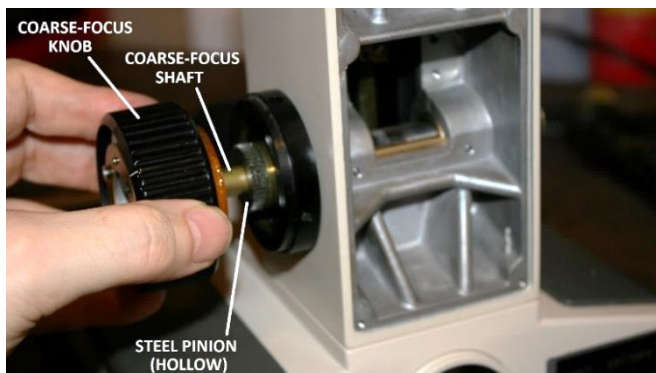
Using a suitable JIS screwdriver, reinstall the two flat-head screws (on the left and right sides) and the single pan-head screw (in the middle) to secure the flat retaining ring in position to hold the gears in place (see **Figure 48**).



**Figure 48 – Reinstall three screws to secure retaining ring**

## Remove the Coarse-Focus Shaft

Once the drive gear cluster has been cleaned and reassembled, grasp the coarse-focus knob on the right-hand side and withdraw the coarse-focus knob and attached coarse-focus shaft from within the hollow steel pinion (see [Figure 49](#)).



**Figure 49 – Withdraw the coarse-focus shaft from pinion**

## Remove the Pinion Assembly from the Frame

The pinion assembly is held in the frame by two 1/16" Allen-head set screws. These set screws can be rather difficult to remove, since they are staked in place with thread-locking adhesive, which has frequently filled the Allen heads of the set screws. When this is the case, it can be very difficult to sufficiently seat the Allen wrench or driver in the screw heads to allow them to be removed without risking damage to the set screws. Proceed carefully here to avoid rounding the fasteners. The adhesive *must* be removed from the set screw heads before attempting to remove these screws!

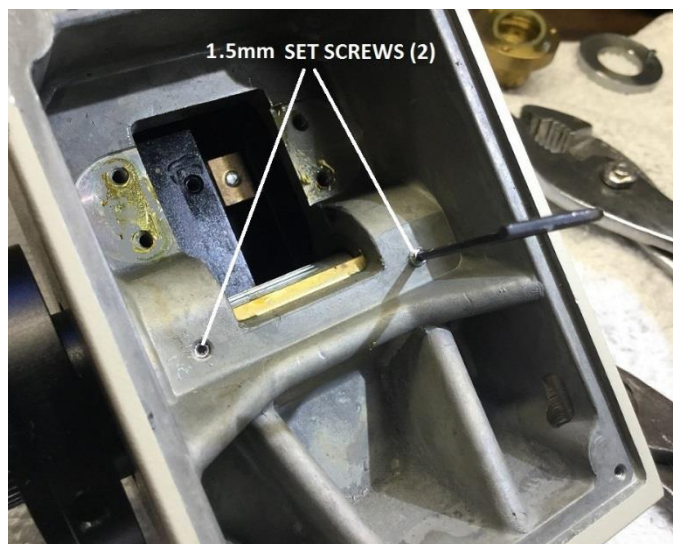
### Clear the Adhesive from the Screw Heads

To remove the adhesive from the screw heads, heat the tip of a spare 1.5mm Allen wrench with a flame, and then insert the hot tip into the plugged screw head to melt the adhesive. Tap the heated tool lightly to seat it in the screw head as deeply as possible. Pull the tip out and wipe away any melted adhesive. Repeat this process until both screw heads are clear of adhesive and the Allen tool can be seated into the screws.

Once the adhesive in both screw heads has been removed, set the Allen tool that was used to clear the adhesive aside. This Allen tool should never be used to try to loosen any set screws, since the heat treatment that originally hardened the tool may have been annealed by the application of the flame, leaving the tip softened. A different 1.5mm Allen wrench or driver should be used to loosen and remove the set screws.

### Remove the Set Screws

Before loosening the set screws, use a heat gun to thoroughly heat both set screws to soften the adhesive staking them in place. It takes quite a bit of heat to accomplish this, since there is a lot of thermal mass in the metal frame. Once both set screws have been thoroughly heated, use a 1.5mm Allen wrench or driver (not the one that was used to clear the adhesive from the screw heads) to loosen and remove the two set screws (see [Figure 50](#)). If the fit of the 1.5mm feels loose, try a 1/16" tool.



**Figure 50 – Loosen set screws holding pinion assembly**

After the two set screws have been removed, grasp the metal tension-adjustment knob on the right-hand side and pull the pinion assembly free of the frame (see [Figure 51](#)).



**Figure 51 – Withdraw the pinion assembly from frame**

## Remove the Tension-Adjustment Knob

Unscrew and remove the black metal tension-adjustment knob from the back of the brass pinion mount (see [Figure 52](#)). Note that this knob threads onto the pinion mount with left-handed threads.

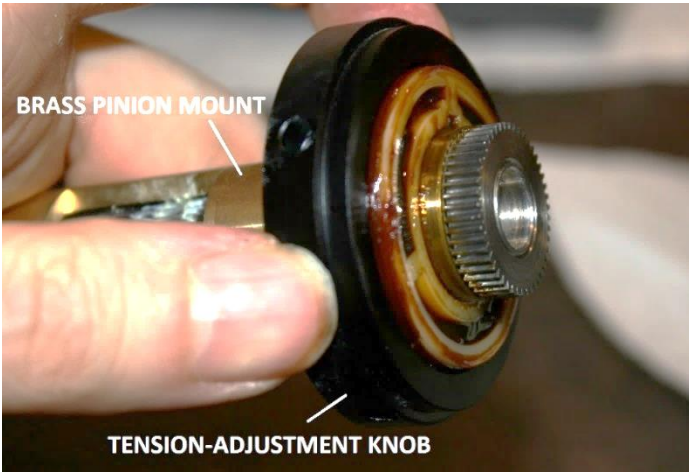


Figure 52 – Unscrew the tension-adjustment knob

### Remove the Coarse-Focus Tension Washers

Remove the nylon tension washer from within the tension-adjustment knob (see Figure 53).



Figure 53 – Remove the nylon tension washer

Remove the wave washer from within the tension-adjustment knob (see Figure 54).

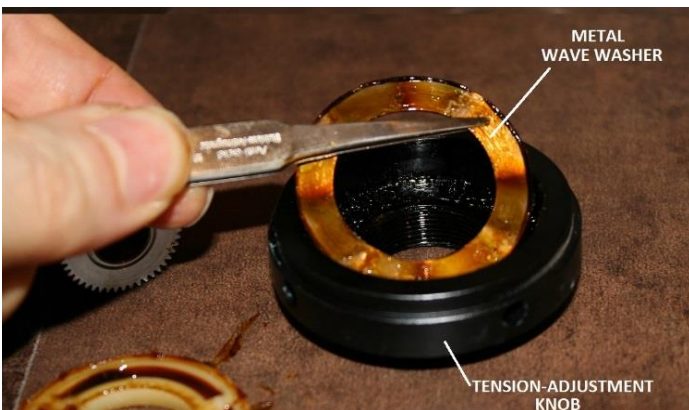


Figure 54 – Remove the wave washer

### Disassemble the Pinion Assembly

The pinion assembly consists of a brass pinion mount (the outer sleeve), a steel pinion (the hollow inner shaft with a gear on it), a slotted brass retaining ring (opposite the gear end), and 60 steel bearing balls (30 of which support each end of the steel pinion). The pinion assembly is disassembled by unscrewing the retaining ring (which is staked in place with adhesive) from the steel pinion, after first softening the adhesive by thoroughly heating it with a heat gun (see Figure 55).

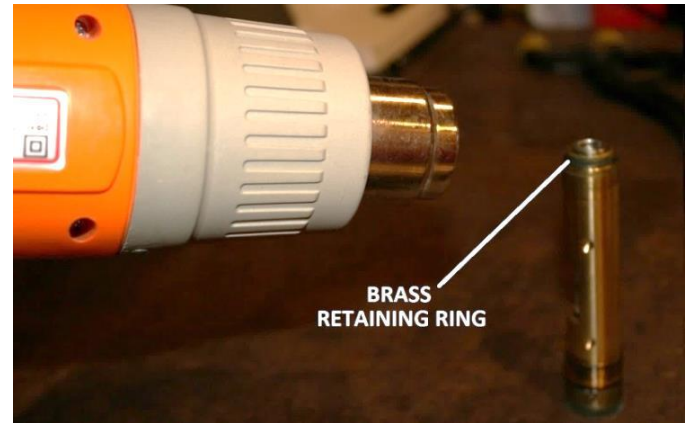


Figure 55 – Heat the slotted brass retaining ring

Once the retaining ring has been unscrewed, the steel balls supporting the pinion ends will be free to come out, and these will fall all over hell and gone<sup>2</sup> if given half an opportunity. To prevent this, remove the retaining ring while holding the pinion assembly over a catch tray of some sort to collect any steel balls that are inadvertently dropped. A magnetic parts tray, as shown later in this article, is ideal for this purpose. The magnet in the tray will attract the steel balls to prevent them from bouncing or rolling out. Use pliers with non-marring jaws to grip the gear-end of the steel pinion (see Figure 56) when unscrewing the retaining ring.

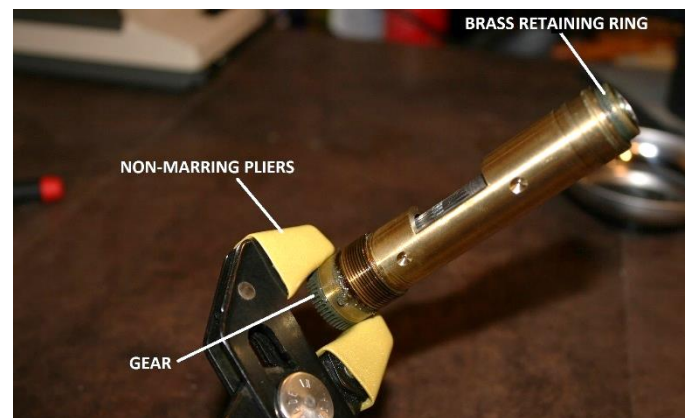


Figure 56 – Grip the gear end with non-marring pliers

<sup>2</sup> The key word here is “gone”.

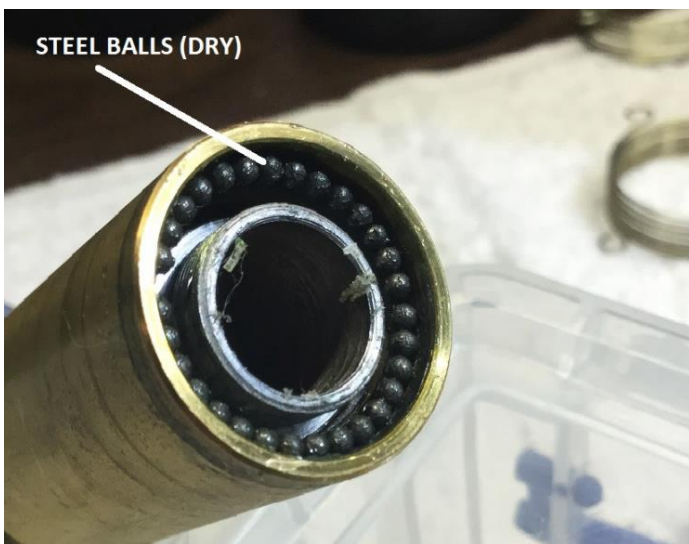
While the slotted brass retaining ring is still hot, hold the pinion assembly over the catch tray with the gear held in the jaws of the non-marring pliers. Loosen and remove the slotted brass retaining ring with a pair of tongue-and-groove pliers (see [Figure 57](#)).



**Figure 57 – Loosen and remove the brass retaining ring**

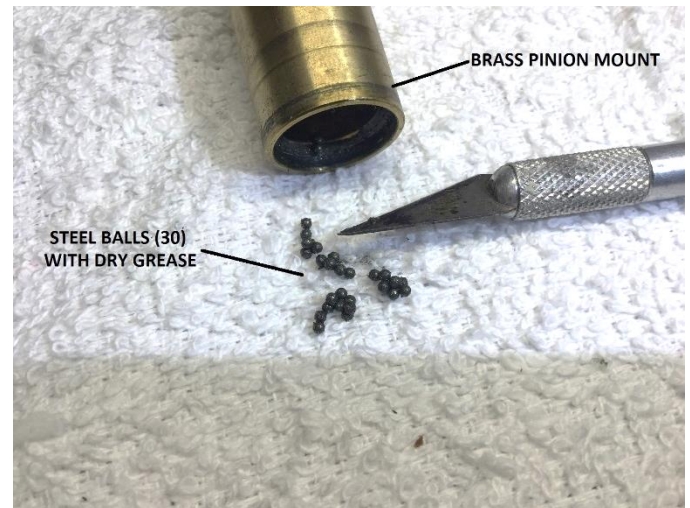
As the slotted brass retaining ring loosens, do not allow the steel pinion to slip out of the brass pinion mount, otherwise the steel balls supporting the gear-end of the steel pinion may drop out and be lost. While keeping the steel pinion fully seated in the brass pinion mount, carefully remove the retaining ring and the 30 steel balls beneath the retaining ring.

[Figure 58](#) shows the steel bearing balls and old dried grease, as frequently found in the retaining-ring end of the pinion assembly after the slotted brass retaining ring has been removed.



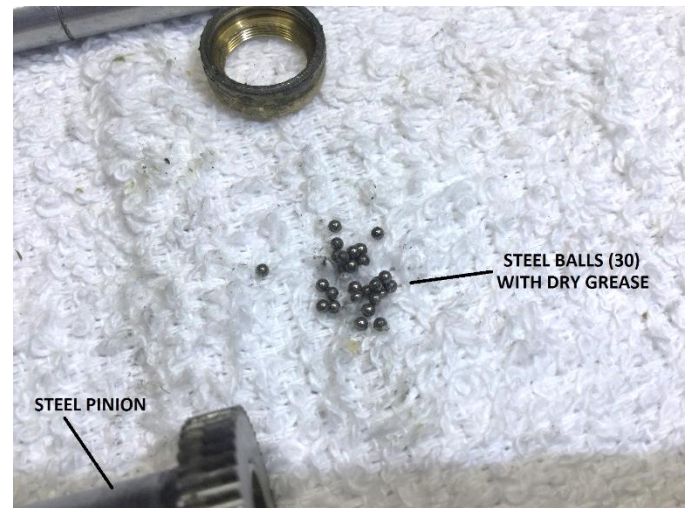
**Figure 58 – The bearing balls with old dried grease**

[Figure 59](#) shows the steel bearing balls with dried grease after they were removed from the retaining-ring end of the pinion assembly.



**Figure 59 – Bearing balls removed from retaining ring end**

Once the steel balls have been removed from the retaining-ring end, and while still holding the pinion assembly over the catch tray, carefully withdraw the steel pinion from the brass pinion mount and remove the 30 steel balls supporting the gear end of the steel pinion (see [Figure 60](#)).



**Figure 60 – The bearing balls removed from gear end**

### **Clean and Reassemble the Pinion Assembly**

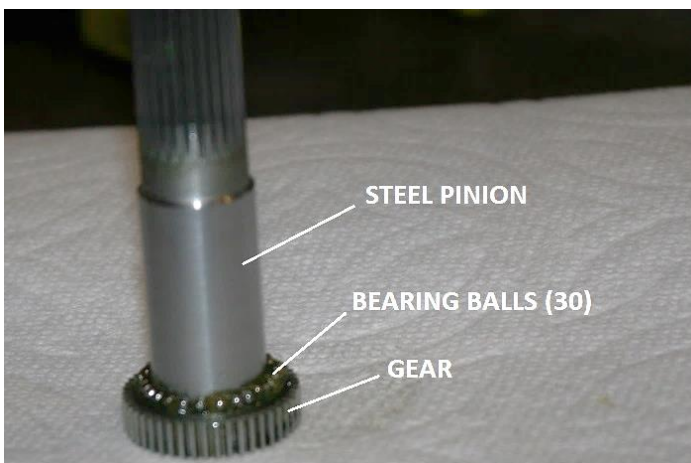
Soak the steel balls in a suitable solvent to remove the old grease, and allow them to dry, or obtain 60 new 1/16" balls (item 1 of Appendix 2). Clean the old grease from the brass pinion mount, the steel pinion, and from the slotted brass retaining ring. Stand the steel pinion on its end, with the gear-end down, and apply a ring of

grease around the perimeter of the back face of the gear (see [Figure 61](#)).



**Figure 61 – Apply grease to back face of the pinion gear**

One at a time, pick up 30 of the steel balls and place them in the ring of grease on the back face of the gear, using fine-point tweezers, and leaving as little space as possible between adjacent balls. Alternatively, the steel balls can be picked up and placed in the grease on the back face of the gear using a toothpick with a small dab of grease on the end. Whichever method is chosen, reposition the balls as necessary, using the tweezers or toothpick as you proceed, to keep them as close together as possible. Continue until 30 of the steel balls have been placed around the back face of the gear (see [Figure 62](#)).

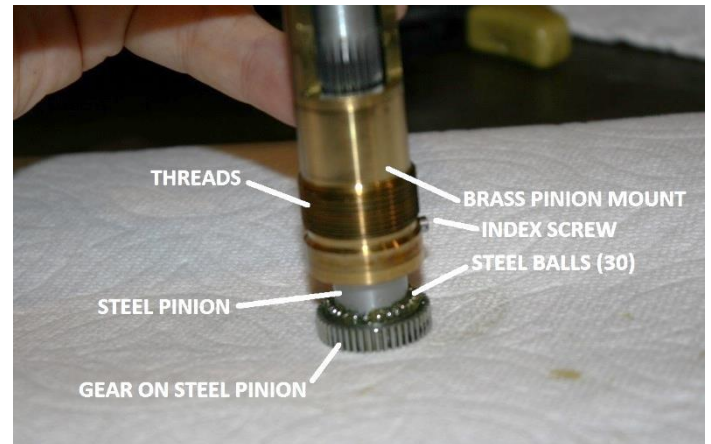


**Figure 62 – Bearing balls on the back face of the gear**

Once all 30 of the steel balls have been placed around the greased back face of the gear, carefully lower the brass pinion mount over the steel pinion (see [Figure 63](#)) with the threaded end (with index screw) facing downward. Lower the brass pinion mount all the way

down, until it's bearing surface contacts the ring of steel balls on the gear, thereby trapping them in place.

As you proceed to re-assemble the pinion assembly, be sure to keep the brass pinion mount fully seated against the ring of steel balls on the back face of the gear, so that the steel balls do not come out of place.



**Figure 63 – Lower brass pinion mount over steel pinion**

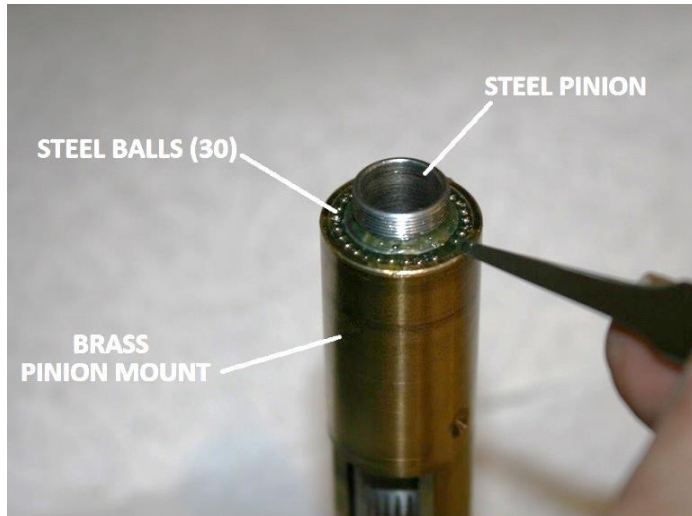
Carefully apply a ring of grease to the opposite end of the brass pinion mount, in the area between the brass pinion mount and the steel pinion (see [Figure 64](#)). Do not apply any grease to the threads of the steel pinion.



**Figure 64 – Apply ring of grease to the retaining ring end**

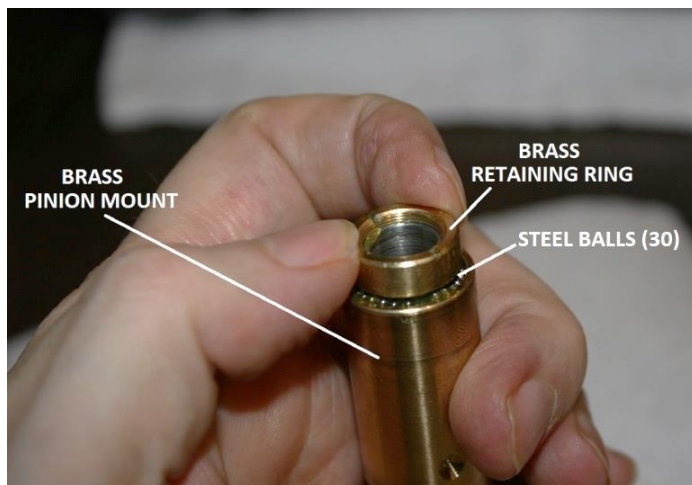
Carefully place the remaining 30 steel balls into this ring of grease, using the same method as described earlier (see [Figure 65](#)). Be careful during this part of the re-assembly, to ensure that none of the grease gets onto the threads of the steel pinion. If any grease does get on these threads, be sure to thoroughly clean it off before proceeding, otherwise this grease will interfere with the bonding of the thread-locking adhesive which

will be applied later to secure the brass retaining ring to the steel pinion.



**Figure 65 – Place bearing balls in the retaining ring end**

Reinstall the brass retaining ring and tighten it to the point where there is no noticeable end-play of the steel pinion in the brass pinion mount (see [Figure 66](#)).



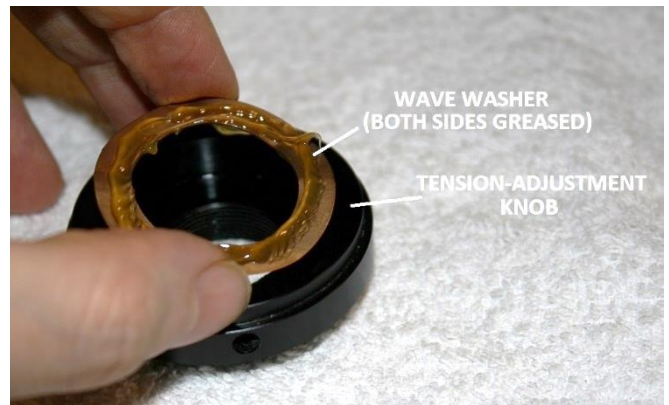
**Figure 66 – Reinstall the slotted brass retaining ring**

Hold the brass pinion mount in one hand and rotate the gear on the steel pinion with the other, and note how it feels. Adjust the retaining ring to the point where the rotation begins to feel rough, and back it off a bit until it feels smooth. If the rotation cannot be made to feel smooth, disassemble the pinion assembly and correct whatever is wrong, and reassemble per above. The final adjustment and staking of the retaining ring will happen in a later assembly step.

### Reinstall Tension-Adjustment Knob & Washers

Clean the old grease from the tension-adjustment knob, wave washer, and nylon washer. Apply grease to both

sides of the wave washer and seat it into the tension-adjustment knob (see [Figure 67](#)).



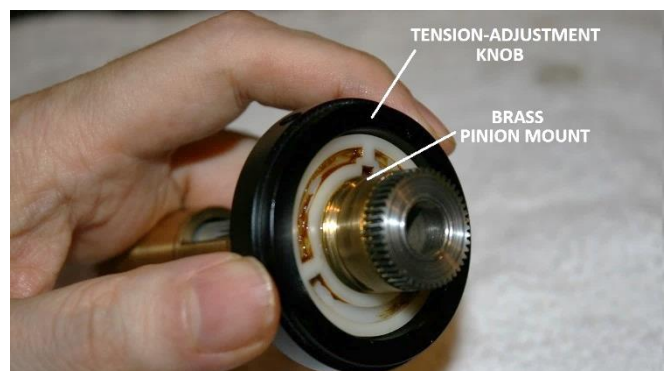
**Figure 67 – Reinstall the greased wave washer**

Apply grease to one of the flat faces of the nylon washer (or to the single flat face, if applicable) and place it on top of the wave washer, with the greased surface contacting the wave washer (see [Figure 68](#)).



**Figure 68 – Reinstall the greased nylon tension washer**

Apply a light coating of grease onto the threads of the brass pinion mount and loosely thread the tension-adjustment knob onto the brass pinion mount (see [Figure 69](#)) from behind the gear. Note that these parts have left-handed threads.



**Figure 69 – Reinstall the tension-adjustment knob**

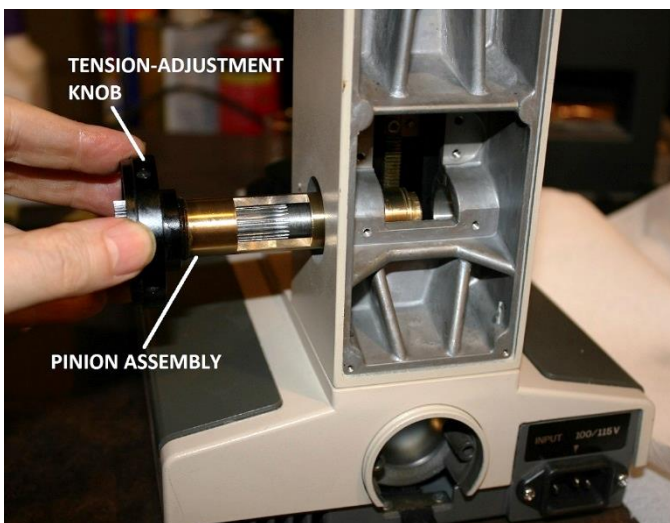
Snug the tension-adjustment knob onto the brass pinion mount, making sure that the index screw on the brass pinion mount seats into the notch in the nylon tension washer as the tension-adjustment knob is snugged (see [Figure 70](#)).



**Figure 70 – Snug the tension-adjustment knob**

### Reinstall the Pinion Assembly into the Frame

From the right-hand side of the frame, carefully insert the pinion assembly (with the tension-adjustment knob and the two tension washers installed) into the frame (see [Figure 71](#)). Be sure to insert the pinion assembly into the frame in the proper orientation such that the two index holes drilled into the brass pinion mount will align with the two set-screw holes in the frame.



**Figure 71 – Slide the pinion assembly into the frame**

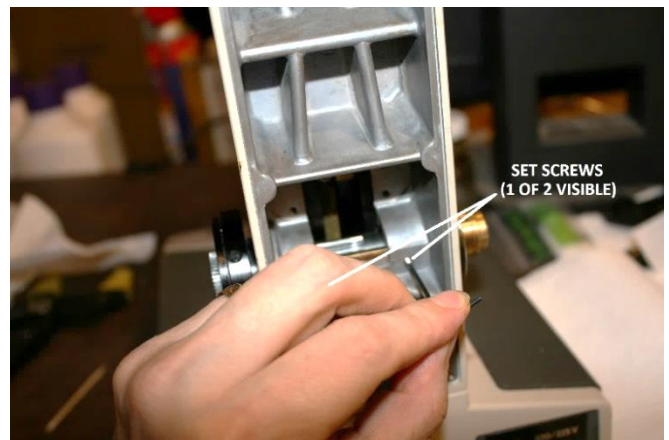
Using a small flashlight, peer into the two threaded set screw holes and position the pinion mount such that the two index holes (see [Figure 72](#)) can be seen through

the threaded holes. This is the proper orientation for the installation of the set screws.



**Figure 72 – A view of the index holes in the pinion mount**

Using a 1.5mm Allen wrench or driver, start the two set screws into the threaded holes of the frame (see [Figure 73](#)). If the fit of the 1.5mm feels loose, try a 1/16" tool.



**Figure 73 – Start both set screws into the frame**

Using a toothpick, apply purple Loctite® to the threads of the two set screws and then tighten them down (see [Figure 74](#)). Apply the Loctite® sparingly, to prevent the screw heads from filling with Loctite® as they are tightened down. The brass pinion mount will lock into the proper position in the frame when the set screws bite into the index holes.



**Figure 74 – Apply Loctite® and tighten both set screws**

Once the pinion assembly has been secured into the frame, rotate the steel pinion by spinning the gear on the right-hand side and note how the ball bearings feel. Adjust the slotted brass retaining ring on the left-hand side to the point where the rotation just begins to feel rough, and back it off a bit until it feels smooth again. Verify that there is no noticeable end play of the steel pinion, and apply blue Loctite® to secure the slotted brass retaining ring to the threads of the steel pinion (see [Figure 75](#)).



**Figure 75 – Apply Loctite® to secure the retaining ring**

### Reinstall the Coarse-Focus Shaft

Apply grease to the metal bearing surface protruding from the rear of the right-hand coarse-focus knob (see [Figure 76](#)). Apply a coating of grease to the coarse-focus shaft.



**Figure 76 – Apply grease to bearing surface and shaft**

From the right-hand side of the frame, insert the coarse-focus shaft into the hollow steel pinion and slide it in until the greased bearing surface contacts the nylon washer in the tension-adjustment knob (see [Figure 77](#)). Be careful when inserting the shaft, so that the drive

gears on the right-hand side are not damaged when they are pressed into mesh with the gear on the steel pinion as the bearing surface seats against the nylon washer.



**Figure 77 – Slide coarse-focus shaft into the hollow pinion**

### Reassemble the Pre-Focus Stop Mechanism

It is important that the sliding surfaces within the pre-focus stop mechanism be extremely clean (i.e., free of grease, fingerprints, debris, etc.) to prevent binding and sluggishness of this mechanism.

Clean the old grease from the threaded lock ring. Be sure to thoroughly clean the inside surface of any grease or contamination. Using a suitable JIS screwdriver, reinstall the threaded lock ring with three flat-head screws<sup>3</sup> (see [Figure 78](#)).



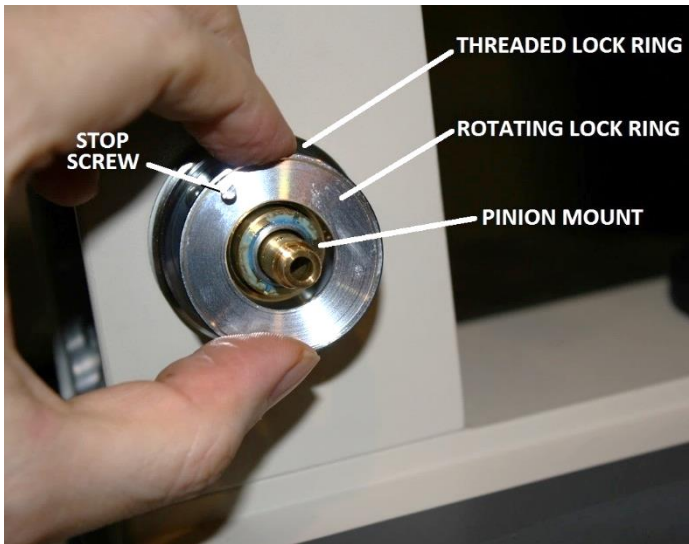
**Figure 78 – Reinstall the threaded lock ring**

Thoroughly clean both sides of the rotating lock ring, as well as the outside surface of the brass pinion mount that protrudes from the left-hand side of the frame, of any grease or contamination. Place the rotating lock ring over the brass pinion mount and into the threaded

<sup>3</sup> This applies if the threaded lock ring was removed earlier.



lock ring, with the stop screw facing outward (see [Figure 79](#)).



**Figure 79 – Reinstall the rotating lock ring**

Lightly grease the threads around the perimeter of the threaded lock ring, being careful to not get grease anywhere else (see [Figure 80](#)).



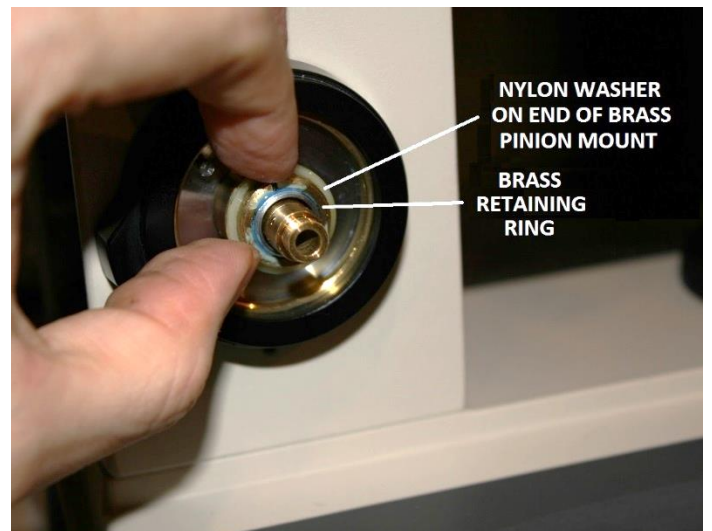
**Figure 80 – Lightly grease threads of threaded lock ring**

Clean the old grease from the threads of the pre-focus lock collar. Be sure to thoroughly clean the inside brass bearing surface of any grease or contamination. Screw the pre-focus lock collar onto the threaded lock ring, making sure that no grease gets on the rotating lock ring, the flat surface of the threaded lock ring, or the inside brass bearing surface of the pre-focus lock collar (see [Figure 81](#)).



**Figure 81 – Reinstall the pre-focus lock collar**

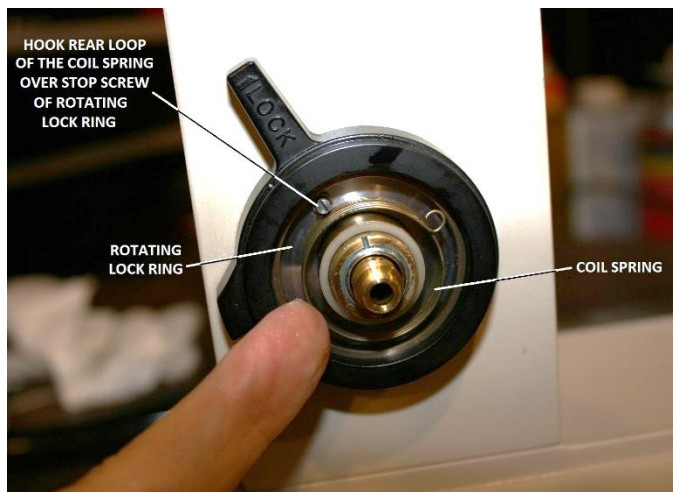
Clean the old grease from the nylon washer that was removed from the end of the brass pinion mount. Lightly coat both sides of this washer with fresh grease and seat the washer onto the end of the brass pinion mount (see [Figure 82](#)).



**Figure 82 – Reinstall nylon washer on end of pinion mount**

With the pre-focus lock collar loosened, rotate the rotating lock ring until the stop screw is at the 11:00 position. Rotate the lock collar clockwise to snug the rotating lock ring at this position. Now place the coil spring over the brass pinion mount and engage the rear

loop of the spring with the forward-facing stop screw on the rotating lock ring (see [Figure 83](#)).



**Figure 83 – Place the rear loop of spring over stop screw**

Clean the old grease from the brass shaft mount. Hold the brass shaft mount up to the threads of the coarse-focus shaft protruding on the left-hand side, with the rear-facing stop screw at approximately the 3:00 position. Engage the front loop of the coil spring with the rear-facing stop screw on the back of the brass shaft mount, making sure that the rear loop stays engaged with the forward-facing stop screw on the rotating lock ring (see [Figure 84](#)).



**Figure 84 – Place the front loop of spring over stop screw**

While holding the brass shaft mount against the threaded coarse-focus shaft protruding on the left-hand side, rotate the right-hand coarse-focus knob clockwise until the coarse-focus shaft engages the threads in the back of the brass shaft mount. Once the threads engage, withdraw the right-hand coarse-focus knob slightly so that the brass shaft mount comes into

contact with the pinion assembly protruding on the left-hand side.

While holding the brass shaft mount in this position, preload the coil spring by rotating the brass shaft mount clockwise until the rear-facing stop screw bumps up against the forward-facing stop screw on the rotating lock ring (which is at the 11:00 position). When the stop screws make contact, apply a slight clockwise force to the brass shaft mount and press in on the right-hand coarse-focus knob until the brass shaft mount moves out just enough to allow the rear-facing stop screw to move past the forward-facing stop screw (i.e., just past the 11:00 position). As soon as this happens, withdraw the right-hand coarse-focus knob to once again seat the brass shaft mount against the protruding pinion assembly. The coil spring is now pre-loaded.

From this point on, it is important to not allow the brass shaft mount to rotate, to prevent damaging the coil spring. While holding the brass shaft mount stationary with the non-marring pliers, and with it in contact with the protruding end of the pinion assembly, carefully rotate the right-hand coarse-focus knob clockwise until the brass shaft mount begins to snug down. Be careful that the gears on the right-hand side are not damaged as they slip into mesh when the brass shaft mount snugs down.

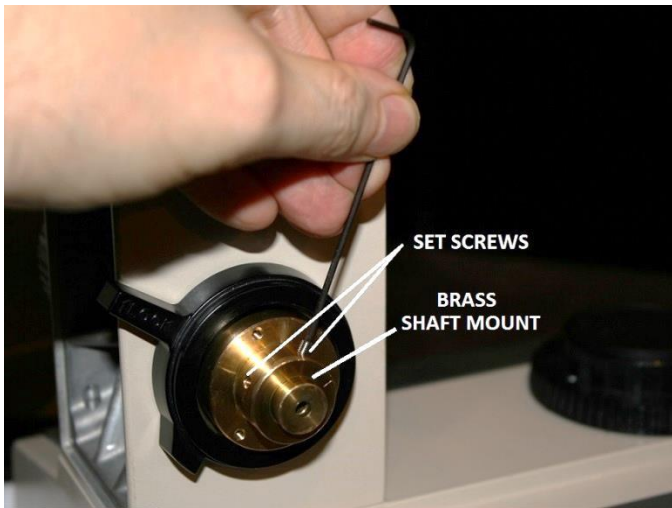
Once the brass shaft mount starts to snug down, release the pliers grip from the brass shaft mount (and loosen the tension-adjustment knob on the right-hand side, if necessary) and rotate the left-hand coarse-focus knob back-and-forth slightly, to assess the freedom of rotation of the coarse-focus knob and brass shaft mount.

If the knob feels stiff or will not rotate, the coil spring may be out of place and may be interfering with the brass shaft mount. If this is the case, do not tighten any further or the coil spring may be damaged. In this event, turn the coarse-focus knob counter-clockwise to loosen and remove the brass shaft mount, and reassemble per above until the coarse-focus knob rotates freely with the brass shaft mount snugged down.

Grip the brass shaft mount with non-marring pliers once again and rotate the right-hand coarse-focus knob clockwise to hand tighten the brass shaft mount. Release the pliers grip on the brass shaft mount. With the tension-adjustment knob on the right-hand side loosened (i.e., rotated counter-clockwise), spin the coarse-focus knob on the right-hand side back-and-

forth slightly to make sure that it rotates freely. Once again, if excessive friction is encountered, remove the brass shaft mount and repeat the assembly steps above until the coarse-focus knob rotates freely.

Once the brass shaft mount has been hand-tightened, if the action of the coarse-focus knob is found to be acceptable, use a 1.5mm Allen wrench or driver to reinstall and tighten the two perpendicular set screws into the brass shaft mount to prevent this piece from loosening from the coarse-focus shaft (see [Figure 85](#)). If the 1.5mm feels loose, try a 1/16" tool.



**Figure 85 – Reinstall set screws to lock the shaft mount**

### Test the Pre-Focus Stop Mechanism

Test the operation of the pre-focus stop mechanism by loosening the plastic lock collar on the left-hand side and rotating the brass shaft mount counter-clockwise a bit. Now rotate the plastic lock collar clockwise to set the pre-focus stop. Verify that the brass shaft mount cannot be further rotated counter-clockwise, but will freely rotate clockwise.

Rotate the brass shaft mount clockwise approximately one quarter turn from the stop and loosen the lock collar. You should hear a positive “slap” sound when the lock collar is loosened. Snug the lock collar once again and verify that the brass shaft mount cannot be rotated counter-clockwise, but can be freely rotated clockwise. The pre-focus stop mechanism is working correctly if these conditions are met.

If the brass shaft mount can be rotated a noticeable amount in the counter-clockwise direction from the point where the lock collar was set, this indicates that the pre-focus stop mechanism is not working properly. The coil spring may not have been properly pre-loaded

or there may be grease or other contamination on one or more of the various stop pieces preventing the rotating lock ring from moving freely. If this is the case, disassemble and correct whatever is wrong, and reassemble as described above.

### Reinstall Stop Screw for Pre-Focus Lock Collar

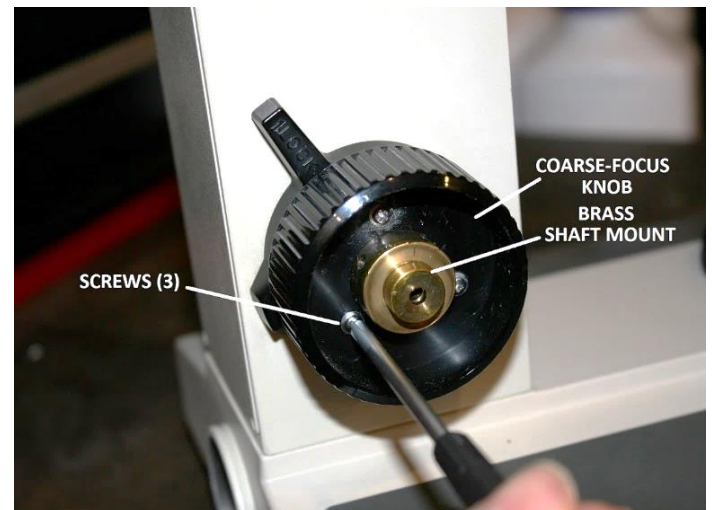
Rotate the plastic lock collar on the left-hand side clockwise, to set the pre-focus stop. Using a small (3mm) slotted screwdriver, reinstall the slotted stop screw into the hole just below the plastic lock collar (see [Figure 86](#)).



**Figure 86 – Reinstall slotted stop screw for lock collar**

### Reinstall the Left-Hand Coarse-Focus Knob

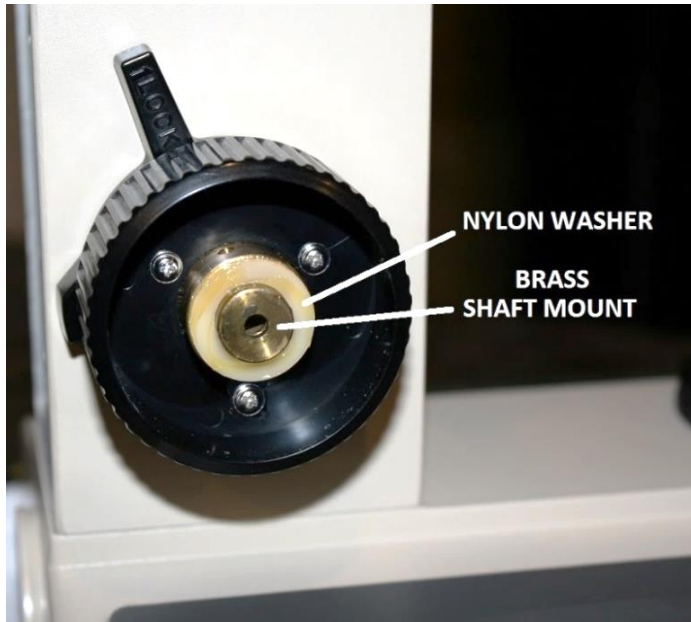
Place the left-hand coarse-focus knob over the brass shaft mount. Using a suitable JIS screwdriver, reinstall the three screws to secure the knob onto the brass shaft mount (see [Figure 87](#)). Do not overtighten these screws, or the knob may crack.



**Figure 87 – Reinstall the coarse-focus knob**

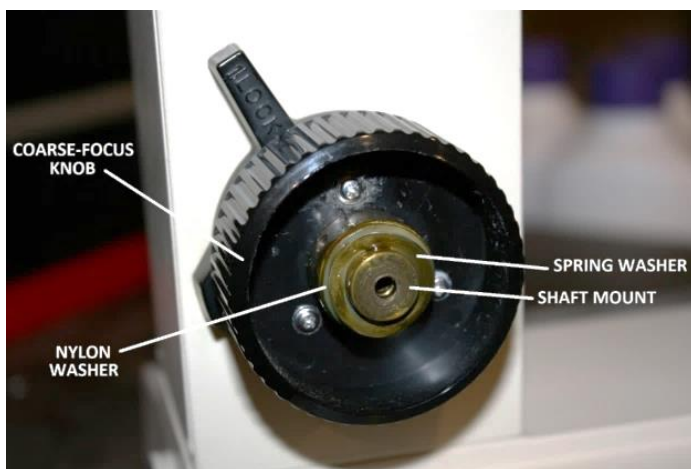
### Reinstall the Fine-Focus Thrust Washers

Clean the old grease from the nylon thrust washer, and apply fresh grease to both sides of this washer. Reinstall the nylon washer onto the shoulder of the brass shaft mount (see [Figure 88](#)).



**Figure 88 – Reinstall nylon washer onto the shaft mount**

Clean the old grease from the curved-disk spring washer, and apply a fresh coating of grease to both sides of this washer. Reinstall the spring washer over the top of the nylon washer (see [Figure 89](#)).

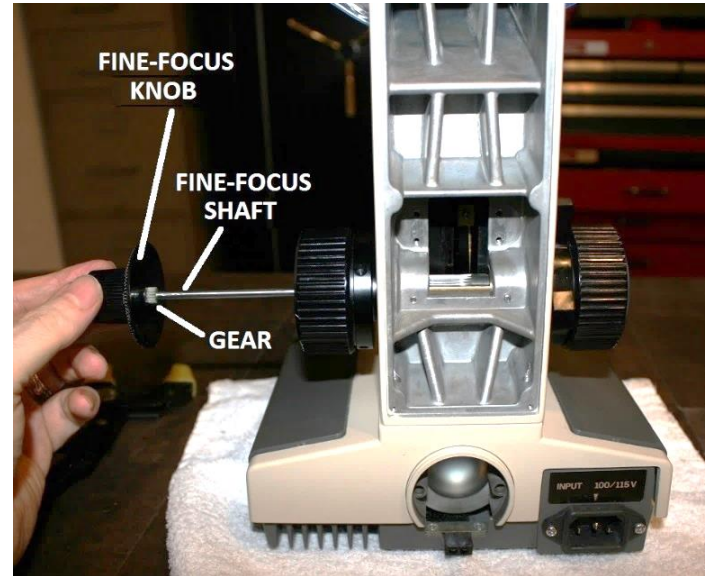


**Figure 89 – Reinstall spring washer over the nylon washer**

### Reinstall Fine-Focus Shaft with Attached Knob

Clean the old grease from the fine-focus shaft. Apply a light coating of fresh grease to the entire length of the shaft and insert the shaft into the hole in the coarse-

focus shaft, from the appropriate side (see [Figure 90](#)). Be very careful if inserting the shaft from the right-hand side, such that the small plastic gear which is pressed into the underside of the fine-focus knob (see [Figure 15](#)) does not get damaged when it is pressed into mesh with its mating gear in the coarse-focus knob as the shaft seats.



**Figure 90 – Slide fine-focus shaft into coarse-focus shaft**

### Reinstall the Second Fine-Focus Knob

Insert a 2.5mm Allen wrench or driver into the screw in the fine-focus knob that is attached to the fine-focus shaft. Slip the remaining fine-focus knob over the fine-focus shaft protruding on the opposite side (see [Figure 91](#)). If this is on the right-hand side, be careful when doing this, such that the small plastic gear which is pressed into the underside of the fine-focus knob (see [Figure 15](#)) does not get damaged when the shaft slips into this gear or when the gear is pressed into mesh with its mating gear in the coarse-focus knob.



**Figure 91 – Reinstall the fine-focus knob (left side shown)**

Use a second 2.5mm Allen wrench or driver to reinstall the screw and lock washer to secure the loose fine-focus knob (see [Figure 92](#)) onto the fine-focus shaft. Be sure to keep the fine-focus knob on the right-hand side fully seated while tightening the screws, to prevent damaging the fragile plastic gear pressed into the underside of the right-hand fine-focus knob (see [Figure 15](#)).

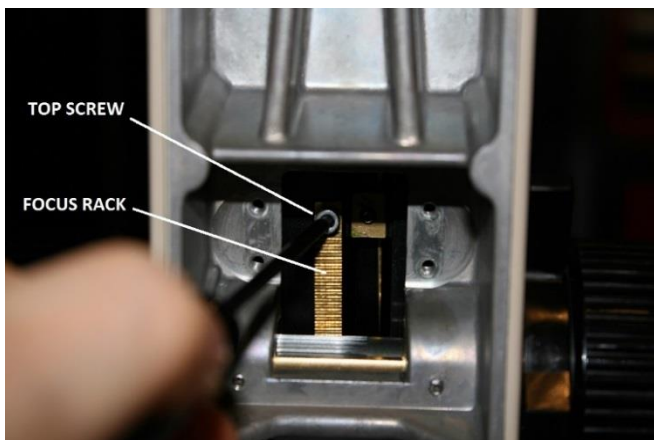


**Figure 92 – Reinstall the set screw to secure the knob**

After tightening the set screws in the knobs, verify that both the coarse-focus and fine-focus knobs rotate freely. Test for end-play in the fine-focus knobs. If noticeable end-play is present, remove the fine-focus knobs and re-shape the curved-disk spring washer on the shoulder of the brass shaft mount and reassemble per above.

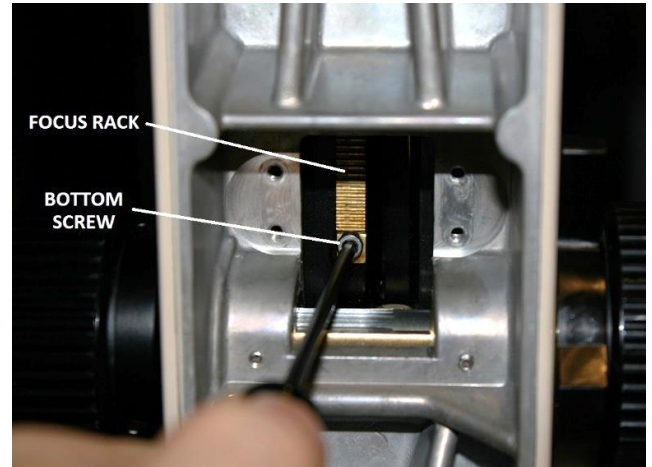
### Reinstall the Focus Rack on Sliding Focus Block

Clean the old grease from the brass focus rack. With the sliding focus block sitting at its lowest position, loosely mount the brass focus rack onto the back of the sliding focus block by reinstalling the top mounting screw, using a 2.5mm Allen wrench or driver (see [Figure 93](#)). Do not fully tighten this screw yet.



**Figure 93 – Reinstall the top screw to hang the focus rack**

Reach around to the front of the stand with one hand, and raise the sliding focus block to gain access to the bottom screw hole in the brass focus rack. Reinstall and tighten the bottom screw while holding the sliding focus block in this position (see [Figure 94](#)). Lower the sliding focus block back to its lowest position and tighten the top screw.

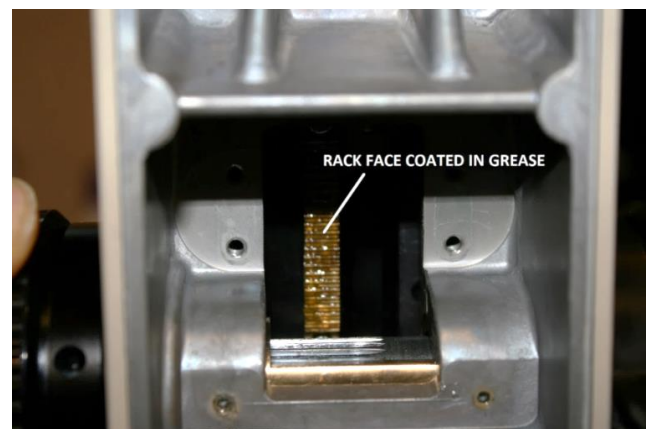


**Figure 94 – Reinstall the lower screw for the focus rack**

### Grease the Brass Focus Rack (Optional)

Note: This step is optional, and may be omitted if the equipment will be used in an environment where debris might accumulate on the greased focus rack and foul the mechanism.

Apply grease to the teeth of the brass focus rack, manipulating the sliding focus block as necessary to expose the face of the rack to facilitate the application. Make sure that the entire face of the rack is greased (see [Figure 95](#)).

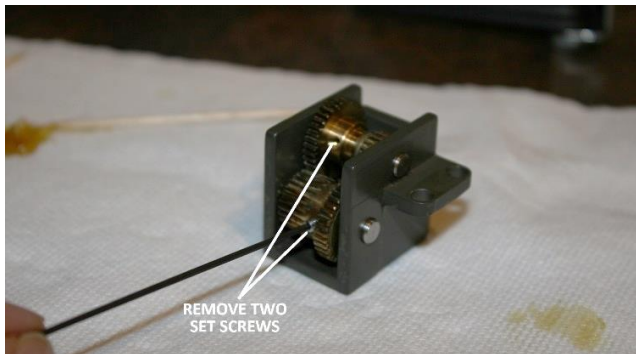


**Figure 95 – Grease the teeth of the focus rack (optional)**

### Disassemble the Gearbox

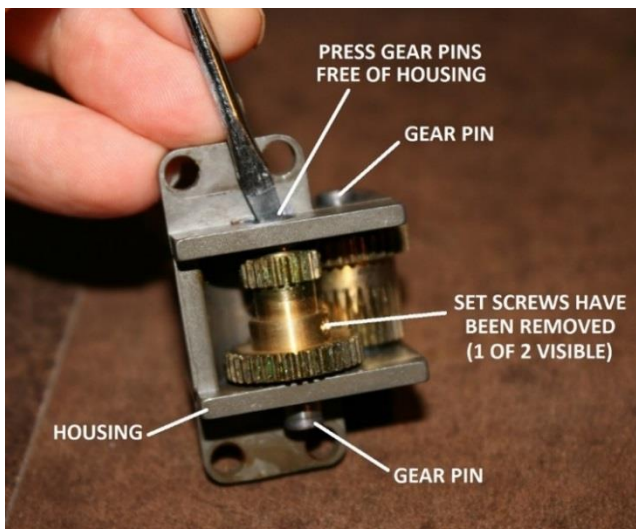
The gearbox must be fully disassembled so that the old grease can be removed. To disassemble the gearbox,

rotate the gears until the two Allen-head set screws are accessible, and remove these screws using a .050" Allen wrench or driver (see [Figure 96](#)). If necessary, heat the gearbox with a heat gun to allow the gears to rotate.



**Figure 96 – Remove two set screws securing the gears**

Use the tip of a screwdriver to press the two gear pins free of the gear housing (see [Figure 97](#)) and remove the two gears and the four nylon washers at the ends of the gears. If necessary, heat the gearbox with a heat gun to allow the pins to be removed. The fully disassembled gearbox is shown in [Figure 98](#).



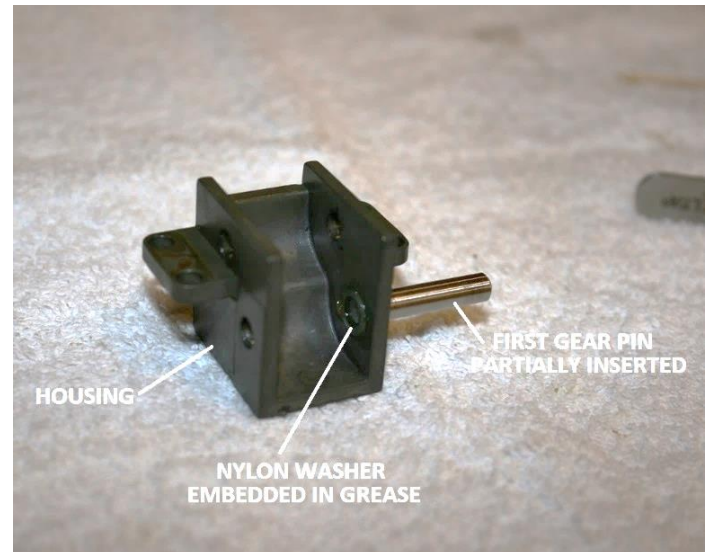
**Figure 97 – Press both gear pins free of the housing**



**Figure 98 – A view of the gearbox fully disassembled**

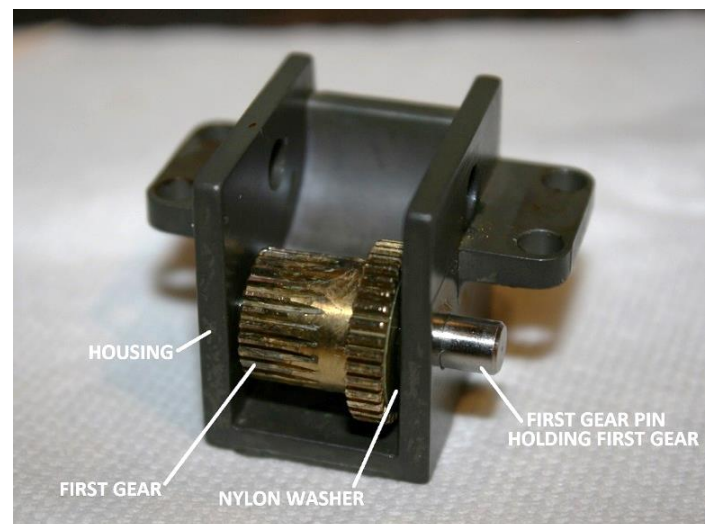
### Clean and Reassemble the Gearbox

Clean the old grease from the gears, gear pins, nylon washers, and from the gear housing. Stick one of the nylon washers into position inside the gear housing, using a bit of grease, and apply grease inside the hole as well. Partially insert the first gear pin into the housing (see [Figure 99](#)), in preparation for the installation of the first gear.



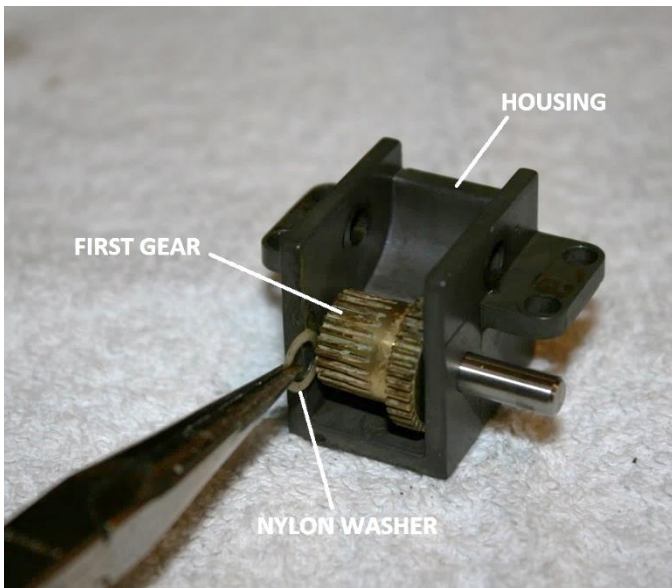
**Figure 99 – Washer and pin ready to receive the first gear**

Apply a light coating of grease onto both end faces of the first gear. Hold the first gear in the proper position and press the first gear pin into the housing until the first gear is engaged with the pin, but not to the point where the gear pin protrudes from the opposite end of the first gear (see [Figure 100](#)). This will allow a nylon washer to be installed on the opposite end of the gear.



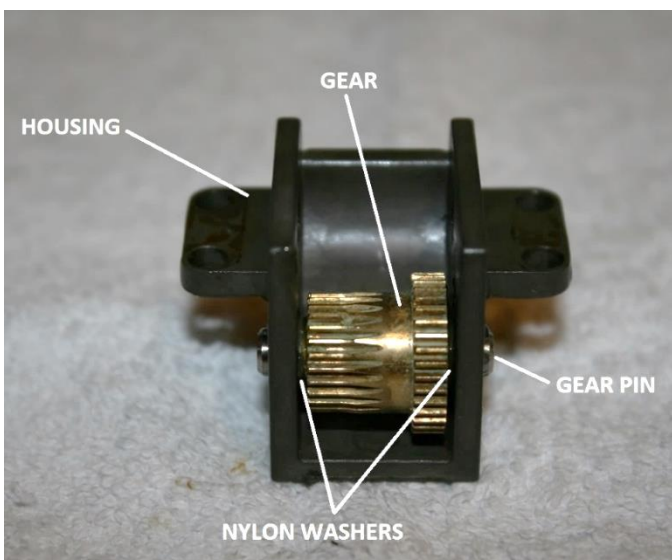
**Figure 100 – The first gear held in place by the gear pin**

Using tweezers or needle-nose pliers, slide a nylon washer in between the opposite end of the first gear and the wall of the gear housing (see [Figure 101](#)).



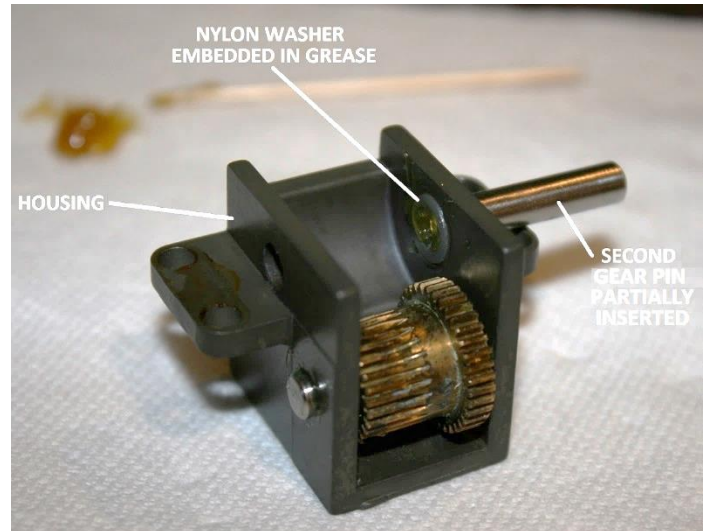
**Figure 101 – Insert nylon washer on opposite side of pin**

Look into the hole in the housing where this washer was just inserted and reposition the washer with a toothpick or tweezer tips as necessary to properly align it with the hole, such that the washer will not be damaged when the gear pin is slid into this hole. Apply grease to the inside of the hole and slide the gear pin into the final position to retain the nylon washer, being careful not to damage the washer. Make sure that the gear pin protrudes from both sides of the housing by approximately the same amount (see [Figure 102](#)).



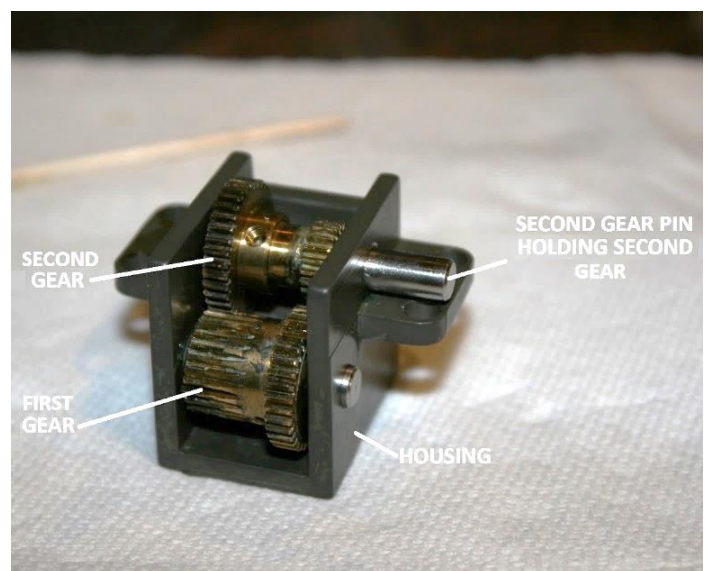
**Figure 102 – Gear pin and first gear in final position**

As before, use a bit of grease to stick a nylon washer into position inside the gear housing, for the second gear. Apply grease inside the hole as well. Partially insert the second gear pin into the housing (see [Figure 103](#)), in preparation for the installation of the second gear.



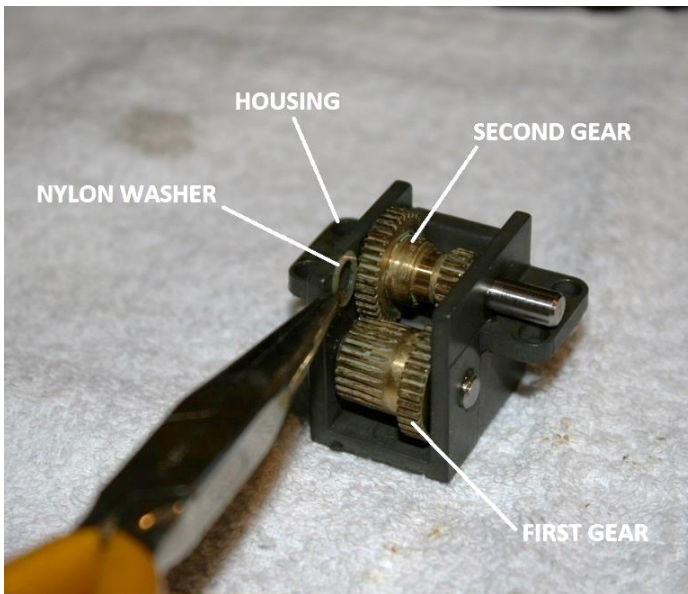
**Figure 103 – Washer and pin ready to receive second gear**

Apply a light coating of grease onto both end faces of the second gear. Hold the second gear in the proper position and press the second gear pin into the housing until the second gear is engaged, but not to the point where the gear pin protrudes from the opposite end of the second gear (see [Figure 104](#)). This will allow a nylon washer to be installed on the opposite end of the gear.



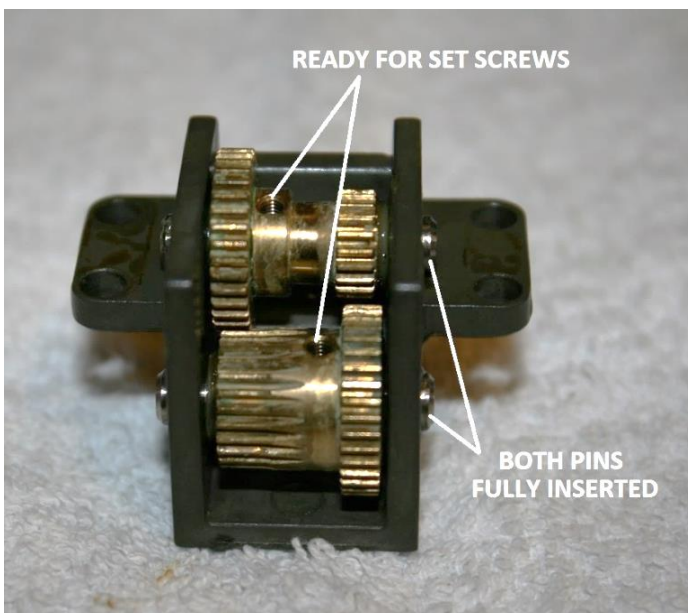
**Figure 104 – The second gear held in place by the gear pin**

Using tweezers or needle-nose pliers, slide a nylon washer in between the opposite end of the second gear and the wall of the gear housing (see [Figure 105](#)).



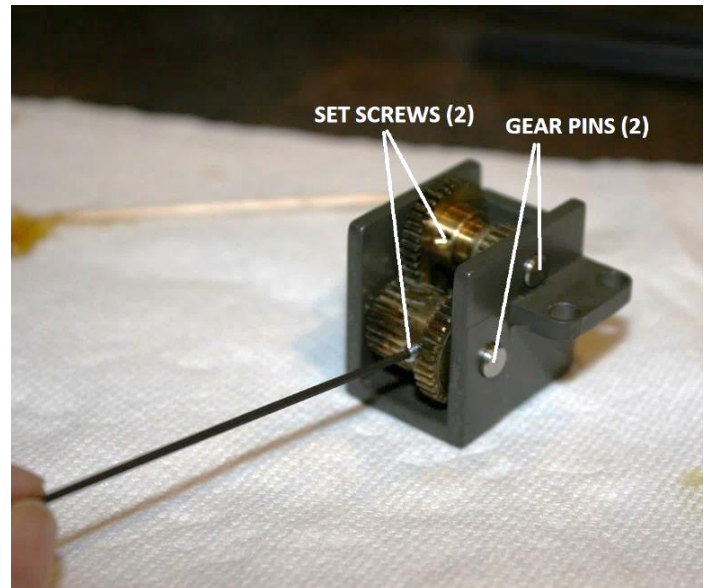
**Figure 105 – Insert nylon washer on opposite side of pin**

Look into the hole in the housing where this washer was just inserted and reposition the washer with a toothpick or tweezer tips as necessary to properly align it with the hole, such that the washer will not be damaged when the gear pin is slid into this hole. Apply grease to the inside of the hole and slide the gear pin into the final position to retain the nylon washer, being careful not to damage the washer. Make sure that the gear pin protrudes from both sides of the housing by approximately the same amount (see [Figure 106](#)).



**Figure 106 – Gear pins holding both gears**

Using a .050" Allen wrench or driver, loosely reinstall the two set screws used to secure the two gears onto the gear pins. If necessary, readjust the positioning of the two gear pins such that there is an equal amount protruding from each side of the gear housing, and then tighten the two set screws to secure the gears onto the gear pins (see [Figure 107](#)).



**Figure 107 – Reinstall two set screws to secure the gears**

### Reinstall the Gearbox

Apply grease to the teeth of both gears, rotating them as necessary to ensure complete coverage of all of the teeth (see [Figure 108](#)).



**Figure 108 – Apply grease to the teeth of both gears**

Add a small dab of grease between the two mounting holes on both mounting flanges of the gearbox. Place the two brass shims into position, allowing the grease to hold them in place while you reinstall the gearbox (see [Figure 109](#)).



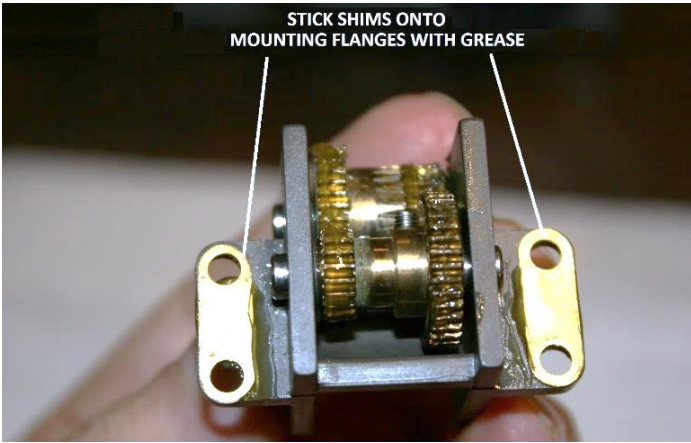


Figure 109 – Stick shims onto housing with dabs of grease

Hold the gearbox up to the mounting surface of the frame and align the four holes in the mounting flanges with the four threaded holes in the frame (see Figure 110).

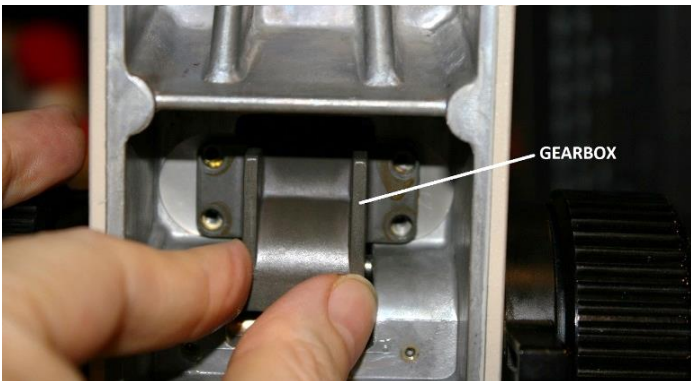


Figure 110 – Hold gearbox to the mounting surface

Using a 2.5mm Allen wrench or driver, loosely reinstall the top two Allen-head screws and lock washers to hold the gearbox in place (see Figure 111). Be sure not to damage the brass shims when reinstalling these screws.

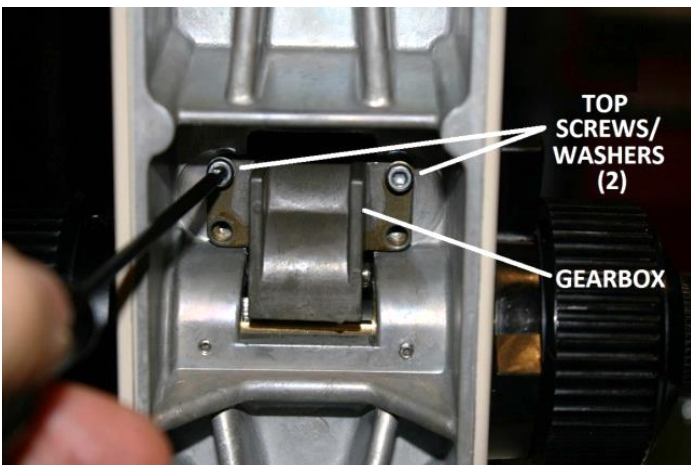


Figure 111 – Start the top screws for the gearbox

Sight through the two bottom screw holes on the mounting flanges of the gearbox, and re-position the gearbox as necessary until the mounting holes are centered relative to the threaded holes in the frame.

Hold the gearbox in this position and use a toothpick or tweezer tips to adjust the position of the brass mounting shims as necessary so that they do not obstruct the threaded holes. Loosely reinstall the two remaining screws and lock washers in the bottom holes of the gearbox (see Figure 112).

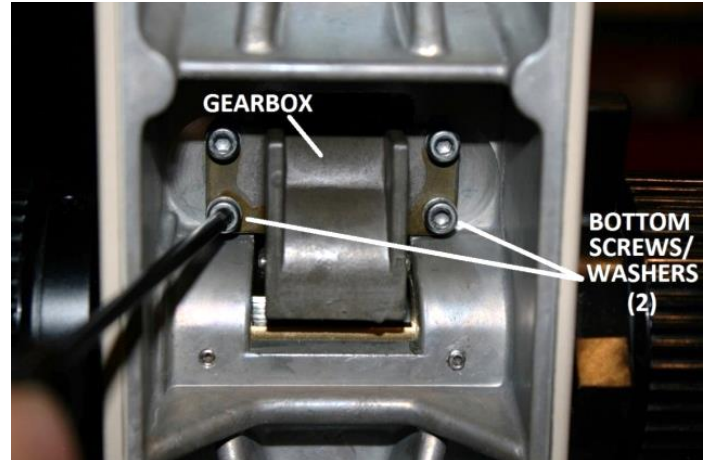


Figure 112 – Start the bottom screws for the gearbox

Snug all four of the screws down lightly, and then back them off a bit such that the gearbox is just free enough to shift on the mounting screws. Manipulate the sliding focus block by hand and observe how the gearbox shifts on its mounting screws as the sliding focus block is moved up and down.

Hold the sliding focus block such that the gearbox is centered (i.e., is not straining against the mounting screws in either direction) and tighten all four screws to secure the gearbox in this position (see Figure 113). Verify that the coarse-focus mechanism feels smooth when adjusted throughout its range using the coarse-focus knobs. If it does not feel smooth, loosen the four mounting screws, readjust the positioning of the gearbox, and re-tighten the four screws until it does feel smooth.

An alternative way to position the gearbox is to lay the stand down on its nose, such that the weight of the sliding focus block no longer pulls on the gearbox, and hold the gearbox in the proper position while tightening the four screws to secure it.

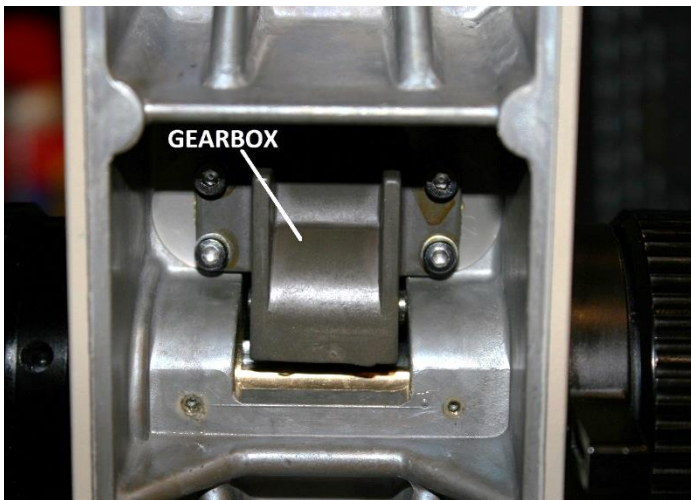


Figure 113 – The gearbox reinstalled in proper position

### Reinstall the Rear Cover

Using a suitable JIS screwdriver, reinstall the rear cover onto the back of the arm with the four small, cross-point screws (see Figure 114).

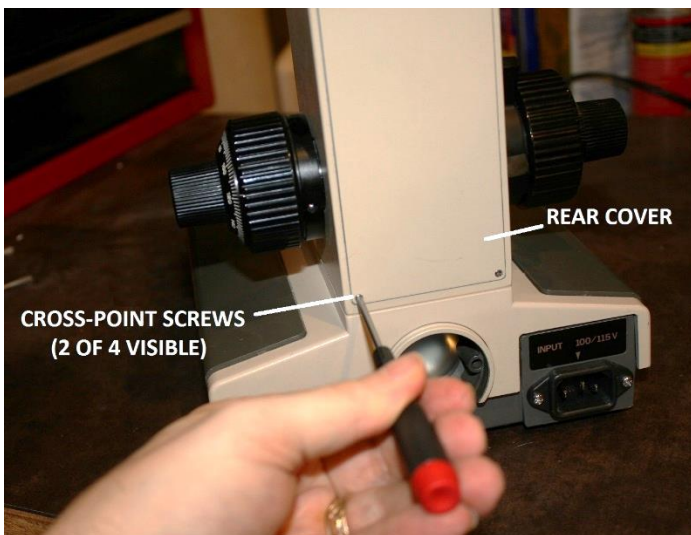


Figure 114 – Reinstall rear cover on the back of the arm

### Reinstall the Fine-Focus Knob Caps

Reinstall the two knob caps onto the ends of the fine-focus knobs (see Figure 115). If the adhesive on the knob caps will no longer adequately hold the caps to the knobs, a layer of double-sided tape (item 6 of Appendix 2) may be applied to the back side of the caps to hold them in place. Before applying double-sided tape to the knob caps, be sure to clean the existing adhesive off the knob caps with a suitable solvent.

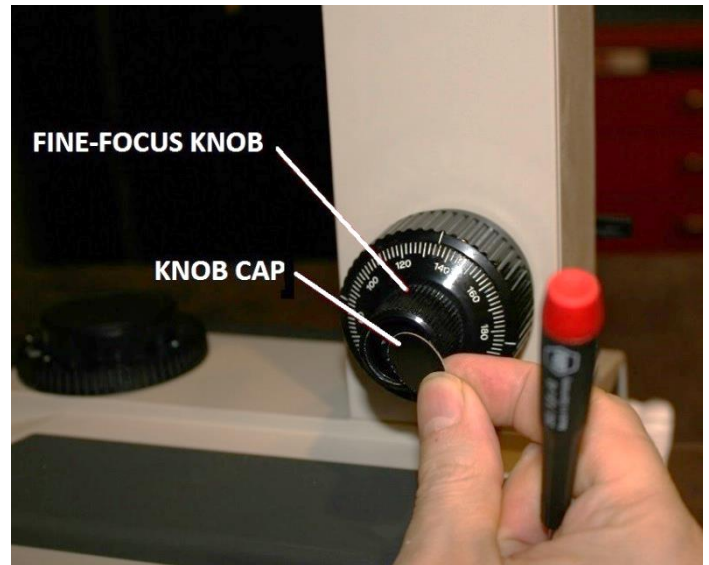


Figure 115 – Reinstall the caps on both fine-focus knobs

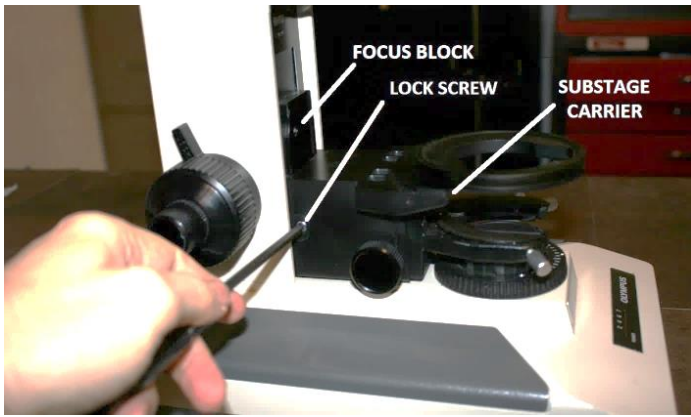
### Reinstall the Substage Condenser Carrier

Adjust the condenser-height knob on the substage condenser carrier to raise the condenser mount to the top of its range of travel. Rack the sliding focus block on the stand to its lowest position using the coarse-focus knobs. Lower the substage condenser carrier (with the condenser mount at the top-most end of its travel) onto the mounting rails of the sliding focus block on the frame (see Figure 116).



Figure 116 – Lower substage condenser carrier onto rails

Using a 3mm Allen wrench or driver, tighten the Allen-head lock screw to secure the substage condenser carrier in place on the sliding focus block (see Figure 117).



**Figure 117 – Secure the substage condenser carrier**

### Reinstall the Lamp House

Reinstall the lamp house onto the back of the base of the microscope stand by engaging the two alignment pins into the holes on the back and seating the lamp house with gentle pressure (see [Figure 118](#)). Do not touch the halogen lamp with your fingers, as oils from your skin may cause premature failure of the bulb. If the bulb is accidentally touched, clean it with isopropyl alcohol.



**Figure 118 – Reinstall the lamp house on rear of the base**

### Reinstall the Accessories

Remove the plastic bag protecting the upper arm. Reinstall all the major components onto the microscope stand (i.e., AC power cord, condenser, x-y stage, viewing head, eyepieces, objectives, and nosepiece, if applicable). Remove the protective cap from the field lens.

### Ready for Service

The newly reconditioned microscope stand is now ready to be put back into service.

### Acknowledgements

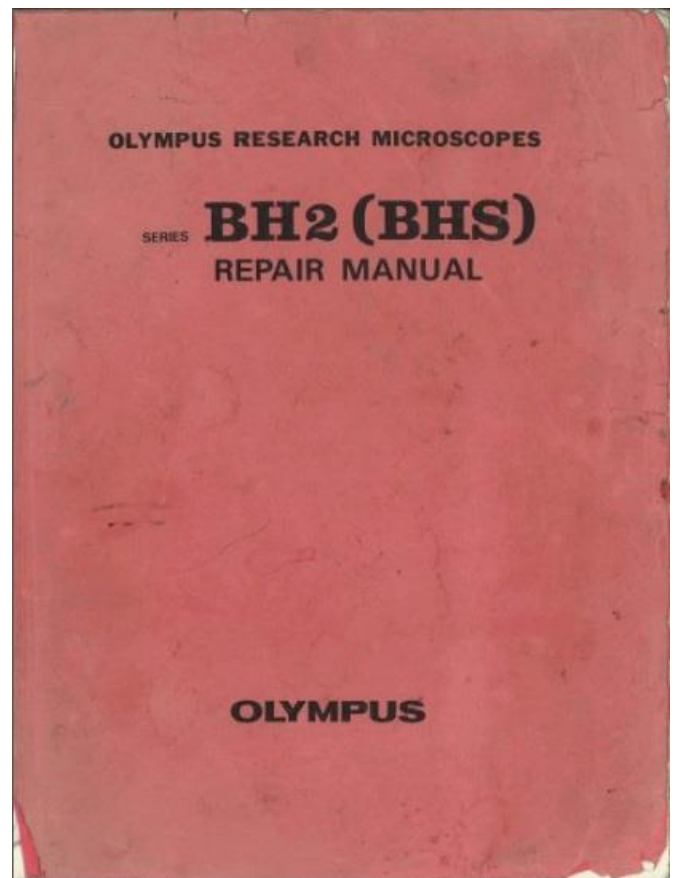
Special thanks to Jerry Clement, of J & H Microscope Services in Madison, Wisconsin, for his generous assistance and encouragement, without which this document would not have been written.

### How to Contact the Author

Please feel free to direct any questions or comments regarding this document to the author, at the following email address: [carlh6902@ieee.org](mailto:carlh6902@ieee.org)

### Original Olympus Documentation

An early version of the *Olympus Research Microscope Series BH2 (BHS) Repair Manual* (see [Figure 119](#)) was referenced during the preparation of this document. A scanned PDF version of this manual is available for download at various microscope-related hobbyist sites on the internet, and can be readily located by searching for the title in an internet search engine, such as Google or Bing.



**Figure 119 – The Olympus BHS repair manual**

## Appendix 1

### A Caution About the Plastic Gears in the Olympus BH-2

#### Shipping Damage of BH-2 Microscope Stands

The Achilles heel of the BH-2 microscope stand is the small plastic gear pressed into the underside of the right-hand fine-focus knob. [Figure 120](#) shows a view of this gear, pressed into the back of a fine-focus knob, and [Figure 121](#) shows the knob with this gear pressed in, and with the fine-focus shaft installed, as well.

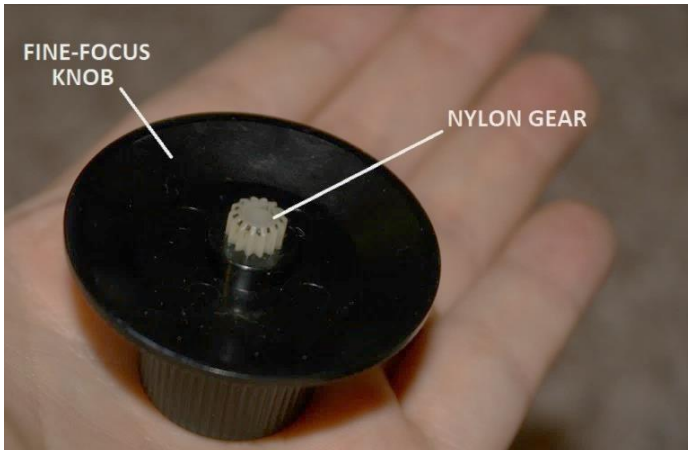


Figure 120 – Plastic gear in the back of fine-focus knob

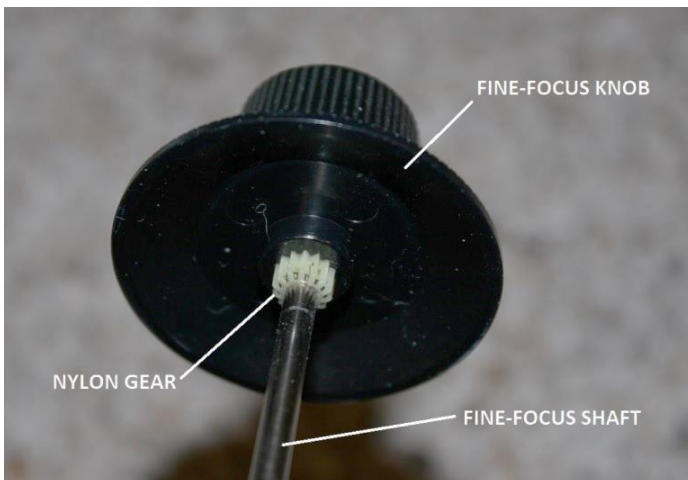


Figure 121 – The fine-focus shaft and plastic gear in knob

This gear, which is no longer available from Olympus, is inherently fragile and very frequently sustains damage when these microscope stands are packaged incorrectly for shipping. The BH-2 stands must be packaged such that the normal shocks which occur during shipping do not produce excessive stresses on this gear, otherwise damage can (and very frequently does) occur.

[Figure 122](#) shows an example of what can happen to a BH-2 stand during shipping when the proper packaging guidelines are not followed. As many as 10-20% of all BH-2 stands which are improperly shipped will be damaged in this way.

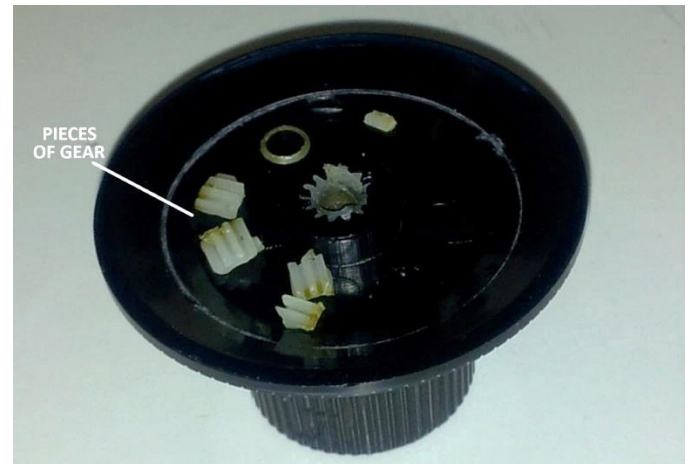


Figure 122 – A fine-focus gear broken during shipping

In addition to breaking this plastic gear, these shocks also can damage the brass focus rack mounted on the back side of the sliding focus block (see [Figure 123](#)). The teeth on this part may be deformed, or in extreme cases, sheared off entirely. And of course, these parts also are not available from Olympus.



Figure 123 – The brass focus rack

#### Preparing BH-2 Stands for Shipping

To prevent the damage described above, it is critical that all BH-2 stands be properly prepared and packaged prior to shipment. Refer to the document [Successfully Shipping Olympus BH-2 Microscopes](#) for details of how to ship BH-2 microscopes without physical damage.

## Appendix 2

### Sources for Replacement Parts, Tools, and Supplies Referenced in this Document

**Table 1** lists specific information for the various parts, tools, and supplies discussed in this document. The pricing and availability listed below is accurate as-of April 2017, but is subject to change without notice.

Item	Description	Manufacturer	Manufacturer Model / #	Vendor	Vendor #	Price
1	Bearing balls, chrome steel, 1/16" (.062"), G5, 100 count	various	---	Amazon	---	\$5.90
2	Brake Grease, Plastilube®, 35 cc	Plastilube®	ATE70014	Amazon	---	\$8.82
	Brake Grease, Plastilube®, 75 cc	Plastilube®	ATE70015	Amazon		\$8.42
3	Heat Gun, electric, 1500W	Drill Master	---	Harbor Freight	96289	\$12.99
4	Pliers, soft-jaw	---	Non-Scratch Pliers	Micro-Mark	---	\$34.95
	Pliers, non-scratch	Tamiya	74061	Amazon	---	\$26.27
5	Screwdriver set, JIS, 4 pieces	Hozan	JIS-4	Amazon	---	\$19.70
6	Carpet tape, general purpose	3M	714DC-NA	Amazon	---	\$7.02
	Gorilla double-sided tape, 1" x 60"	Gorilla Glue, Inc.	Touch and Clear	Amazon	---	\$5.83
7	Loctite, Blue	Loctite®	242	Amazon	---	\$5.07
8	Loctite, Purple	Loctite®	222	Amazon	---	\$8.59

**Table 1 – Parts, Tools, and Supplies**

**Table 2** lists the contact information for the vendors referenced in **Table 1**.

Vendor	URL	Local Phone	Toll Free	Fax	email
Amazon	www.amazon.com	---	---	---	---
Harbor Freight Tools	www.harborfreight.com	---	1-800-423-2567	---	---
Micro Mark	www.micromark.com	---	1-800-225-1066	1-908-665-9383	info@micromark.com

**Table 2 – Vendor Listing**