Olympus BH-2 Ramblings and Musings

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"To the last, I grapple with thee; from Hell's heart, I stab at thee; For hate's sake I spit my last breath at thee." – Herman Melville, Moby Dick

Table of Contents

Click on a section heading to go to the desired section.

Acknowledgements

Back to the Table of Contents

Jerry Clement: Jerry, I can't thank you enough for all the helpful advice, custom machine work, FedEx packages, and countless emails over the years. Thanks to you, I have a virtual Noah's Ark full of Olympus parts in my little "Empire of Dirt" workshop in the basement. I'm glad I could help you clear out your shop, and I surely do miss those FedEx packages from Madison!

Kevin Cunningham: Thanks for taking the time to correspond with me and share both your technical and historical knowledge on the Olympus BH-2 scopes.

Joe Haralson: Thanks for being a good friend, thanks for all the information and photos, and thanks for making me feel not quite so bad about my own microscope obsession. And oh yeah, thanks for the "Mother of all Shipping Fiascos" story. And as always, Joe: "It's not my fault!" But I must confess I can't help but at times feel like maybe it is my fault. At least a little bit.

Tom Jones: Thanks for the generous hardware contribution in support of my PDFs.

David Martella: Thanks for the generous contributions in support of my YouTube videos.

Paul Rompel: Thanks for getting me the parts I needed to do my very first BH-2 scope repair. That sure seems like a long time ago now. Also, thanks for dropping by my neck of the woods every few years or so with a trunk-load of really cool BH-2 stuff! Nothing feels more down-and-dirty illegal than buying used microscope parts out of the trunk of a guy's car in a dimly lit parking lot someplace. Update 3-1-2021: Rest in peace, Paul. You will be missed.

Alan Wood: Thanks for hosting my various BH-2 documents on your wonderfully informative website. Your site is the best Olympus reference out there. **http://www.alanwood.net/photography/olympus/microscopes.html**

Now Selling a Bunch of Stuff

Back to the Table of Contents

Over the past seven or eight years, I have been an avid microscopy hobbyist. My interests have been primarily focused on Olympus scopes, especially the BH-2 line. I have devoted a great deal of time learning to repair and restore BH-2 scopes, as well as collecting (some would say hoarding) all things "BH-2". This hobby has gradually grown into a full-blown obsession with me, requiring ever-increasing amounts of time, space, and money, and has now reached the point where it interferes with my responsibilities in the home. My wife has been complaining about this for some time now. According to her, because of the time I spend in my little "Empire of Dirt" microscope shop in the basement, I have not been holding up my end of the household chore list (for example, I'm the one who prepares the dinners in our house, and I have admittedly been letting that slip more and more lately). As a result of this, and after a great deal of soul searching, I have made a very difficult decision. Something must go in my life. Accordingly, I have listed below a bunch of equipment that I need to sell off ASAP, to free up some space and to restore a bit of sanity to my life. I would like to offer this equipment to other Olympus fans before putting it on ebay for general sale, but one way or another, it all must go. Please email me with any offers for any of the following equipment. Photos are available upon request.

- Kitchen-Aid Stand Mixer with pasta attachment
- Cuisinart food processor
- Cuisinart blender
- Complete (and sharp!) collection of chef's knives
- Stainless steel saucepans, various
- Non-stick pans, various
- Cast-iron skillets, various

Biological and Polarizing Versions of the BH-2

Back to the Table of Contents

Your choices for a biological microscope in the Olympus BH-2 line are the BHS, BHT, BHSU, and BHTU scopes. For a polarizing microscope, your choices are the BHSP and BHTP scopes. The BHS and BHT models were the first BH-2 scopes to be introduced (along with the BHSP and BHTP polarizing variants). The BHT was targeted primarily for labs and clinical applications and was "the" working scope in many such facilities. In contrast, the BHS was intended to be more of a research scope, designed to satisfy the complex needs of laboratory users for whom a single scope capable of many different operating modes was needed. The BHS and BHT models share the same basic design modularity, with the BHT offering 20W halogen illumination, and the BHS offering 100W (!) halogen lighting. Both the BHS and BHT utilize the same forward-facing modular nosepiece, which can be quickly swapped in or out to accommodate four, five, or six objectives, of various types.

The BHSU and BHTU models were introduced later, primarily due to competitive pressures in the US markets (hence the "U" in the model names) that could not be adequately satisfied by the BHS and BHT scopes. To address growing demand for a scope with a reverse-inclined nosepiece, the modular nosepiece of the BHS/BHT was abandoned in favor of the permanently attached reverse-inclined nosepiece on the BHSU/BHTU. Although no longer modular, this nosepiece design answered the growing customer demands for greater access to the slide area on the stage, and the BHTU quickly became the dominant scope in US labs and clinics (note that the BHSU was not sold in the US) thanks to its improved ergonomics. As part of the design change in the BHSU/BHTU variants, an additional optical assembly was developed which was placed between the nosepiece and the viewing head, to optically compensate for the increase in mechanical tube length that was introduced by the reverse-inclined nosepiece. This optical assembly works by creating a small infinity space within the mechanical tube, bringing the effective optical tube length back to the required 160mm.

In addition to the biological and polarizing BH-2 versions described above, there were other models manufactured for specific purposes (such as metallurgical, etc.), but these will not be addressed here. The table below details the differences between the various biological and polarizing stands.

Model	Lighting	Lumens	Lamp Life	Nosepiece Type	Sold In US	Type
BHS	12V/100W Halogen	2800	2000 hours (See Note 1)	Modular, Forward Facing (See Note 2)	Yes	Biological
BHSP	12V/100W Halogen	2800	2000 hours (See Note 1)	Modular, Forward Facing BH-PRE (see Note 2)	Yes	Polarizing
BHSU	12V/100W Halogen	2800	2000 hours (See Note 1)	5-Position, Reverse Facing (see Notes 3 and 4)	No	Biological
BHT	6V/20W Halogen	460	100 hours (See Note 1)	Modular, Forward Facing (See Note 2)	Yes	Biological
BHTP	6V/20W Halogen	460	100 hours (See Note 1)	Modular, Forward Facing BH-PRE (see Note 2)	Yes	Polarizing
BHTU	6V/20W Halogen	460	100 hours (See Note 1)	5-Position, Reverse Facing (see Notes 3 and 4)	Yes	Biological

Notes:

1. Rated life using Philips #7388 (6V/20W) and #7724 (12V/100W) lamps.
2. Suitable modular nosepiece types: BH2-5RE (5-position RMS), BH2-6RE (6-position RMS), BH-NRE (4-position Neo SB), BH2-NRE (4-position Neo LB), and BH-PRE (4-position RMS, centering).
3. The reverse nosepiece on the BHSU and BHTU scopes is permanently attached to the stand, and therefore cannot be swapped like those on the BHS/BHT stands can.
4. The reverse nosepiece on the BHSU/BHTU stands includes a corrective optics barrel to maintain the required 160mm tube length. The presence of the compensating optics limits the compatibility of these stands somewhat. For example, the drop-in polarizing filter made for the BHS/BHT stands cannot be used on the BHTU, nor can the BH2-RLA Vertical Illuminator.

Which Version of BH-2 Should You Buy for Biological Use?

Back to the Table of Contents

So, which scope should you buy? Like many questions in life, the answer is "it all depends." Specifically, it depends on what you expect from your microscope, and in no small way it also depends on what type of a microscopist you are. For a biological microscope, your choices in the Olympus BH-2 line are the BHS, BHT, BHSU, and BHTU scopes. If you are buying a BH-2 because you want a good, solid, well-performing clinical microscope on your bench for brightfield, darkfield, Rheinberg, and maybe even phase contrast or polarizing observations, then a BHT or BHTU with its 20W halogen lighting would probably be a great choice for you. These are nice, full-size scopes which were designed to perform and were built to last. The 20W models utilize relatively simple electronics that you can expect to maintain and use for a long time. If on the other hand, your intent is to impress, then nothing short of the BHS, and maybe even the ultra-rare BHSU, will do.

The BHTU utilizes a reverse-inclined nosepiece, which puts the objective in use up-front and center, with the other objectives pointing back away from the operator. This arrangement leaves tons of room for the operator to access the specimen on the stage and is therefore the best choice for oil-immersion microscopy, and any other techniques where physical access to the specimen on the stage is needed. In contrast, the objective lens in use on the BHT (with its conventional forward-facing nosepiece) is at the back, with the unused objectives facing forward, obscuring access to the specimen. For some, this difference is not a big deal. But for many, the improved ergonomics of the BHTU are a must-have. The relative sales numbers of the BHT and BHTU speak for themselves in this regard. The BHTU, with its improved ergonomics, was generally seen as the more desirable option and therefore handily outsold the BHT. However, things are a bit flipped now. You should expect to pay more for a BHT in the used market, over a comparably equipped BHTU, due to the relative scarcity of BHT scopes.

Before you make your final decision, keep in mind that the reverse-inclined nosepiece of the BHTU, as popular as it was, does come with some trade-offs. The nosepiece on the BHTU is permanently attached to the microscope stand, and to swap objectives you must unscrew and remove the existing objectives, and then screw in the new ones you wish to use. "Like, isn't that how microscopes work?" Not always. The BHS and BHT scopes utilize a modular nosepiece that can be easily removed with the objectives in place and replaced with another nosepiece already loaded with a totally new lineup of objectives. So, if you think you will be swapping out the entire set of objectives frequently (in practice, people almost never do this), then the BHT may be the better choice for you. You may think that nosepiece modularity is a clear advantage for the BHT, but keep in mind that this second nosepiece with its full boat of premium objectives will cost you far more than you paid for your entire BHT scope. You should carefully consider whether or not you would ever really use this feature, and weigh this against the improved ergonomics of the BHTU. This may sound crazy, but maybe a second BHTU stand makes more sense if you ever get to that point.

An additional factor to consider when making your decision as to which scope to buy is that, because the physical recess where the viewing head mounts onto the BHTU stand contains an optical lens assembly which is not present on the BHT scopes (this lens assembly was needed to allow the reverse-inclined nosepiece to work on the BH-2 stand), a few accessories for the BH-2 line are not compatible with the BHTU, since they would physically interfere with this lens assembly. Specifically, there was a small drop-in polarizing filter/analyzer, as well as a brightfield/darkfield vertical illuminator for reflected-light viewing (the BH2-RLA), that won't fit the BHTU. The issue with the drop-in polarizer is not a big deal, as there was a BH2-KPA Simple Polarizing Kit offered by Olympus that is a better way to add simple polarizing capabilities to your microscope than the drop-in filter, and this kit is 100% compatible with the BHTU. Failing this, a simple piece of linear polarizing film could be trimmed with scissors to fit the recess of the BHTU. Don't let the lack of compatibility with a stupid little polarizing filter dissuade you from the BHTU, if you like the idea of the reverse nosepiece. As for the BH2-RLA vertical illuminator, unless you have a strong interest in metallurgical microscopy (and most amateur

microscopists do not), you will likely never miss the inability to utilize this particular vertical illuminator on your BHTU stand. And besides, the various brightfield vertical illuminators for the BH-2 line can be used on the BHTU.

So, enough about the BHT and BHTU scopes, what about the BHS scope? At first glance, and from a bit of a distance, the BHS looks just like a BHT scope. In fact, from the knees up, the two scopes are essentially identical, and they share the same design modularity. It's below the knees where the crucial differences can be found. Upon closer inspection, you'll see that the BHS has a much wider base than the BHT, and a much larger lamphouse attached to the back. The wider base of the BHS contains beefier electronics, and the larger lamphouse contains the brighter halogen lamp, that comprise the integral 100W (!) halogen lighting. When a BHS is turned up to 11 (you had to know there would be a Spinal Tap reference in here someplace, right?), there is enough sheer light intensity to all but obliterate the retinas of any who may innocently peek into the eyepieces. It is as bright as the sun, and to many of the microscope freaks in the crowd, that's perfect! Practically speaking, for the majority of users and for the majority of applications, the 20W of a BHT or BHTU is absolutely fine. But for the rest, there is the BHS. To be fair, there are legitimate reasons for a microscope to utilize 100W halogen lighting, but most amateur microscopists on a finite budget will never require this level of lighting intensity. When new, BHS scopes sold for quite a bit more than the BHT and BHTU scopes, and this still holds true for their pricing on the used market. BHS scopes have a much larger footprint on the bench, generate far more heat, and utilize more complicated electronics (for which replacement parts can be difficult to find). For these reasons, I don't usually recommend a BHS scope for most new users. Why waste the additional money and sacrifice all that desk space for a scope that will make you pay through the nose when the electronics require servicing or replacement, and which offers little in tangible benefits in exchange? I should briefly mention the BHSU here. This scope is essentially a BHS scope with the non-modular, reverse-inclined nosepiece of a BHTU. The BHSU was never sold in the United States and doesn't seem to have sold very well elsewhere. There are BHSU scopes out there, but they are quite rare. If you're hellbent on having such a scope, it is a simple manner to make your own from a BHS stand and a BHTU stand. You start out with a BHS stand and a BHTU stand and end up with what is essentially a BHSU stand and a BHT stand.

So, having discussed the advantages and disadvantages of the various models, it's now time to look at what type of a microscopist you are. To most people, a microscope is a tool that allows them to look at the microscopic world, and so long as their microscope performs this function well, they will be happy with their microscope. At the other end of the spectrum are people to whom the microscope is a wonder of mechanical engineering and a thing of beauty, and the hardware itself is their primary source of satisfaction, not the things that they can do with their scopes. For them, observing the microscopic world is just a small part of their enjoyment of the hobby. These people tend to be extreme gadget freaks who want all of the high-dollar, top-of-the-line hardware that they can get their hands on. They will collect all the various bits and bobs that were made for their scopes and are always on a quest to upgrade. Money is of course no object. They might spend more on a single apochromatic objective than the average hobbyist has invested in their entire system. They likely have several different microscopes (OK, let's be honest, they have a lot of microscopes) from the Big Four manufacturers. Those who are truly sick may even have a dedicated microscope workshop in their basement.[1] For these people, a simple BHT or BHTU alone would never be sufficient. Don't get me wrong, they will have one or two of these in their collection, but they will also have countless other scopes, often from various manufacturers, in their line-up. For these people, there is no such thing as enough, and there is no cure for their affliction[2].

Modular Nosepieces for the BH-2

Back to the Table of Contents

There are four modular nosepieces which were available for the BHS and BHT scopes, as listed in the table below. Note that these cannot be used on BHTU scopes, since the BHTU does not use a modular nosepiece.

[1] Guilty as charged.
[2] Yes, I'm talking to you, Joe. And it's not my fault.

Model	Objectives	Mounting Threads	Application	Comments
BH2-5RE	5	RMS	Biological	For standard LB objectives.
BH2-6RE	6	RMS	Biological	For standard LB objectives.
BH2-NRE	4	26mm	Reflected DF	For LB Neo reflected darkfield objectives
BH2-PRE	4	RMS	Polarizing	For LB polarizing (PO) objectives. Objective mounts are adjustable to common axial center.

Condensers for the BH-2

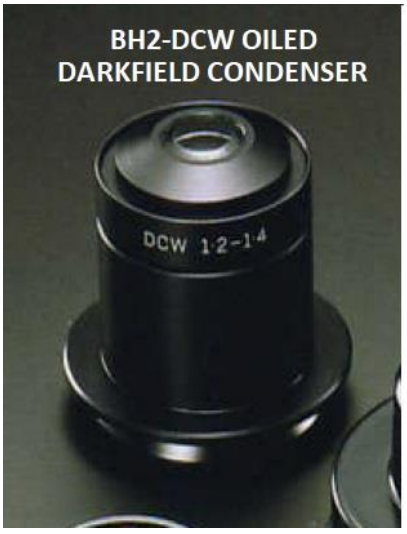
Back to the Table of Contents

The table below lists the various condenser options for the BHS, BHT, BHSU, and BHTU scopes, for brightfield and phase contrast applications. For general-purpose applications, the BH2-CD Abbe condenser will be your best and lowest-cost option. This commonly available condenser provides sufficient field coverage for objectives of 4X and up, and when oiled to the bottom of the slide provides sufficient N.A. for routine brightfield oil-immersion applications. Although an Abbe condenser does not contain corrections for optical aberrations, the Abbe remains the standard condenser for routine microscopy. The BH2-PC and BH2-PCD phase contrast condensers have similar optical performance to the BH2-CD when oiled to the bottom of the slide and used for brightfield, and in addition provide phase contrast when used with the proper phase-contrast objectives. The BH2-PC and BH2-PCD are described in more detail elsewhere in this document. The next step up in optical performance is the BH2-AAC achromatic, aplanatic condenser. This condenser, which is not as commonly available as the BH2-CD, provides improved imaging, due to its aberration-corrected optics, and also provides an increased N.A. of 1.4 (when oiled to the bottom of the slide) for coaxing that last bit of resolving power out of top-tier oil-immersion objectives. This is the condenser to use for times when absolute maximum resolving power is required. However, this condenser does not provide sufficient field coverage for 4X or lower

objectives, and typically sells for $300 or more. For the lazy ones in the crowd[3] who don't typically bother with oiling the condenser to the bottom of the slide when using oil immersion, or for those who rarely use oil immersion at all[4], the BH2-SC is a good condenser choice. This condenser, while not suitable for oil-immersion with the bottom of the slide (and please don't ever do this with this condenser), provides field coverage from 10X to 60X when the top lens is swung into the optical path, and a wider field coverage suitable for 2X to 4X, when the top lens is swung out of the optical path. The modest N.A. of 0.9 may sound limiting, but unless a condenser is oiled to the bottom of the slide, no condensers on the planet will provide an N.A. above 0.9. So, if you don't plan to oil the condenser, this is a great condenser choice. The BH2-ULC condenser was made to provide sufficient illumination for low-power viewing from 1X to 4X.

Model Number	Description	Objectives	N.A.	Comments
BH2-AAC	Achromatic Aplanatic Condenser	10X – 100X	1.4	Corrected for optical aberrations.
BH2-CD	Abbe Condenser	4X-100X	1.25	Standard Abbe condenser
BH2-DCD	Darkfield Condenser, Dry	4X – 40X	0.92 – 0.8	Dry darkfield condenser for lower power objectives
BH2-DCW	Darkfield Condenser, Oil	40X – 100X		Oil-immersion darkfield condenser for higher power objectives
BH2-PC	Phase Contrast Condenser	4X-100X	1.25	Contains 10X, 20X, 40X, and 100X phase annuli.
BH2-PCD	Phase Contrast Condenser w/ Darkfield	4X-100X	1.25	Contains simple darkfield stop in place of 20X phase annulus.
BH2-SC	Swing-Out Condenser	(2X-4X) 10X-60X	0.9	Swing-out for 2X and 4X. Swing-in for 10X-60X
BH2-ULC	Ultra-Low Power Condenser	1X-4X	0.16	Use for low-power objectives only.

The BH2-DCD and BH2-DCW condensers were offered for darkfield work. The BH2-DCD is a "dry" condenser (i.e., it should never be oiled to the slide) that was made for low power darkfield up to (maybe) 40X. The BH2-DCW is an oil-immersion condenser intended for objectives of 40X and up. The upper optical element of the BH2-DCW must always be oiled to the bottom of the slide for it to work at all. Both of these condensers are quite rare and often fetch prices of $400 or more when offered for sale on ebay. The reason for this scarcity is that darkfield microscopy is rarely used by professional microscopists, and because of this, these condensers did not sell in large volumes while the scopes were actively marketed and sold to professional users. The bottom-line focus for professional users is always technical accuracy, rather than image aesthetics. When viewing non-living tissue or specimens, they rely on sample preparation and staining to best observe the structures of interest. When live imaging is needed (and chemical staining therefore cannot be employed), the techniques of phase contrast and differential interference contrast will almost always be chosen over darkfield.



[3] Reluctantly raising my hand
[4] Once again raising my hand…

Amscope sells a couple of darkfield condensers for their T690 scopes which use a dovetail mount compatible with that of the BH-2. These condensers, which are available on Amazon, are much cheaper than the Olympus condensers, and the best part is that they seem to work very well with the BH-2. Credit goes to user *RudiV* on the microbehunter.com forum for this nice little bit of information.

Darkfield Patch Stops for the BH-2

The lowest-cost way to implement darkfield on just about any scope (including the BH-2) is to use a simple darkfield patch stop to obscure some of the light reaching the condenser aperture diaphragm. A simple 20mm patch stop can easily provide darkfield on the lower-power BH-2 objectives (i.e., 20X and below), and with careful setup, likely even with the 40X achromatic objective. While the design of the dovetail-mounted condensers used in the BH-2 makes this more difficult than simply placing a patch stop in a filter carrier beneath the condenser, it is nonetheless something that can be done. If you have access to a 3D printer, it is quite simple. Refer to the ***A Darkfield/Rheinberg Accessory Kit for Olympus BH-2 Microscopes (Revision 1)*** section of this document for a description of the *BH2-DFR Accessory Kit*, which can be easily 3D printed and is compatible with both the BH2-CD and BH2-AAC condensers used on BH-2 scopes.

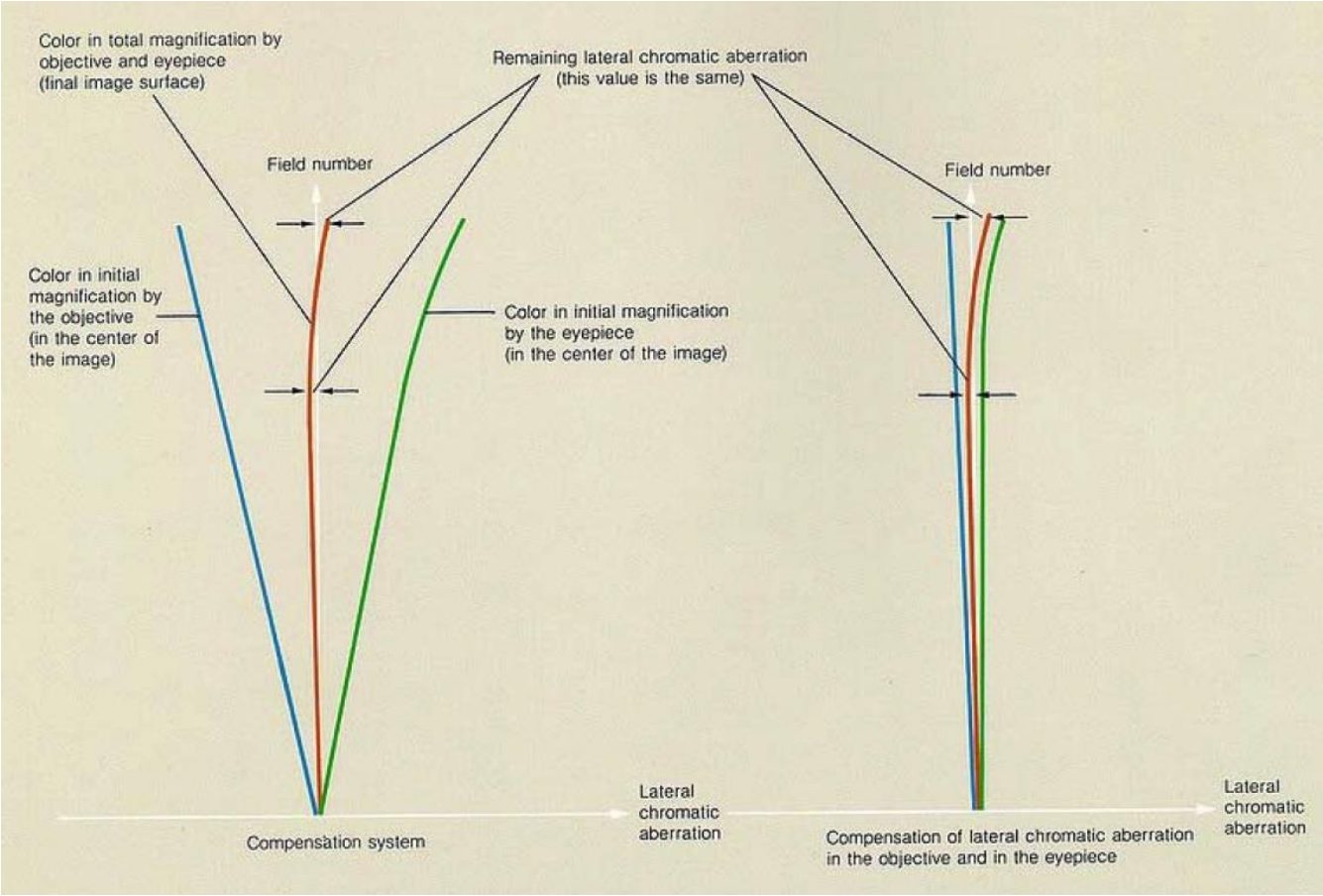
Compensated Optics of the BH-2

Back to the Table of Contents

What optics are compatible with the Olympus BH-2 microscopes? The best answer of course is to use only Olympus LB (long barrel) objectives. These were designed by Olympus for the BH-2, and if you stick with them, you really can't go wrong. But there are valid circumstances where you may wish to use non-Olympus optics on your scope, so an answer of "always use Olympus LB objectives", while it may be the *best* answer is not a particularly good answer. The biological versions of the BH-2 use objectives built to the DIN standard, and therefore any manufacturer's objectives which also conform to the DIN standard can be used, albeit with a few caveats. The DIN standard specifies a few critical parameters, such as optical tube length (160mm), the objective mounting thread type (RMS), and the objective parfocal height (45mm). Specifically, DIN objectives must be used on a scope with a 160mm optical tube length, RMS threads in the nosepiece turret (i.e., 20.32mm diameter with a thread pitch of 0.706mm), and a 45mm parfocal height. Any objective which meets these parameters will physically mount onto the BH-2 and will theoretically work. But there is a little bit more to it than that. As always, the devil is in the details.

The image below was taken from an old Olympus LB Objectives sales brochure, not so much for the purpose of copyright infringement, but as a fair-use way to illustrate a crucial aspect of the Olympus LB optics. The left-most plot shows the optical design typical of the LB optics. The blue line shows the lateral chromatic aberration of the objectives, as a function of field number (i.e., distance from the optical axis), and the green line shows the lateral chromatic aberration of the compensating oculars for the objectives, as a function of field number. Note that the blue and green lines show increasing chromatic aberration with higher field number, meaning that the images get progressively worse as you move away from the optical axis. The brown line in the middle shows the

result of applying the correction of the oculars (the green line) to the objectives (the blue line). The white vertical "Field Number" line can be interpreted to represent perfect optical performance with no lateral chromatic aberration, and the extent to which the brown line deviates from the white lines shows the overall lateral chromatic aberration present in the LB achromatic optics.



Now consider the right-most plot. This shows the design of optics which, to the greatest extent possible, fully correct for lateral chromatic aberration within the objectives (as seen in the blue line) and the oculars are essentially optically neutral (as seen in the green line). This is typical of objectives such as the chroma-free Nikon CF series. The result of this scheme is shown in the middle brown line. Note that the overall performance of the two optics systems, as shown by the brown lines on the left and right, are the same in both cases, meaning that both provide equivalent image quality to the scope user. However, it is critical to understand that in the case of the optics shown in the left-most plot, optimal optical performance will only be obtained when the objectives are mated with the manufacturer's compensating oculars made specifically for those objectives, whereas in the right-most plot, optimal optical performance will only be obtained when the fully compensated objectives are used with non-compensating oculars.

So, why even bring all of this up? The reason is because optical systems of both of the types illustrated by the image above have been made which comply with the DIN standard. To say that you can use any DIN objective on your BH-2, without talking about the accompanying oculars, is only telling half the story. What should be said is that any DIN-compliant objective can be used on your BH-2, so long as it is mated with the proper ocular type. For the BH-2, this means LB objectives must be used with LB oculars. For Nikons of the same era which used the Nikon CF objectives, this means use that the Nikon CF objectives must be used with non-compensating oculars. If the objective and ocular types are mis-matched, the resulting lateral chromatic aberration will be far higher than it should be.

So, assuming you match the objectives with the proper type of oculars, which scheme is best? As can be seen by the resulting brown lines in the plots above, both schemes ultimately perform equally well, at least as far as lateral chromatic aberration is concerned. But in engineering, nothing is ever black and white, and there are tradeoffs inherent to every design decision. At least in theory, the scheme used by Olympus in their LB objectives gave the optical designers greater flexibility to correct other optical aberrations and to correct for such things as field flatness, as compared to the CF scheme. In practice, however, the performance of the Nikon CF optics compares well to that of the Olympus LB optics.

One significant disadvantage of the compensation scheme used in Olympus LB optics is that when equipping your setup for photomicrography, both the objective and a matching compensating lens of some sort must *always* be in the optical path of the camera, otherwise objectionable lateral chromatic aberration will be present in the resulting images. This means that when using Olympus LB objectives, either an LB ocular or one of the NFK photo relay lenses made for the LB objectives must be present in the camera setup. This requirement totally precludes the use of direct projection, wherein the objective directly projects its intermediate image directly onto the optical sensor of the camera (such as the case in the ultra-convenient "eyepiece" cameras). This also precludes the use of most third-party solutions for coupling a camera to a microscope, since these third-party options frequently include their own reduction optics which do not provide the necessary compensation needed for the LB objectives. Many manufacturers who explicitly claim compatibility with the BH-2, such as Diagnostic Instruments, do not provide the proper compensation needed for optimal optical performance of LB objectives.

What about the Chinese made DIN objectives available at a very low cost these days? What type are they? A few years back, I beat my head against the wall for a few days with Amscope customer service, trying to get an answer to this question from them. I asked them which optical scheme their objectives employed (i.e., full compensation within the objectives or compensation via matching compensating oculars). I kept getting back the same answer: "Our objectives will work correctly with any eyepiece", which of course cannot be the case. I came away utterly frustrated and 100% convinced that Amscope has absolutely no idea what they are selling.

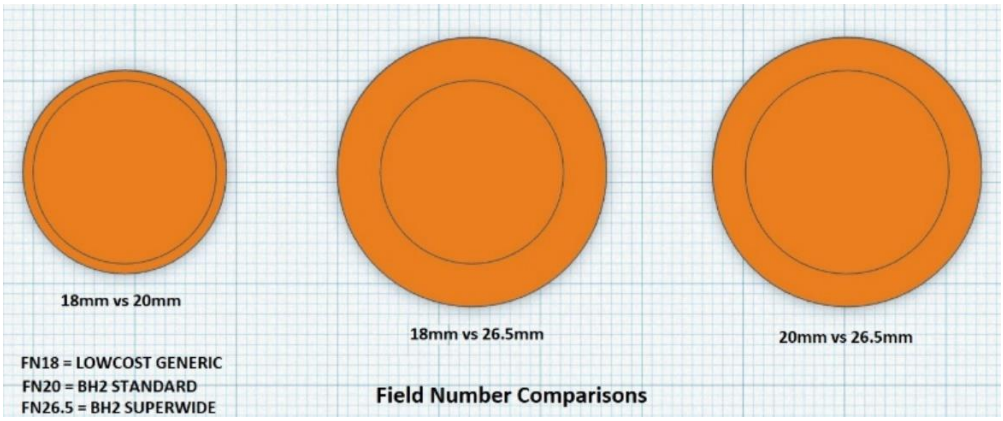
The basic takeaway is this: You can use Olympus LB objectives, but you must always use them with matching LB oculars and/or NFK photo relay lenses. Or you can use Nikon CF objectives, but you must always use these with non-compensating oculars and/or photo relay lenses. When using Nikon CF objectives, you can skip the photo relay lens entirely and use direct projection onto the camera sensor (assuming a compatible sensor size), since the objectives produce a fully compensated (i.e., finished) intermediate image. Regardless of whichever manufacturer's DIN objectives you decide to use, just be sure to pair them with the manufacturer's matching eyepieces and photo relay lenses, and you should be good. You must keep in mind that not all compensating oculars and photo relay lenses are created equal. Some manufacturer's objectives require more compensation in the oculars than others, and some may even include compensation other than lateral chromatic aberration (such as corrections for field flatness), so it's best to always pair objectives and oculars from the same manufacturer and from the same optical series. That way, you will achieve the best optical performance that your objectives can provide.

The Field of View of the BH-2

Back to the Table of Contents

The field of view of the standard configuration of the BH-2 is a circle of 20mm diameter, which is achieved when using either the BH2-BI30 binocular viewing head or the BH2-TR30 trinocular viewing head, along with widefield eyepieces of 23mm diameter. If you step up to the BH2-SWBI30 binocular viewing head or the BH2-SWTR30 trinocular viewing head, along with the super-widefield eyepieces of 30mm diameter, the field of view increases from 20mm to 26.5mm. The rightmost diagram in the illustration below shows the standard widefield FN20 field of view, as compared to FN26 field of view. The difference is quite impressive when looking through the eyepieces.

The FN20 performance of the standard widefield BH-2 configuration is typical of what is found in the majority of the mid-market scopes offered today from the various Chinese suppliers. These same manufacturers of course also offer wider viewfields in their higher end offerings, and many also offer viewfields as low as 18mm on the lowest-end offerings.



Photomicrography Through the BH-2

Back to the Table of Contents

Olympus provided a few options to attach a camera to the camera port on the BH-2 trinocular head, as follows.

Photomicro L Adapter

The Photomicro L Adapter mounts onto the 38mm dovetail port on the trinocular head and accepts an Olympus OM-mount SLR or DSLR camera body on the top. The design of the system is such that when one of the Olympus NFK photo-projection lenses is placed into the top bore of the trinocular head before the Photomicro L Adapter is attached to the trinocular head, the resulting optical configuration projects a fully corrected image of the specimen under observation directly onto the film plane or image sensor of the attached camera. The total magnification of the resulting image, as projected onto the film plane or image sensor, is the mathematical product of the magnifications of the objective lens and the NFK photo-projection lens. For example, a 10X objective and an NFK 2.5X will produce a total magnification of 25X at the film or sensor plane (i.e., the image projected onto the film or digital image sensor will be 25X life size). An NFK photo-projection lens must always be used in this application since it provides the necessary optical corrections for the Olympus LB objectives used in the BH-2, and since it projects a focused image directly onto the film plane of the attached camera. NFK lenses of the following magnifications were available: 1.67X, 2.5X, 3.3X, 5.0X, and 6.7X.

PHOTOMICRO L ADAPTER

When using a standard DSLR with an APS-C or ASP-H image sensor, the NFK 1.67X is the correct lens to use. Unfortunately, the NFK 1.67X is very rare and is therefore extremely expensive (often in the range of $600 to $1000 on ebay). If, instead of an APS-C or APS-H camera, you use a full-frame DSLR (which has an image sensor

the size of a 35mm film frame) then the much-cheaper NFK 2.5X is the correct lens to use. The problem with this approach is that full-frame DSLR bodies, even in used condition, are expensive as well. If you'd like to add a camera to your BH-2, but wish to save some money, you can simply do what most people do and just use an NFK 2.5X with your APS-C or APS-H camera and live with the resulting reduction in the field of view. The Photomicro L Adapter was designed for use with Olympus OM-mount SLR cameras, but it can also be used with Canon EOS (EF mount) DSLRs or older Canon FD mount SLR equipment by adding a very inexpensive OM-to-EF or OM-FD adapter, available from Amazon or ebay, to provide a fully parfocal solution for Canon SLRs and DSLRs. Other camera types may or may not be adaptable to the Photomicro L Adapter, so be careful. Some (such as Nikon) will not provide proper positioning of the image sensor relative to the NFK photo-projective lens to provide parfocality with the eyepieces. In general, the following DSLR camera types can be mounted onto the Photomicro L Adapter using the appropriate lens-mount adapters, to provide parfocal imaging for the BH-2: Canon EOS cameras, Sony NEX cameras, and 4/3 or Micro 4/3 cameras. When using a Canon EOS, use the NFK 2.5X projection lens for camera models utilizing full-frame sensors, and use the NFK 1.67X for camera models utilizing APS-C sensors. When using a Sony NEX, use the NFK 1.67X projection lens. For 4/3 or Micro 4/3 cameras, the best results will be obtained using the NFK 1.67X projection lens, but even then, the field of view of the resulting images will be noticeably restricted, as compared to the view through the oculars. For cameras using 4/3 sensors, better results would be obtained with an MTV-3 or U-PMTVC adapter, rather than the Photomicro L Adapter, since the MTV-3/U-PMTVC contains an integral 0.3X reduction optic to increase the field of view.

MTV-3 and U-PMTVC Adapters

Like the Photomicro L Adapter, the MTV-3 adapter connects to the 38mm dovetail port of the trinocular head, along with a suitable NFK photo-projection lens, and allows the resulting optical configuration to project a finished image of the specimen under observation directly onto the image sensor of an attached camera. The MTV-3 differs from the Photomicro L Adapter in that the MTV-3 accepts a C-mount camera and contains an integral 0.3X reduction lens, whereas the Photomicro L Adapter accepts an Olympus OM-mount camera and contains no reduction optics.

An NFK 2.5X photo-projection lens, when used with an MTV-3 with the accompanying 0.3X reduction lens, projects an image of approximately 16mm diameter onto the image sensor plane, thereby requiring a C-mount camera with relatively large image sensor. This requirement for a large sensor-size unfortunately excludes most of the modern C-mount cameras out there today. The Nikon J1 and V1 cameras have a CX sensor of the proper size, and with a suitable C-mount adapter should work well with the MTV-3, although I have not actually tried these cameras with the MTV-3, so take that for what it's worth.

As an alternative to the MTV-3, the very similar Olympus U-PMTVC adapter can also be used to attach a C-mount camera to the BH-2. The black U-PMTVC has one advantage over the cream-colored MTV-3, in that the design allows for a slight adjustment of the optical length to tweak the parfocality of the attached camera. Be careful if you plan to buy an MTV-3 or U-PMTVC. Make sure you buy one the has the accompanying 0.3X reduction lens (i.e., the silver-colored metal piece on the top) included in the sale. Most of the ones I see listed on ebay do not include this reduction lens, for some reason.

MTV-3 ADAPTER

U-PMTVC ADAPTER

The table below lists various sensor sizes that were used in C-mount cameras, along with the most appropriate NFK photo-projection lens for each of these sensor sizes. In addition to the standard CCD sizes, this table also includes the 4/3, Micro 4/3, and Nikon CX sensor sizes, as used in many modern mirrorless cameras which can be converted to C-mount using inexpensive and readily available adapters. DSLRs are generally not suitable for use with the MTV-3/U-PMTVC since the mirror-swing of a DSLR prevents the C-mount threads from being close enough to the image sensor plane to achieve parfocality with the microscope eyepieces. Note that DSLRs can be used with the BH-2, when connected with the Photomicro L Adapter, but they are not compatible with the MTV-3 or U-PMTVC adapters.

Nominal Sensor Size (mm)	Aspect Ratio H:V	Actual Sensor Size H x V (mm)	Diagonal Size (mm)	Photo Projection Lens (Best Fit)
1/4"	4:3	3.2 x 2.4	4.0	(See Note 3)
1/3"	4:3	4.8 x 3.6	6.0	(See Note 3)
1/2"	4:3	6.4 x 4.8	8.0	(See Note 3)
2/3"	4:3	8.8 x 6.6	11.0	NFK 1.67X
1"	4:3	12.8 x 9.6	16.0	NFK 2.5X
1/4"	16:9	3.49 x 1.96	4.0	(See Note 3)
1/3"	16:9	5.23 x 2.94	6.0	(See Note 3)
1/2"	16:9	6.97 x 3.92	8.0	(See Note 3)
2/3"	16:9	9.59 x 5.39	11.0	NFK 1.67X
1"	16:9	13.95 x 7.8	16.0	NFK 2.5X
4/3	4:3	17.3 x 13.0	21.6	NFK 3.3X or NFK 5.0X (See Note 1)
MFT (Micro 4/3)	4:3 (See Note 2)	17.3 x 13.0	21.6	NFK 3.3X or NFK 5.0X (See Note 1)
Nikon CX	3:2	13.2 x 8.8	15.9	NFK 2.5X

Notes:

1) The Micro 4/3 sensor may show vignetting when used with the NFK 3.3X lens. If this is unacceptable, step up to the NFK 5.0X.

2) Although the MFT standard allows aspect ratios of 4:3, 3:2, 16:9, and 1:1, most MFT cameras use a 4:3 aspect ratio.

3) Note that sensors smaller than 2/3" can be used with the MTV-3 or U-PMTVC adapters with integral 0.3X reduction optics but this setup will provide a limited and likely disappointing field of view. If you do choose to use one of these smaller sensors, be sure to use the lowest magnification NFK lens you have available, to maximize the field of view.

Diagnostic Instruments PA1-10A Adapter

The Diagnostic Instruments (more recently, Spot Imaging) PA1-10A camera adapter is a third-party alternative to the Olympus Photomicro L Adapter, which, while no longer manufactured, can often be found on the used market at a lower cost than the Photomicro L Adapter. As with the Olympus solution, the PA1-10A provides a camera mount that's parfocal with the viewing oculars and that produces fully corrected images. Like the Photomicro L Adapter, the PA1-10A attaches to the 38mm dovetail on the BH-2 trinocular head and must be used with a suitable NFK photo-projection lens in place. The PA1-10A differs from the Photomicro L Adapter in that instead of an Olympus OM mount, it features T2 threads (42mm x 0.75mm) on the top, to allow various camera body types to be attached using the appropriate T-ring adapters. Diagnostic Instruments sold the EOSC-T2 T-ring adapter to allow Canon EF-mount camera bodies (e.g., EOS) to attach to the PA1-10A, and the CANC-T2 T-ring adapter to allow standard Canon FD-mount bodies to be attached. The Diagnostic Instruments EOSC-T2 and CACN-T2 adapters are very hard to find these days, but fortunately, generic T2-to-EF and T2-to-FD T-ring adapters are readily available at low cost on ebay which can be used to attach Canon cameras to the PA1-10A. It should be noted that there are two distinct variations of this Diagnostic Instruments adapter that can be found in the wild, as shown in the image below. Both are marked as "PA1-10A". The variation on the left has a circular dovetail on top with female T2 threads internal to the dovetail, while the variation on the right has male T2 threads.

Diagnostic Instruments PA1-10A Adapters, female threads (left) and male threads (right, photo courtesy Joe Haralson)

Other Diagnostic Instruments Adapters

I recently asked Spot Imaging (formerly Diagnostic Instruments) about the older adapters (excluding the PA1-10A discussed above) that they used to sell which were advertised as compatible with the BH-2. An excerpt of their response is included below. Based on this response, I would not use any Diagnostic Instruments adapters other than the PA1-10A on a BH-2 scope.

> …what is to be expected when using SPOT Imaging Solutions couplers on (older) microscopes that used "compensating" style optics. The image is sharp in the center but blurry towards the edges. The reason for this is that compensating style optics used on older microscopes let the lateral color aberration go uncorrected in the intermediate image and depended on the eyepieces (visual or photo) to provide the correction. Lateral color means that colors smear outward radially from the center of the image. SPOT Imaging Solutions couplers relay the intermediate image (the image inside the phototube) to the camera's sensor. If the intermediate image isn't fully corrected, the imperfect image will be relayed to the camera and displayed in the images. SPOT Imaging Solutions considered making a line of compensating couplers to provide correction for lateral color, but decided not to when it was determined that each microscope manufacturer had a different standard for how much lateral color was built in to their intermediate image. Older microscopes that use compensating lens designs include the Olympus BH-2, Olympus SZ and SZH stereos, and the Zeiss Universal. Most finite tube length microscopes utilized compensating lens designs except for the Nikon CF series. All newer scopes have very well corrected intermediate images except for the Leica HC optics. Leica HC optics allow a small curvature of field in the intermediate image that gets corrected in Leica eyepieces and couplers. Customers with Olympus microscopes who wish to correct this may be able to do so by constructing a coupler that would use an Olympus NFK compensating photo eyepiece to correct for the lateral color. The "K" in "NFK" stands for "Kompensating"...

Richard Kinch Adapters

Since neither the Olympus Photomicro L Adapter nor the Diagnostic Instruments PA1-10A adapter are currently manufactured, perhaps a better option is the *Olympus 38mm to T-Mount* adapter manufactured by Richard Kinch, at **http://www.truetex.com/olympus-38mm.htm**. Like the Olympus Photomicro L Adapter and the Diagnostic Instruments PA1-10A adapter, the Kinch adapter secures to the 38mm dovetail on the trinocular head, along with an NFK photo-projection lens, and through the use of a suitable T-mount adapter, accepts a compatible DSLR (e.g., Canon EOS) to provide a parfocal solution to produce fully corrected images.

Eyepiece Cameras

"So, what about those little drop-in digital cameras that replace one of the eyepieces, surely those will work?" No, they will not work properly on the BH-2. Since the optical design of the BH-2 relies on the eyepieces (or the NFK lens) to provide some of the required correction for lateral chromatic aberration, replacing an eyepiece with one of these little eyepiece cameras (which do not provide the required optical compensation) will produce images with significant uncorrected lateral chromatic aberration. This will be visible in the resulting images as color fringing which gets progressively worse the further you get away from the optical axis (i.e., the center of the image). Now, if you were to replace the Olympus LB objectives on your BH-2 with Nikon CF objectives from the same era (or some other fully compensated objectives), the little eyepiece camera would drop in and work just fine, since all the compensation for chromatic aberration would be provided within the objectives themselves. But then, considering the cost of replacing all of your objectives, you might as well just get an NFK 2.5X and a Photomicro L Adapter for your trinocular head.

Save Money by Getting Rid of the Trinocular Head

The Photomicro L Adapter and the MTV-3/U-PMTVC setups described above can be rather expensive, especially when you factor in the cost of the NFK photo-projective lens and the upgrade from a binocular to a trinocular head. One way to lower the total cost of these solutions is to eliminate the viewing head from the setup entirely. Olympus offered a BH2-PT vertical phototube, which is essentially a vertical monocular tube, as well as the IMT2-PT phototube, which was intended for the IMT2 inverted scope but also works well on the BH-2. Either of these phototubes can replace the traditional binocular or trinocular viewing head and provide a camera port (note that a PM-ADF adapter is also needed if using the BH2-PT). The Photomicro L Adapter or the MTV-3/U-PMTVC adapter then attaches to this port, along with a suitable NFK photo-projective lens. You of course lose the ability to directly view the image through the ocular lenses, but when using a suitable camera with live-view functionality, this can be a workable option for many people. The BH2-PT and IMT2-PT are rare but can occasionally be found on ebay.

BH2-PT PHOTOTUBE

Afocal Methods

A time-honored approach to microphotography is to simply position the lens of a camera to shoot through one of the eyepieces of the microscope. When done correctly, the resulting images can be of very high quality. The problem with this is that it is rather awkward to position a camera to shoot down one of the eyepieces on the BH-2, since the BH-2 eyepieces are not vertically oriented. Additionally, the presence of the camera on one eyepiece makes it difficult to look through the remaining eyepiece, so it is tempting to instead just drop an eyepiece into the NFK slot of the trinocular head and proceed that way. The problem with this approach is that it doesn't work well, since the NFK bore in the photo port is too small to accept the normal Olympus WK 10X or WHK 10X eyepieces. They will go in part way, but they will not seat to the proper position to be parfocal with

the regular eyepieces. If you're using the BH2-PT phototube, the solution is simple - just remove the PM-ADF adapter and drop your 10X eyepiece into the ocular tube. A WHK is better here than WK, since it has a higher eyepoint, but either of these can be made to work. Another lesser-known option is to use a WHK15-L eyepiece in the NFK slot. So long as you use the regular "-L" version, and not the "-H" helical version, it will drop right into the NFK bore and work just fine. It will provide a reduced field of view as compared to 10X (very similar to using an NFK 2.5X with an APS-C or APS-H camera) but that seems to be life for many in BH-2 land. Another way to take the occasional image without spending a lot of money is to take images afocally using your smartphone, by simply holding the phone up to one of the eyepieces and snapping the picture. You have to be careful to make sure that the camera is properly aligned with the optical axis of the eyepiece before taking the shot, but the results can be very good. There are inexpensive adapters available to allow a smartphone to mount onto a microscope eyepiece, which allow the camera to be properly aligned with the optical axis of the eyepiece.

Total Magnification of Digital Images

Everybody knows that the total magnification of a compound microscope is equal to the magnification of the objective lens multiplied by the magnification of the eyepieces. That's easy, right? But what is the total magnification when using an objective lens and an NFK photo-projection lens with a Photomicro L Adapter, to shoot images with a digital camera? Or how about when using an objective lens and an NFK photo-projection lens with an MTV-3 or U-PMTVC adapter, with its integral 0.3X reduction optics? The answer to these questions gets a bit more complicated. After all, the eyepieces have nothing to do with the resulting images in these scenarios.

When looking through the eyepieces, the images you see appear magnified by the mathematical product of the objective and eyepiece magnifications. But the total magnification of a digital image shot through an objective lens and an NFK photo-projection lens depends not only on the magnification of these two bits of optics, but also on the size of the image sensor in the camera, and on the size of the image displayed on the computer monitor. And this of course depends on the monitor size, on the window size of the image-viewing software, and on the zoom factor of the image-viewing software. Or, if you are viewing a hard copy of the digital image, the answer depends on the size of the image printed on the page. I think you get the idea. There are a ton of variables here, but the eyepieces themselves do not affect the total magnification that the camera sees.

So why do we even care about the total magnification? The answer, of course, is so we can determine the size of the specimen details in the image. Take my advice and forget about trying to calculate the "total magnification" of the final image, and all that that entails, and just go at it this way instead. If you know the dimensions of the digital image sensor in your camera, and if you know the relative size of the specimen in the image, as compared with the image size, then you can easily determine the size of the specimen image that was projected onto on the image sensor via the objective lens, NFK lens, and MTV-3/U-PMTVC reductions optics (if applicable).

For example, the APS-C image sensor in a Canon DSLR has dimensions of 22.3mm in width and 14.9mm in height. So, if the specimen fills half the width of the resulting image, then that means that the image of the specimen that was projected onto the sensor was approximately half the width of the sensor, or 11.5mm. But how do you then go from there to determine the actual size of the specimen? Just divide the size of the projected image on the sensor by the total magnification of the projecting optics (including the objective lens, NFK lens, and MTV-3/U-PMTVC reduction optics, if applicable), and that will give you the size of the specimen.

For example, if you're using a 40X objective and an NFK 2.5X photo-projection lens, then the total magnification of the image projected onto the image sensor is 100X (40 X 2.5 = 100). So, just take the calculated size of the image projected onto the sensor and divide it by the total magnification of the projecting optics, and you will have your original specimen size. In this case, that would be 11.5mm divided by 100, yielding a specimen size of 0.115mm, or 115µm.

If you wish to mark your images with magnification information (instead of using scale bars), be sure to not only include the total projection magnification, but also the image sensor type or dimensions, as knowledge of one of

these is useless without knowledge of the other. The text “25X on APS-C”, for example, provides the viewer with all of the information needed to determine the specimen size, regardless of whether they are viewing the image on a monitor or on a printed page. Note that this method of image marking will not produce accurate size estimates if the photograph has been cropped or if the aspect ratio has been altered from that of the camera sensor. If the image has been cropped or if changes to the aspect ratio have been made, use scale bars instead. But either way you do it, please don’t ever put “400X” on your images, simply because you used the 40X objective and happened to have 10X eyepieces in the scope when you shot the photo. Imagine if you were to shoot an image with 10X eyepieces in the scope, using the 40X objective, then remove the 10X eyepieces and sneak in a pair of 20X eyepieces and quickly shoot another image. Should the first image be marked “400X”, while the second image (which is identical to the first image) gets an “800X” mark? This example should illustrate how ridiculous it is to mark that magnification number on your captured images. Keep an eye out as you read articles and watch YouTube videos on microscopy. This error is embarrassingly common.

Watch Out for This When Buying a Trinocular Head

Be careful when shopping for a trinocular head for your BH-2 microscope. You will find that there are many out there that look like the one shown on the left of the image below (photo courtesy Joe Haralson), and these should be strictly avoided, for the reasons described below.

The chimney tube (see photo below) has been removed from the trinocular head on the left side of the above image and replaced by a third-party C-mount adapter. Compare this to the trinocular head shown on the right, which still has the original chimney tube present. The chimney tube is a critical piece that contains the recess that accepts the Olympus NFK photo-relay lens, and which provides the proper 38mm dovetail mount for the Olympus Photomicro L Adapter or the MTV-3 or U-PMTVC adapter. The NFK is of course strictly required if optimal photomicrographic imaging is to be obtained from the BH-2.

As discussed in detail elsewhere, the type of third-party adapter shown on the left of the above image is a poor way to add photomicrographic capabilities to your BH-2. While mechanically suitable, the reduction optics

integral to this adapter do not contain the optical compensation that is required to obtain proper photo-imaging through the Olympus LB objectives on the BH-2. That critical bit of compensation resides within the NFK photo-relay lenses, which of course cannot be used when the chimney tube is missing!

The third-party vendors selling these things were of course well aware of the optical limitations of their adapters while they were actively marketing them to BH-2 owners, but they either didn't bother to tell their prospective customers of the limitations, or if they did, the BH-2 owners who bought them chose to save a few bucks and live with lower-quality imaging on their scopes. Many BH-2 owners who went with third-party (such as Diagnostic Instruments) C-mount adapters no doubt removed and summarily tossed their chimney tubes straight into the trash can, as trinocular heads missing the chimney tube are quite common and the lone chimney tube is ultra rare. They do occasionally show up on ebay, but when they do, they often sell for $100 or more. In a pinch, a 3D-printed replacement could be used, but the poor mechanical tolerances inherent with 3D printing might cause alignment or parfocality issues. So, unless you get a really good deal, hold out for a complete trinocular head with the original chimney tube in place.

Storing a Trinocular Head

The best way to store your trinocular head when it's not being used is to place suitable dust caps into the two ocular tubes, over the top camera port, and over the bottom circular dovetail mount, so that no dust can make its way into the housing to foul the internal optics. Additionally, push the prism selector shaft on the right-hand side of the housing fully in, to the "V" position. Keeping the selector shaft in this position will do two things: 1) The selector shaft will be somewhat protected, since it will not protrude as far from the housing and will therefore be much less likely to be accidentally damaged. 2) The glass prism that selects the desired operating mode will be positioned such that there will be no glass directly exposed beneath the opening on the camera port. Any dust that does make its way into the camera port will tend to settle on bare metal, rather than exposed glass. If you choose to store the trinocular head in a large Ziploc bag, be sure to place a fresh desiccant package in the bag before you zip it closed. Otherwise, the humidity in the sealed bag can reach very high levels as the room temperature fluctuates, which can contribute to fungus growth. Be sure to replace this desiccant packet every few months.

Eyepiece Reticules for the BH-2

(Back to the Table of Contents)

Eyepiece Type	Reticle Diameter	Comments
CWHK10X	19mm	---
NFK 2.5X, 3.3X, 5X, 6.7X	20.4mm	---
SWHK 8X	28mm	---
SWHK 10X	24mm	See note below.
WHK 8X, 10X, 15X	20.4mm	Not for the -H versions.
WHK -H	---	---
WK	19mm	---

NOTE: For the SWHK10X super-wide eyepieces, it is difficult to position a reticle in the front focal plane of the eyepiece. Therefore, it is necessary to purchase and convert a reticle eyepiece to achieve the desired result. The photomask reticle in a 35-SWHK10X field-of-view eyepiece (Olympus catalog #2-LC403) can be removed and replaced with a 24mm diameter reticle positioned on the reticle shelf. This was an Olympus-approved conversion.

Phase Contrast for the BH-2

Back to the Table of Contents

If you get serious in the microscopy hobby, you will likely get to the point where you wish to add phase contrast capabilities to your BH-2. Fortunately, this can be easily done, and it is not prohibitively expensive to do so (unlike DIC, for which the components are rare, thereby making them horrendously expensive). The various components for phase contrast are frequently available at reasonable prices on ebay, or at least this is true in

the US. It is almost always best to search out the various components and purchase them individually as they show up for sale, rather than trying to find a complete kit. In doing it this way, it may take longer to get all of the components you need, but this will generally give you the best bang for your buck and will also allow you to buy exactly the components you want. Unless you buy a phase-equipped scope, it is rare for all the necessary components to all show up together. You will need the following components for phase contrast microscopy:

- Phase contrast condenser (BH2-PC or BH2-PCD)
- One or more phase contrast objectives (10x, 20X, 40X, or 100X oil)
- A phase-centering telescope (CT5)
- A green filter

Phase Contrast Condensers

Look for either a BH2-PC or BH2-PCD Zernike style phase contrast condenser. These typically sell for $250 to $350 on ebay. Another option is the BH2-UCD universal condenser, so long as you can find the correct phase annuli inserts (BH2-URS10/20/40/100) to go with it, but now you're getting into the realm of very rare and very expensive. You can also, at least in theory, use the venerable BH2-CD Abbe condenser that likely is on your scope right now, if you can find the required phase contrast inserts made for the BH2-CD condenser. These inserts are also rare, and in practice are quite tedious to use. In comparing the phase-equipped BH2-CD with the BH2-PC or BH2-PCD Zernike-style condensers, which are both relatively common and are a pleasure to use, I wouldn't waste my time or money on the BH2-CD option.

If you decide to take my advice and go the Zernike route, be careful. Don't do what I did when I was young and naïve. I bought an Olympus phase contrast condenser that looked like the one I needed for my BH-2, but it was in fact the wrong condenser. As stated earlier, the condenser you want to get is either the BH2-PC or the BH2-PCD. The two are essentially the same, except that the BH2-PCD omits the 20X phase annulus in favor of a simple darkfield stop. What you do not want to buy is the U-PC or the U-PCD, or the newer U-PC2 or U-PCD2 equivalents. These condensers were made for later scopes with UIS (infinity) optics and the Ph1 (10x) phase annulus in these condensers does not match the phase rings in the 10x phase contrast objectives for the BH-2. There is a lot of misinformation out there, and many will tell you they will in fact work with the BH-2. Take it from me, they will not! At least not for 10X. Fortunately for me, I was able to sell off the unneeded U-PCD and buy the correct BH2-PC with the proceeds, with only a bit of time wasted.

So, how do you tell the difference between these condensers? If you're lucky, the model will be stamped on the body of the condenser, but a lot of them are not marked. The sure way to tell is to look at the markings debossed into the rotating disk that identify the various phase annuli. The proper BH-2 condensers have numerical markings which correspond to the objective magnifications with which they work (i.e., 10, 20, 40, 100). In contrast, the UIS versions label them as Ph1, Ph2, etc., and you need to **STAY AWAY FROM THESE** (see images below). Olympus used to sell the BH2-PC/PCD 10x phase annulus separately, so that a U-PC/PCD (or the newer U-PC2/PCD2 versions) could be converted into the BH-2 version, if need be. To perform the conversion, the Ph1 annulus was removed and replaced by the BH-2 10x annulus. Of course, the 10x phase annulus needed to perform this conversion is no longer available from Olympus.

So, between the BH2-PC and the BH2-PCD, both of which are suitable for the BH-2, which is preferable? I would always recommend going with the BH2-PC over the darkfield-equipped BH2-PCD. The reason for this recommendation is simple. Why hobble your phase-contrast capabilities for a simple darkfield patch? There are other ways to get darkfield on your BH-2 that don't involve giving up the ability to use 20X phase objectives!

Phase Contrast Objectives

There were a fair number of phase contrast LB objectives made for the BH-2. At the low end were the basic D achromats (confusingly, D achromats are labeled as "A"), which were available with phase rings for PL, PLL, NH, or NM contrasts. At the higher end (for scopes equipped with super-widefield optics or for those used for photomicrography), there were the SPlan achromats, and these were available with phase rings for either PL or NH contrasts. Of the various contrast types, PL objectives are more widely available and tend to sell at a lower price and are therefore the recommended type. If you're just starting out but are pretty sure that microscopy is going to be "the" hobby for you, you can save a significant amount of money in the long run by equipping your scope with SPlan PL objectives right from the start. These objectives will provide a very flat visual field which is ideal for photomicrography and will also work just fine for both brightfield and darkfield use. While it's true that there is a theoretical reduction in optical performance when using phase contrast objectives for brightfield or darkfield, as compared to non-phase objectives, in practice this difference is minimal and is in fact imperceptible to most people. Buying SPlan PL objectives will cost you significantly more money up front but will likely save you money in the long run. The typical newcomer to the hobby buys a scope with basic non-plan achromats, and then, as their interest in the hobby grows, their dissatisfaction with the non-plan objectives also grows, and they find themselves upgrading to plan objectives. Even further down the road, many decide to add phase contrast to their arsenal and are therefore forced to upgrade again.

Phase Centering Telescope (CT)

A phase centering telescope (also sometimes called a *centering telescope* or a *Bertrand lens*) is required to align the phase annuli in the condenser with the phase rings in the objectives, in order to get proper phase contrast performance. Olympus made two types of centering telescopes for the BH-2. These are known as the CT-5 and the CT-30 (both of which are simply labeled *CT*). The CT-5 has a 23mm diameter and fits the ocular tubes of the standard binocular and trinocular heads. The CT-30 has a 30mm diameter and will not fit the standard heads, since it was made for the larger ocular tubes of the super-widefield binocular and trinocular heads. Be sure you understand these differences before buying one for yourself. The CT-30 typically sells for twice the price of a CT-5. Given this, why bother with the CT-30 at all? The 23mm CT-5 can be used in the super-widefield heads if a suitable 23mm to 30mm adapter is used to adapt the fit. Such an adapter can be easily 3D printed if needed. Another nice thing is that if a CT-5 cannot be found, a 23mm phase centering telescope from just about any other manufacturer will work with the BH-2. Be careful that it is not too long, or it may reach too far into the ocular tube and contact the fragile prisms within.

CT-30 CT-5

Green Filter

The IF-550 filter was provided by Olympus as part of their higher priced phase contrast kits, and with their phase-equipped scopes that included the BH2-PC, BH2-PCD, and BH2-UCD condensers. The 45G533 filter was provided with the lower-cost BH2-KPC kit and with phase-equipped scopes equipped with the BH2-CD

condenser. The IF-550 is a 550nm (green) interference bandpass filter, and the 45G533 is a conventional 533nm (green) absorptive filter.

Either of these filter types can be used to block all but the green wavelengths of light to which the achromatic objectives have been optimally corrected, and to which the phase plates in the objectives have been designed to provide the required quarter-wave phase shift. By excluding the lesser-corrected optical wavelengths, the achromatic objectives can be expected to provide the sharpest images possible when using monochrome film for photomicrography applications. Similarly, by excluding all but the wavelengths to which the phase plates in the objectives were designed to provide maximum interference extinction, optimal image contrast will also result.

For visual observations (i.e., non-photomicrographic applications), the green filter is often omitted to provide a more natural viewing experience. The IF-550 is preferable over the 45G533 filter, since interference bandpass filters exhibit much better optical performance (albeit at a significantly higher cost) than conventional absorptive bandpass filters. If neither the IF-550 interference filter nor the 45G533 absorptive filter can be found, any green phase contrast filter from another manufacturer (such as Nikon) should also be usable with acceptable results, so long as it has the proper 45mm diameter to fit into the recess of the field lens and has peak transmissivity at approximately 530 - 550nm.

The 20W Lamphouse for the BH-2

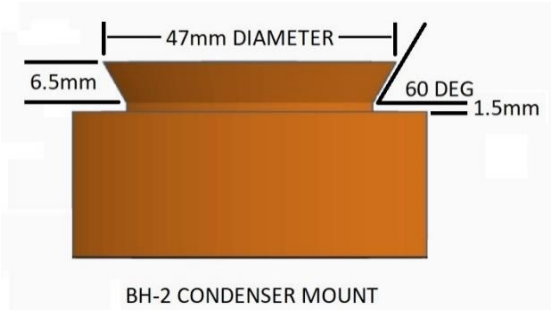
Back to the Table of Contents

There were two versions of the 20W lamphouse made for the BHT/BHTU scopes. The original version, the 5-LB402 (see image below, as shown on the left) did not contain a lamp reflector. Eventually, Olympus began losing sales to Nikon, who were supplying some of their newer scopes with 30W halogen lighting. As a quick-and-dirty way to remain completive with these 30W scopes (and without completely redesigning the lighting electronics), Olympus added a reflector to the 20W lamphouse, changing the part number to 5-S119 in the process (see image below, as shown on the right). The 5-S119 provides more usable light than the 5-LB402 version.

Physical Dimensions of the BH-2 Condenser Mounting Dovetail

Back to the Table of Contents

The image below shows an adapter designed to allow the Vanox wet darkfield condenser to be used on a BH-2 scope. This image includes the physical dimensions of the circular mounting dovetail of the various BH-2 condensers. Note that these dimensions were measured from a BH2-CD condenser using digital calipers, and as such should not be assumed to be particularly accurate. However, when tested, the resulting fit of the 3D-printed adapter in the condenser-mounting yoke of the BH-2 substage assembly was good.



Olympus / Nikon Condenser Compatibility

Back to the Table of Contents

There is a common misconception that the Olympus BH-2 scopes and the competing Nikon finite scopes of the same era share the same dovetail mount on their condensers, but this is not quite true. The dovetail on the Nikon scopes is slightly smaller than that of the BH-2 scopes. Because of this, the Nikon condensers will mount onto BH-2 scopes (with the condenser centering adjustments compensating for the intrinsic centering error caused by the incorrect dovetail size), but the BH-2 condensers will not mount onto Nikon scopes.

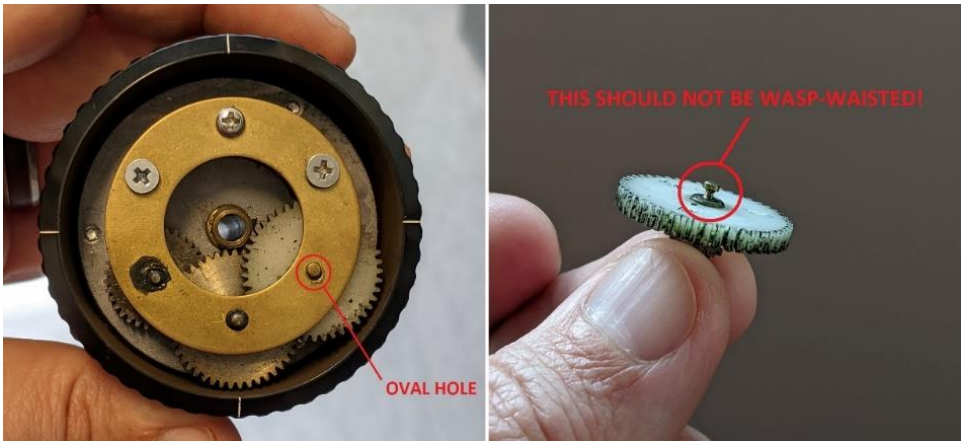
This is One Very Hard Working BH-2 Scope

Back to the Table of Contents

There is a BH-2 scope owned by the Bigelow Laboratory for Ocean Sciences in East Boothbay, Maine, that is used very hard. Like, when I say hard, I mean this hard:

> "…This scope is being used with an automated stage and focus system along with cross polarized and image analysis system light to quantify and size birefringent planktonic coccolithophores. The scope is used heavily (16 hours a day) since it's automated, analyzing 8 slides at a time, both day and night. The automated stage is also very heavy which I'm sure has added to the wear…"

After working this hard for God knows how many years, the pictures below show the resulting wear that has occurred to the focus gearing. Hopefully a few replacement parts will put this scope back to work for the Bigelow Laboratory for a few more hundred thousand miles. Photos courtesy of the Bigelow Laboratory for Ocean Sciences.



Frequently Asked Questions

Back to the Table of Contents

Olympus BH-2 Service / Repair Documents

OK, skip the malarkey. Where can I find the BH-2 repair documents?

There is a hyperlink to the folder containing all of my Olympus stuff in this section **here** (if the hyperlinks do not work for you, just scroll down until you find them).

General Questions

Easy there Ahab! What's with the Melville quote on the cover?

See the *My Story* PDF in the ***Miscellaneous Microscopy Stuff*** section of this document for an explanation of the Melville quote, and for the reason for the amoeba nose art on the image of the BHT on the cover page of this document.

What's that black plastic piece inside the housing of some binocular and trinocular heads?

Thanks for pointing out that I omitted any mention of this curious piece in my BH-2 repair documents. I'll be sure to include something in the next revisions, where appropriate. That device is referred to in the Olympus service literature as …wait for it… the *Kabinon*. Seriously, that's how it's listed. So, what is it? It's a vented plastic housing that contains pellets of the anti-mold / anti-fungal agent known as Kabinon, and its purpose is to prevent fungus from growing on the prisms in the binocular and trinocular heads. Per the manufacturer of the "Kabinon", a fresh, new Kabinon will provide protection from fungal growth for three or four years, after which time it should be replaced. This means that the ones you're seeing in BH-2 binocular and trinocular heads are way past their "best-by" dates. Replacements can be purchased, if you know where to find them, but they are expensive. Plan on spending $30 per microscope every three or four years to keep them protected from fungus growth. Personally, unless I thought the equipment would be subjected to very high levels of relative humidity, I'd skip the Kabinon replacements and spend my money on a good basement dehumidifier instead. No more fungus fears for all of the many microscopes and their associated components, and as an added bonus, no more musty-basement smell. That's way better than buying a new Kabinon, at $30 a copy, every three years for each of my microscopes. If you have binocular or trinocular heads to store, you can put them in a one-gallon Ziploc bag, along with a fresh desiccant packet, and zip it closed. Just be sure to replace or recharge the desiccant packets every few months, and Bob's your uncle.

Microscope Purchases

Do you want to buy any BH-2 stuff?

Very possibly. I am less interested in complete scopes that are ready-to-go, but if the price is really good, then sure, I might be interested. I would much rather buy stuff that still needs work, which I can overhaul and refurbish. Rather than a complete and recently serviced phase contrast scope, what really floats my boat are parts and components. What's that you say? You have a bunch of gears, washers, knobs, covers, shafts and other BH-2 bits left over from your recent rebuild? You've got an old gummed-up stand with stiff knobs that hardly move, or a binocular head with missing parts or damaged prisms, and maybe even some defective lamphouses or electrical bases? If so, then we should definitely talk.

Which type of objectives should I buy for my BH-2?

The answer, of course, is *Olympus* objectives. Specifically, Olympus *LB* objectives. What are LB objectives? Olympus used the "LB" designation to differentiate their so-called "long-barrel" objectives, which were used on the BH-2 and CH-2 scopes, and which had a parfocal distance of 45mm (per the DIN standard), from the "short-barrel" objectives used on the earlier BH and CH scopes (which had a parfocal distance of 36.65mm). Unless you have very specific imaging requirements dictating specialty optics of some sort, I recommend you get yourself a set of LB achromatic objectives, rather than the much-higher-priced apochromats or fluorites.

There were a few different types of LB achromats produced, so which type should you get? At the bottom rung of the quality ladder are the EA (Educational Achromat) objectives. These were low-cost achromats supplied with the CH-2 educational scopes, which were intended to be paired with the CWHK eyepieces (and which provided a limited field size of 18mm). These objectives are not particularly desirable for use on the BH-2, since they do not provide a flat enough field for use with the wide-field WHK or WK eyepieces (which provide a field size of 20mm).

The next rung up on the quality ladder are the so-called "D" achromats. Confusingly, "D" achromats are labeled as "A", rather than "D". The "D" achromats are non-plan objectives, which were designed to work with the 20mm field of the WHK and WK eyepieces. Since these are non-plan objectives, the entire visual field cannot be brought into focus at a single setting of the focus knobs (when the center is in focus, the edges of the field will be out of focus, and vice-versa). This situation is not as bad as it sounds if you're using the scope for visual observations but is not so good for photomicrographic applications. So, if what you primarily care about are visual observations, the "D" series objectives (labeled "A") are probably sufficient.

However, if photography is important to you, go one more rung up on the quality ladder to the *DPlan* objectives, which were made to provide an acceptably flat field of view (for photomicrographic applications) over the entire 20mm field provided by the WHK or WK eyepieces. DPlans are the "sweet spot" in the optical quality vs. cost continuum, providing the best bang for the buck to most people.

The next rung above DPlans are the *SPlans*. The SPlans were made to provide a super-wide field of 26mm(!) when used with the SWK or SWHK eyepieces in a super-wide binocular or trinocular viewing head. If your scope is equipped with a super-wide viewing head and SWK or SWHK eyepieces, SPlans would be the obvious choice. Note that using SPlans with a regular (i.e., not super-wide) viewing head will provide only a marginally better image, in terms of field flatness, although the SPlans do tend to have a slightly higher N.A. than the DPlans, so there will be some resolution benefit there.

Which is better, the Photomicro L Adapter or the MTV-3/U-PMTVC Adapters?

Both can provide excellent results if used with the appropriate NFK optics and the proper camera type. However, there are inherent drawbacks to the MVT-3/U-PMTVC adapters, as compared to the Photomicro L Adapter. The MVT-3/U-PMTVC adapters utilize 1" male threads to attach C-mount cameras, which inherently limits the free aperture for the image sensor such that the maximum sensor size for a C-mount camera is in the neighborhood of a little under 1". Because of this size limitation, reduction optics are needed between the NFK optics and the image sensor, in order to obtain a satisfactory field of view for the attached camera. The

presence of the reduction optics, which are integral to the MVT-3/U-PMTVC, are an additional optical element in the system, which adversely affects the brightness and contrast of the final image. To make matters worse, many C-mount cameras today utilize sensors significantly smaller than 1", making the field of view poor even with the lowest power NFK optics and with the integral 0.3x reduction optics. In comparison, the Photomicro L Adapter supports cameras with a significantly larger maximum image size (i.e., up to 35mm full frame), and therefore does not require reduction optics when used with an NFK 1.67X or NFK 2.5X lens. This allows imaging with fewer elements in the optical pathway, thereby providing inherently superior imaging.

Microscope Repairs

Can you repair my BH-2 microscope?

Very likely. Keep in mind that new parts are no longer available for these ~~beasts~~ beauties, but I have a pretty good stock of old mechanical and new electrical parts (for the 20W versions), so contact me if you would like to inquire. I can almost certainly repair the 20W electrical base or UYPC48 dimmer boards. I can also (usually) rebuild defective lamphouses or can offer trade-in credit for your defective ones if you choose to buy a new or rebuilt one rather than attempting to repair it yourself.

Do you repair BHS (100W) microscopes?

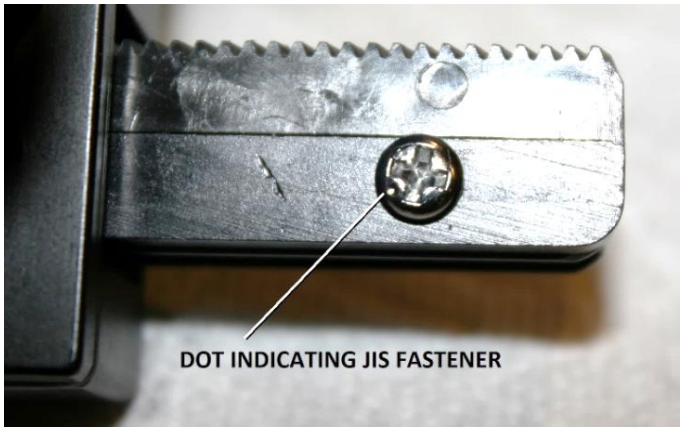
Yes and No. I don't currently have a stock of electrical parts to allow me to repair the electricals of a BHS. But if the scope needs mechanical work and the electricals are OK, then I can probably repair that for you.

Flat-Rate repairs I offer:

- Flat-rate repair of UYPC48 20W dimmer boards (you send me your bad board, and I send it back fixed). Quick-turns available.
- Flat-rate repair of 20W electrical base (you send me your bad electrical base, and I send it back fixed). Quick-turns available.

Are JIS Screwdrivers Really Necessary?

Most of the screws used in the BH-2 scopes are either Allen-head or JIS-head screws. There are no plain old Phillips screws. Does this really matter? Let me put it this way. I have a motto: "You can use a proper JIS-compatible screwdriver, or you can use a Phillips screwdriver and then a drill press, to get JIS fasteners out." If you plan on working on BH-2 equipment, do yourself a favor and get yourself a decent set of JIS-compatible screwdrivers. **Old-school Phillips screwdrivers are a disaster when used with JIS screws!** Even when using the proper JIS screwdrivers, it's still a good idea to seat the driver bit in the head of the screw and give the driver a quick whack with a soft-faced mallet, for luck, before loosening the screws. Olympus really liked to put thread-locking adhesive on all of their fasteners. How can you tell if a given cross-point screw needs a JIS driver? Look carefully at the screw head. JIS screws can usually (but not always) be identified by the presence of a single dot, or by an "X", stamped into one of the four quadrants of the cross-point depression (see picture below).



The Japanese cross-point screws commonly referred to as "JIS" screws were made to the now obsolete *JIS B 4633* standard. Subsequently, a screwdriver made to this standard will work the best on these JIS fasteners. But good luck finding a real "JIS B 4633" screwdriver these days. There are very few manufacturers still making screwdrivers to this obsolete standard. The DIN 5260-PH standard (which has an identical tip to ISO 8764-1) was created to be compatible with both JIS and Phillips screws. Subsequently, quality drivers conforming to the DIN 5260-PH standard will do a good job with both types of fasteners. Will a real JIS driver work better with JIS fasteners than a DIN 5260-PH driver? Almost certainly. Will a quality DIN 5260-PH driver work well enough with JIS screws? Yes, for all but the most stubborn screws.

So, having said all of that, what drivers should you get? *Hozan* makes a set of drivers that are advertised as JIS. These are reasonably priced drivers but are probably not the best choice for heavy-duty or commercial usage. The set that I bought seems to be real JIS drivers, and not the newer DIN 5260-PH drivers. But as always, your mileage may vary. The Japanese tool company *Vessel* (who made the first JIS screwdrivers in the early 1950s) makes their *Megadora* cross-point drivers to the DIN 5260-PH European standard and, although significantly more expensive than Hozan, are excellent drivers. Vessel also makes a 4-piece impact bit set that contains +2, +3, and +4 JIS-compatible bits.

From the Vessel Tool website:
"As you might know, VESSEL is the oldest screwdriver manufacturer in Japan, and made a contribution to set a Japanese Industrial Standard (JIS) standard. We do follow JIS (Japanese Industrial Standard) standard for cross point screwdrivers. Because the technology to manufacture screwdrivers in Japan had already become above a certain level, JIS (Japanese Industrial Standard) recognition system for screwdrivers became extinct in 2008. So there is no authorized JIS (Japanese Industrial Standard) manufacturer now, and we therefore cannot print "JIS" mark on our screwdrivers."

Rumor has it that *Sunflag* still makes real JIS drivers (look for their 888 and 215-P series), but I don't believe Sunflag tools are distributed in the US. *Moody* also still makes JIS drivers in the very small sizes.

Microscope Sales

Do you sell refurbished microscopes?

I do frequently offer refurbished BH-2 scopes (both complete scopes and bare stands that I have overhauled) for sale. I usually do a bit better than breaking even, but I certainly don't do this to get rich. The reason I do this is simple. I *really* like working on these things, and if I kept every single one that I've ever worked on, I would need another house to store them in. And I'd need a second job. Oh, and a new wife, too. So, you get the idea. Like it or not, they *have* to go. I also enjoy helping people who would like to get a nice reliable Olympus BH-2 scope without the risks associated with buying a scope in "as-is" condition from an unknown ebay seller, who likely does not accept returns. But even still, parting with a nicely refurbished BH-2 scope always feels like I'm selling one of my children. In addition to newly overhauled complete scopes and stands, I also have replacement parts I've sourced in or fabricated myself to allow BH-2 owners to keep their scopes running for many more years. If you're interested in any of these, contact me at the email address listed on the cover of this document.

Stuff I Usually Have:

- LS20H-M (20W) BH-2 lamphouses. New ones are usually available, also sometimes used ones. I also offer exchange credit on any bad ones you may have.
- Overhaul kit for the 20W lamphouse (LS20H-M)
- Replacement for the DW1195 socket on the electrical base that the lamphouse plugs into.
- BH-2 Rebuild survival kit (includes bearings, set screws, and some very tiny screws that are way too easy to drop and lose)
- Intensity slider replacements – a few different types of linear potentiometers to replace the erratic intensity slider in a 20W BH-2.
- Knob caps and adhesive dots for BH-2 knobs
- The very hard-to-find DIN927 (ISO2342) M3X10 slotted headless shoulder screws that are used as the stop for the pre-focus lock collar.
- M2.6 setscrews. Please do not buy the M2.5/2.6 screws commonly offered. These are just 2.5mm screws that are sold as "close enough" to 2.6mm, but if you buy them, you'll learn that they are not even close to "close enough"!
- Osram - ESB 6V/20W halogen lamps. Beware of the various no-name Chinese imitations. I've tried a few of these, and they are noticeably dimmer in comparison to the proper Philips or Osram lamps.
- Replacements for the molded-on rubber feet on BHT/BHTU scopes which have often cracked and dropped off over the decades.

Solvents for Cleaning Old Grease from Parts

What solvents do you recommend?

I typically use acetone or mineral spirits to clean the old grease from BH-2 scopes. Over the years, the grease Olympus used in these scopes polymerizes and turns into something that smells quite funky and best resembles green wax. This stuff is especially difficult to remove from the brass focus rack and from the two brass gears of the focus gearbox. I guess you can't blame Olympus for this, after all, the grease in Nikons of the same era did the exact same thing. A soak in acetone or mineral spirits will soften this stuff up but won't get rid of it. The best way I've found to remove this waxy mess from gears and gear racks is to soak it for half an hour or so in acetone or mineral spirits and then use a sharp wooden toothpick to physically scrape the muck out, tooth by tooth. Note that acetone does not work too well on Plastilube or Mobilith SHC 220 grease, so I use mineral spirits for these.

Screws and Fasteners

Where can I find setscrews that fit the BH-2?

Olympus used metric setscrews throughout the BH-2 design, as listed below. You can usually find most of these setscrews (except M2.6) on ebay, for very cheap prices.

Be very careful when you buy M2.6 setscrews. Most that are offered for sale as 2.6mm are not true 2.6mm fasteners but are in fact 2.5mm. They are sometimes described as 2.5/2.6, but either way, M2.5 is not "close enough" to M2.6. M2.5 is too small. The reason for this confusion is that, back in the day, the Japanese standardized on 2.6mm screws, whereas the rest of the world settled on 2.5mm. Don't even bother asking the Chinese suppliers on ebay which type they have. They either won't understand your question, won't know the answer, or they will simply tell you whatever they think you want to hear. If you choose to buy from them, you will almost certainly receive 2.5mm screws, instead of the requisite 2.6mm. And believe me, when an undersized fastener spins out while being tightened, damaging the threads in the process, it can ruin your whole day. You should only buy M2.6 setscrews from reputable and knowledgeable fastener suppliers, so that you can be sure you are getting the correct screws. If you Google "M2.6 setscrews", you'll get a ton of hits, most of which will be European suppliers who won't ship outside the EU. I have successfully bought M2.6 setscrews from Misumi USA.

COAXIAL FOCUS MECHANISM: The two setscrews in the brass shaft mount and the two that secure the pinion assembly to the pillar arm casting are M3X5 cup-point screws. The two setscrews in the gearbox (or the four setscrews, depending on the equipment vintage) are M2.6X4 cup-point screws.

X-Y STAGE: There are two M2.6X10 cup-point setscrews, two M2.6X5 cup-point setscrews, and two M2x3 cup-point setscrews in the coaxial positioning assembly of the stage. Additionally, there are three M3X6 cup-point setscrews in the Y-axis slide of the X-Y stage. For the two M2X3 setscrews in the black plastic backing disk in the middle of the coaxial positioning assembly, use either a 1.3mm or .035" Allen tool on these (if you do the math, you'll see that they're virtually the same size).

BINOCULAR / TRINOCULAR HEADS: There are three M2.6X4 (cup-point) setscrews in the helical adjustment on the left-hand ocular tube of the BH2-BI30 binocular and BH2-TR30 trinocular viewing heads.

Greases and Lubricants

Should I use Marvel Mystery Oil to loosen up stubborn microscope mechanisms?

It is my opinion that Marvel Mystery Oil should not be used on microscopes. If you're wondering why, just take a whiff of the stuff. While some would say they like the smell, here's a good rule of thumb to keep in mind: "If you can smell it, you should probably not use it in optical equipment." All kidding aside, there is some truth to this. Any oil or grease with a strong smell (and Marvel Mystery Oil certainly falls into this category) likely contains significant amounts of volatile compounds. These volatile compounds will, in time, out-gas and dry up, changing the nature of the remaining lubricant, possibly leaving it stiff and gummy. Worse still, these volatilizing compounds can potentially fog nearby optical components as they out-gas from the grease.

Regarding Marvel Mystery Oil specifically, there was an NTSB investigation into an incident involving a Piper aircraft, in 2003. The NTSB report for this investigation states that Marvel Mystery Oil contains 74% mineral oil, 25% Stoddard solvent, and *1% lard*. Yup, you read that right, lard. Look up NTSB Identification NYC02LA181 if you're skeptical of this claim. If this claim is indeed true, I guess this means that the mystery has now been solved. Kind of sad really, since "Marvel Oil" just doesn't have the same ring to it. But whether or not it contains lard, that doesn't explain the wintergreen smell. Or perhaps it does. Maybe the wintergreen is in there to cover the smell of bacon. Either way, thanks, but no thanks. I like bacon as much as the next guy, but I won't be using lard in any of the microscopes I repair.

Why do you recommend Plastilube grease?

"*Plastilube is a high-temperature grease consisting of highly refined mineral oils molecularly bonded to an inert bentonite-clay base. Plastilube does not contain any metallic soap or fatty acids and is water insoluble. Plastilube can absorb 50% of its weight in water without any breakdown or impairment of its lubricating properties*." So, marketing hype aside, Plastilube works well in microscopes in typical lab environments and has been proven to be safe for extended contact with the plastic parts in the BH-2. Also, the base lubricant does not bleed out or creep, nor will it volatize and fog nearby optics. Plastilube has a long history of use in microscopes, going back to Spencer and their Microglide stages. The grease used in these stages was Plastilube #1, which is an NLGI-1 light-consistency grease, whereas the Plastilube I recommend is Plastilube #2, which is an NLGI-2 medium-consistency grease.

Where can I find Plastilube? Are there any alternatives you can recommend?

The Plastilube I recommend is Plastilube #2, which is an NLGI-2 medium-consistency grease. Also available is Plastilube #3 (heavy-consistency grease), as well as Plastilube #3 Moly, which contains molybdenum disulfide. Plastilube #2 is still manufactured by Henkel (i.e., LocTite) but is not directly marketed in the US. However, some European car makers are gray-market importing it for sale through their repair-parts divisions, primarily for use on disk brakes. In fact, most BMW and Audi dealers carry tubes of Plastilube. I don't recommend you use the Plastilube brake grease from Audi, as I believe it is #3 Moly. Plastilube #2 is also generally available on Amazon and ebay, where it is sold as *Plastilube ATE Brake Grease*. You can go to autohausaz.com and purchase their item 1161688, which is *Plastilube ATE Brake Grease*, in a 75ml tube. If you wish to use an alternative grease, refer to the links below for the various repair documents that I've written for each section of the BH-2. If these documents do not already include alternative greases, the text above the links should include a suitable alternative (which will be rolled into the document the next time it is revised).

Why Should I Listen to You?

What qualifies you to work on BH-2 scopes?

I started this whole thing by reverse engineering the electrical circuitry in my first BHTU scope, sitting cross-legged on the floor at the living-room coffee table, with a Harbor Freight DMM, a sketch pad, and a big glass of Diet Doctor Pepper, while my wife watched *Say Yes to the Dress* on TV. I am an Electrical Engineer by trade (40+ years in the aerospace avionics industry), so I feel confident to speak with authority on the electrical aspects of the BH-2 design. As for the rest (i.e., the mechanical bits) I learned the ins and outs of servicing these parts by working closely with a few extremely knowledgeable Olympus repair experts. One of these friends (Jerry) has recently retired after a 50-year career of servicing microscopes in the Madison Wisconsin area. I get along well with Jerry, since according to him, the BH-2 was "the best damn scope Olympus ever made."

Additional References

Do you have any videos on YouTube?

Yes, I do have a series of BH-2 videos on YouTube. Look for the channel name "Carl Hunsinger".

ebay Musings

Back to the Table of Contents

Over the years, my wife and I have bought a lot of stuff on ebay. More recently, in addition to buying, I've also sold a fair amount on ebay. By and large, our ebay experiences have been good, but that's not always been the case. If not "good", they fall into the category of "amusing" or "infuriating". Either way, ebay/PayPal has made good on these otherwise-not-so-good transactions.

You're Being Ridiculous

My favorite example of the amusing category is the time my wife bought a cheap necklace on ebay. I say cheap because it was only $3.99, but then there was the $19.99 shipping the seller charged. OK, whatever. It was $24. My wife anxiously awaited the arrival of the necklace, only to be disappointed when she saw that the "stone" had fallen out in shipping. She contacted the seller and explained the situation. He told her to return the defective item, and once he receives it, he would then ship her a replacement. At this point, I said to my wife "let me handle this one." I contacted the seller and told him he needed to provide the funds for return shipping, since the item was received in a defective state. He replied "fine, let me know how much the shipping comes to, and I'll send it by PayPal." I told him that the shipping charges would be $19.99. He replied that I was being, and I quote, "ridiculous". I replied that he was, in fact, the one who was ridiculous, since he had set the shipping charges for this item at $19.99 in the terms of the original sale. He then replied "fine, if you want to be ridiculous, just keep the old necklace and I'll send you a new one." Ah yes, good times.

I Don't Like Spiders and Snakes

This was in the very early days of my Olympus BH-2 obsession. One night, while indulging my nightly habit of browsing for BH-2 items on ebay, I came across a six-position modular nosepiece for the BHS/BHT stands. The price was good ($35 with free shipping), but then again, the item did not *look* so good. The photos showed that the brass threading of one of the six objective bores was messed up. You could clearly see brass filings and debris from the mangled threads in of one the bores. The item description made no mention of the thread damage. "So", I reasoned. "Maybe the threads are salvageable, which would mean that the affected bore could once again accommodate an objective, or maybe they aren't salvageable. If they are repairable, I get a usable six-position nosepiece for $35. If they're not repairable, then I can put a plastic plug in that position and still have a usable five-position nosepiece for my BHT." Other than the thread damage, the nosepiece was cosmetically in great shape, so, I pulled the trigger, paid my money, and waited for my ebay booty to arrive.

Time passed, as it does, and the nosepiece arrived a few days later. I opened the box to see for myself how badly the threads were damaged and was faced with an entirely different situation than the ebay photos had led me to believe. Rather than having to work on a damaged objective bore with mangled brass threads, as I was expecting, I instead simply had to blow a dead, spindly-legged, brass-colored spider out of the bore, revealing pristine RMS threads within. Cool. Had it not been for that old dead spider, somebody else would have swooped on this item for sure.

The Antichrist of Microscope Hardware

So, a friend sent me a link to an ebay item. I clicked on the link and up popped a listing for an old (OK, old doesn't really describe it. It was, in fact totally filthy and beat to freakin' hell) Olympus BH2-BI30 binocular head. This beast, arguably in the worst cosmetic condition of anything I have ever seen in my years of scouring ebay for Olympus parts, was absolutely horrible. Yet a statement in the item description said that the cosmetic condition was "average (8/10)." Haha, very funny. The listing photos showed it sitting upside down, with what was left of an old broken-down vertical illuminator attached to the circular mounting dovetail. What with the partial vertical illuminator attached to the bottom and with it sitting on the table upside-down, it almost looked like a trinocular head (at least if you squinted really hard). After all, it has two eyepiece tubes and a cylindrical piece sticking upwards. That was apparently enough for the seller, since it was listed as an "Olympus Trinocular Head Microscope Part." Oh, and it was listed for $299 (Buy It Now!).

I couldn't resist and sent the seller a message explaining that the item was not a trinocular head but was in fact just a plain-old binocular head attached to a broken vertical illuminator. I told him that given the cosmetic condition of the equipment, he would be lucky to get $50 for it (and I was being **extremely** generous with my assessment). I guess the seller didn't believe me, since the description in the listing was never revised. To be fair, the seller did finally drop the price from $299 to $239 – a savings of 20%! My apologies to the seller, but I just had to rip off a few of his photos to include here (the photo caption is mine).

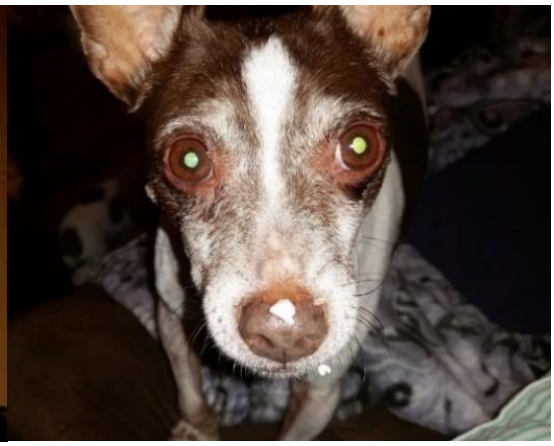
46 Stamps and One Thin Dime

I bought a few boxes of histological slides from an ebay seller a while back. The seller charged $11.60 for shipping. When the package arrived, I was amused to find a box festooned with 46 $0.25 stamps. The whole top of the box was covered with them. In addition to the impressive array of stamps on the box top, the seller had paid the USPS an additional ten cents. Doing the math, I came up with: (46 X $0.25) + $0.10 = $11.60. So, had he put an extra stamp on the box, he would have wasted $0.15. Rather than do that, he waited in line at the post office to pay the dime. I take it he is retired.

No Styrofoam Peanuts!

Repeat after me. Say the words "No Styrofoam peanuts!" Say it loud and say it to the tune of Joan Crawford's infamous phrase "No wire hangers!" from the movie *Mommie Dearest*. Seriously, is there anything worse than opening a big box from FedEx, containing not only your much-anticipated Olympus BHS microscope, but also

literally *gallons* of loose Styrofoam packing peanuts? In the image shown below, they're not just peanuts, but they're the hyper-dreaded micro-peanut variety. Mother of God, why?! Thanks to static cling, these things will end up everywhere, and there is nothing you can do to prevent it. By everywhere, I mean inside the eyepiece tubes in the binocular head, inside the lamp port on the rear of the scope, up into the sliding focus block mechanism of the scope, on the floor, in the bowl of dog water, on Gromit's nose, and even between your freakin' toes, to name just a few places. You'll be picking these godforsaken things up from everywhere. And for a damned long time. /rant mode = OFF.



The Early Bird Gets the Worm!

Every now and again, my habit of obsessively scanning ebay for BH-2 items that I can't live without really pays off. Case in point, I recently sat down after dinner and reflexively picked up the Samsung tablet to see what's new on ebay that I can't live without. In short order, I found an Olympus NFK 1.67X projection lens (that's right, the much coveted 1.67X) that had just a few minutes earlier been listed for auction, and that thus far had no bids. I've seen these things go for as high as a grand, and never below $500, so I know that *I'm* not going to be buying this thing. Nonetheless, I click on it so that I can add it to my watchlist, with plans to later watch in amusement, mixed with just a bit of envy, as the bids climb far higher than should ever happen in any sane reality[5].

It was then that I noticed that this listing also had a BUY-IT-NOW option, and it was only $129.95![6] I quickly scanned the ebay listing, making sure there were no hidden gotchas waiting for the unsuspecting buyer. Let's see, seller feedback rating is 100%. Check. The seller has multiple items listed for sale. Check. The seller has recent feedback. Check. So, at this point, the odds are pretty good that this is not a bogus listing on a hacked account but is instead just a seller who doesn't know what these things should sell for. I see that the seller does not accept returns, but the listing says that the item is in very good cosmetic and optical condition, and the photos in the listing back that up, so I'm probably covered if it turns out to be bad and I need to return it.

All of this due diligence takes under 30 seconds (or should I say, fewer than 200 heart beats), and at this point I'm 100% sure somebody somewhere is just getting ready to hit the BUY-IT-NOW button, after sitting down after eating *their* dinner and reflexively picking up *their* tablet to see what's new on ebay that they can't live without. With some trepidation, I click the BUY-IT-NOW button, and amazingly it works. So far, so good! Now to make the paltry payment and consummate this sweet deal!

Of course, it is at this point that the microscope gods decide to have a bit of fun at my expense. I have to log into PayPal to make the payment, and for some inexplicable reason, even though the damn thing accepts my PayPal account name just fine, it won't let me enter my password. After two or three keystrokes, it kicks me out of the tiny little password box and then clears the box, and it does this over and over and over again! What?!

[5] So, you just "won" an ebay auction, eh? Consider this: You just paid more for that item than any other person on the planet was willing to pay. Still feel like a winner?

[6] /Blood_Pressure_Mode = High

That's when I begin to hear frantic, profane screams that my wife later informed me were in fact my own screams. I keep at it for at least two solid minutes, desperately trying to enter eight damn characters into that tiny little box on the glowing screen, which is mocking me. The loud profanity continues, which is annoying to no end, but I persist despite the noise, making damned sure it's not me doing something stupid in the heat of the moment. But it was not me. As usual, it was the ghost in the damned machine. At some point, the gods relented, and I was able to successfully enter the eight magic characters into the tiny little mocking box on the glowing screen, making the deal final. The loud profanity ceased and on that day I learned that it is indeed the early bird that gets the worm. Oh, and I also learned that my heart can clock a solid 400 beats per minute, at least in the short term.

The BH-2 Shipping Hall of Shame

Back to the Table of Contents

I have a lot of BH-2 stuff shipped to me. Some of it arrives very well packaged, and some arrives …well… let's just say some arrives not so well-packaged. Sometimes the method of packaging is so bad, it rises to the point where it's actually comical. I think I've seen it all by now. Here are just a few examples that come to mind.

- Binocular and trinocular heads frequently arrive with shredded paper and Styrofoam peanuts filling the open ocular tubes and camera port (and thereby fouling the internal prisms). This one is all too common, but there is a simple fix. A Ziploc bag could totally prevent this.
- Speaking of binocular heads, I once received a binocular head that arrived in a 12" X 12" X 6" cardboard box, all by itself. No newspaper, none of the dreaded Styrofoam packing peanuts, nothing. Just a whole lot of air and one pitifully lonely binocular head, shivering alone in the box. This was from a seller who claimed to specialize in microscope equipment. The binocular head was, of course, damaged, but since I had the part on-hand to fix it, I went ahead and repaired and overhauled it, making it good to go once again. I then notified the shipper of the damage, so that he could perhaps do better in the future. I did not request a return or a refund from the seller. It was just a simple "heads up." The seller angrily replied that he had shipped thousands of microscopes and pieces of microscope equipment to people all over the world, with nary a single complaint, and that he was in fact now tired of selling BH-2 stuff to people like me on ebay. His angry reply was no doubt due to my *single* complaint, since by his own admission, there had never been any other complaints from anybody else. "I don't have the time to go through everything to make sure it's all good before shipping it out, for the few dollars I get for it, and I won't be selling any more BH-2 stuff on ebay. I'll just sell everything here locally as a surplus lot. Good luck in finding stuff for your BH-2 in the future." Wow. First off, it wasn't really a matter of checking the condition of the equipment before shipping it out. It was instead simply a matter of using adequate packaging to prevent damage during the shipping process. I replied: "Holy crap, man! I guess your plan is certainly an option, but another, less-radical solution would be to crumple up a bit of newspaper in the box. But I don't want to micro-manage you here. Oh, and by the way, you can never again claim that you have not received a single complaint on your shipping, but I'm guessing that you will continue to do so."
- I once got three naked objective lenses that had been thrown into a single Ziploc bag and allowed to bang together for the entire trip. But of course, "we gotta' wrap this whole Ziploc bag in 4" of bubble wrap because, you know, shipping damage." I'm not really sure why, but this "throw the eyepieces and objectives into a Ziploc bag and zip it shut" method of shipping is employed by a great many ebay sellers. Even those who claim the experience to know better.
- I once received a BHTU stand that had been laid on its side, directly on the bare bottom of the cardboard shipping box, with nothing to protect it from impacts to the bottom of the box. Every time the box was set down (like when it was pitched into the back of the FedEx truck from four feet away), the impact slammed the focus knobs, driving the entire coaxial focus mechanism out of place within the pillar-arm casting, with

the setscrews tasked with holding it in place gouging into the brass pinion carrier in the process. This of course got worse with each successive impact on the shipping container, until it arrived at my front door in sorry shape indeed. I literally had to remove the pinion assembly from the pillar-arm casting with a mallet in order to fix this one! Then there was lots of work on the drill press and bench grinder to make it all go back together again. It looks fine and works well now. In fact, it is one of my favorite microscopes, mainly because I wailed on it with a hammer for 20 minutes that one day. But I can never sell this scope because of the internal damage. To prevent me from ever selling it, there is a label on the front of this scope identifying it as the "Crash Test Dummy."

- A BH2-CD condenser once arrived in an old Kellogg's Corn Flakes box. I really shouldn't even mention this one because, all things considered, it was rather well packaged, and it arrived intact. I just include it here because, Corn Flakes box.

I wish I had photos of some of this earlier stuff, but I don't. I will be including images of the better ones from here on out.

The Inverted BHTU Stand

The seller agreed before I made the purchase to package and ship the BH-2 microscope he was selling in a specific way. Yet, despite all of this, the photo below shows exactly what I saw when I first opened the much-anticipated FedEx box. "Good lord, not again!", I exclaimed. As it turns out, the shipper didn't even bother to remove the eyepieces from the ocular tubes in the binocular head before he did the "invert-and-stuff" maneuver. Oh, and his decision to use the old, empty Amazon Prime boxes (an extremely nice touch) to fill *some* of the void space in the box, while leaving the entire space above the scope empty and unprotected, was a stroke of in-your-face, passive-aggressive genius. Points for that one. Somehow, despite his best attempts, this scope arrived without any damage to it whatsoever. The microscope gods must have really been asleep at the switch on this one. It was in fact this scope that was the straw that broke the camel's back, such as it were, inspiring me to write the *Successfully Shipping BH-2 Microscopes* document listed elsewhere.

I Was Just Speechless

When I bought this scope through ebay, I contacted the seller before they shipped it and asked them if they could remove the stage and substage (to reduce mass on the focus block) per my *Successfully Shipping BH-2 Microscopes* PDF document. I sent them a link to the PDF as well as a link to a video showing the procedure described in the PDF. I got back a one-word reply from the seller: "Yes." Great! Now I feel better. The listing

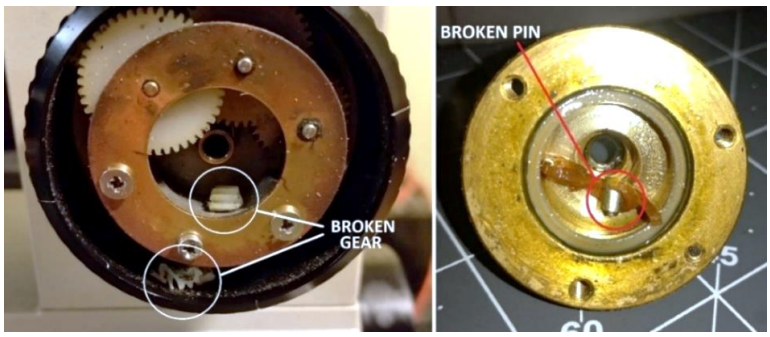
included a binocular head which was so damaged it couldn't be mounted onto the stand, so I wasn't really sure how that part would be packaged, but at least the stand should arrive with the focus gear intact. Fast-forward a few days, and the scope arrived, exactly as seen in the photo below. So much for removing the stage and substage to lower the mass on the focus block to protect the plastic gear! The seller had instead added mass by lowering the stage, jamming the broken binocular head in on top of the stage, and cranking the stage up nice and tight so that the head pressed against the objective lenses to hold it all in place. I guess it's not like objective lenses are fragile, expensive bits of precision optics or anything. The zip ties were a nice touch, because once again, you know, shipping damage. I can't help but wonder what would have happened had the seller responded to my original question with "No."

I Tried to Tell Him

A few days before Thanksgiving (2018), I got an email from somebody who had just received a BHT scope from a family member. He said my name came up in a Google search when he was researching the scope, and he wanted to know if I'd be interested in buying it, since he would be traveling through my neck of the woods on his way home after the holiday and could deliver it personally. Alternatively, if I was not interested in buying it, he wanted to know if I could overhaul it for him so that he could sell it on ebay. He said that all the controls worked, but they felt stiff to him. I wrote him a nice long reply, including the amount I would be willing to pay for it (based on the photos he sent me), and I also went through the whole thing, telling him which components he had, what they typically fetch on ebay, and what the whole thing could bring if everything was sold together. I declined to do the overhaul for him. If he had been a hobbyist wanting to make his scope right so that he could use it himself, I probably would have offered to do the overhaul for free. But for someone who is going to turn around and sell it on ebay, I would have to charge for that, and by the time he paid for the overhaul, he'd be giving the scope away. I sent him my PDF on successfully shipping BH-2 scopes, in the event he decided to sell it, and warned him that if he did not package it properly, it could very well end up irreparably damaged. Well, I guess he didn't like my response, because he never even acknowledged my reply to his email. Not even so much as a single word of thanks.

A few days later, I saw a BHT scope listed on ebay and immediately recognized it from the pictures this guy had sent me. I watched the bids slowly tick up, and it eventually sold for about half of what I told him it could bring. That is, what it could have brought had he offered it for sale at the right time. As I told him, the month or so before Christmas is a terrible time to sell used scopes on ebay (but conversely, it's a great time to buy them). A few more days pass and I see a post on an Olympus Microscope Users Group on Facebook from a severely frustrated guy who had just received a scope he bought on ebay that had been damaged in shipping. You guessed it – it was the same scope. In addition to posting photos of some obvious damage the seller should have disclosed up-front, the buyer also posted photos showing that the plastic gear in the fine-focus knob was shattered, *just like I told the seller would happen if he didn't remove the stage and substage*. The Facebook

photos also showed that the focus-stop mechanism was damaged. The seller ended up issuing a significant partial refund to the buyer, to make good on a messed-up situation. Talk about frustrating. This whole fiasco could have been avoided. I tried to tell him.



Deflated Bags

The photo below shows a BH2-TR30 trinocular head that was shipped in a box with only a few *air-filled packaging pillows* for protection. The heavy head of course sank to the bottom of the box (likely not due to gravity, but instead because of the "density and buoyance" phenomenon frequently cited by Flat-Earthers), and somewhere along the line, some of the packaging pillows became punctured and totally deflated. The end result of this seller's carelessness was of course none-too-good. If you look closely at the photo, you can see that the seller did not even bother to remove the eyepieces from the ocular tubes before shipping it. When notified of the damage, the seller replied that the head was in great condition when he shipped it, and that "I can't be held responsible for what happens to a package once it leaves my hands." Oh really? I think after buying this one back and paying return shipping, he now knows better than to think that again. He also stated that he always ships parts, and even complete microscopes, with just air pillows for protection. I totally believe that he does.

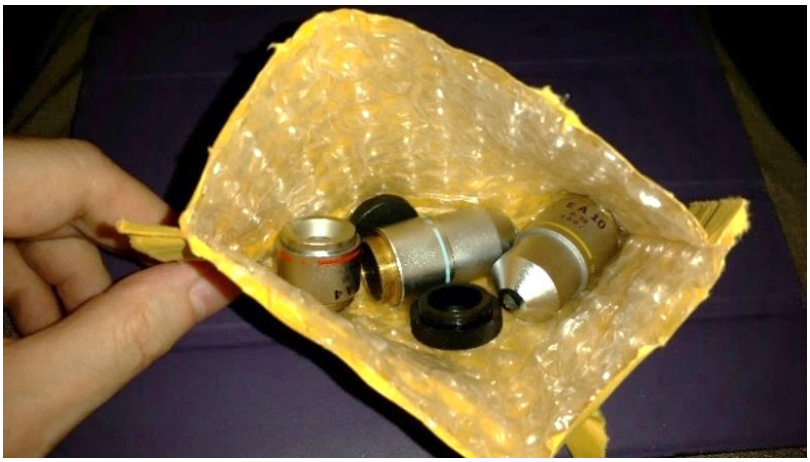
A Severe Head Injury

The photo below shows what happens all-too-often to a binocular head that has not been removed from a BH-2 microscope stand before shipping. Many sellers freely admit that they know nothing about microscopes, and to be fair, many of these sellers in fact do not know that the head can, and for shipping purposes, should be removed from the stand. It was because of these sellers that I wrote the *Successfully Shipping Olympus BH-2 Microscopes* document. Yet even after they have been sent a link to this illustrated document walking them through the exact steps needed to package and ship a BH-2 microscope without damage, many sellers will, as often as not, choose to ignore the shipping guidance and instead just throw the whole thing into a big box. Their

self-proclaimed ignorance of all things microscope related quickly falls away when they decide that they in fact do know how to *ship* a microscope. Sadly, the results speak for themselves. For God's sake, what single item screams "fragile" any louder than a microscope?

Why? Just Why?

This has happened to me quite a few times now, and I'm at a total loss to explain it. I buy a scope and the seller agrees to ship per the procedures detailed in my BH-2 shipping document. So far so good, right? Then the scope arrives, and upon opening the FedEx package, everything is found to have been meticulously disassembled and wrapped, just as described in the shipping document. That is to say, everything, with one exception. For some reason, the sellers don't seem to understand the fragile nature of the objectives, and they throw them all into a padded envelope (as shown in the image below) or Ziploc bag, or wrap them all together in bubble wrap, with no protection from each other whatsoever. So, the objectives bang against each other throughout the shipping process, metal-on-metal, metal-on-glass. Bump, bump, bump. I suppose I should update the shipping document to emphasize the fragile nature of these optics, but I'm not too optimistic this will help. Even so, I need to do this. I'll be right back…



Why? Just Why (Redux)?

So, this just keeps happening! This time, in utter frustration, I sent the seller photos of how I received the pair of WHK eyepieces he shipped to me, along with a message begging him to never again ship fragile optics in this manner. It went something like this: "For the love of God, PLEASE! In the future, make sure you wrap any microscope optics (which are very fragile) individually before placing them into the padded envelope, to protect them from damaging each other in transit." I got back this reply "I am sorry the envelope was torn." Huh? What the hell did he just say?! Exasperated, I replied "No! You missed the point entirely! It's not about the minor tear in the envelope. Those things happen. It's about the fact that you just tossed the fragile eyepieces

into the envelope without any protection from each other!" Addendum: I later sent him a link to this document, after revising it to include this entry, and referred him to the Shipping Hall of Shame section, along with this message "I guess the silver lining to this whole thing is that I now have a new entry for the Shipping Hall of Shame."

So, I Guess That Didn't Work (and I Still Don't know Why They Do This)

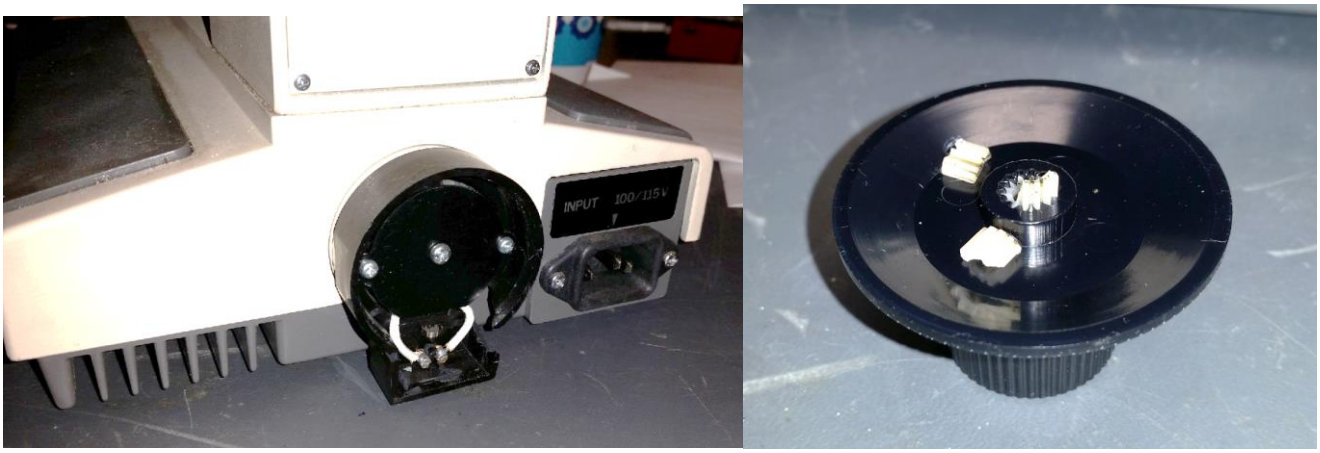
Just before Christmas 2019, I bought a more-or-less complete BH-2 scope from an ebay seller. The reason I bought this particular scope was that it included the rare fiberoptic lamphouse for lighting the pointer on the dual-head adapter. After paying for the scope, I sent the seller a link to my "BH-2 Shipping" PDF (yes, the one I recently updated to tell shippers to NEVER throw all of the optics into a single Ziploc bag) and requested that he ship per the PDF, to avoid mechanical damage to the scope. His reply: "*If one of my people has to read through that very long document and package it like that, I'm going to have to charge you a whole lot more for shipping. We have a high degree of shipping acumen, so it will be OK*." My reply to him: "*It is my experience that of the BH-2 scopes which are not prepared per this document, around 15% will sustain damage to the fine-focus mechanism during shipping. I'm not going to pay you to read and follow the PDF, but I strongly encourage you to do so. Ultimately, proper packaging for shipping is your responsibility. Give yourself a fighting chance and at least pull the stage off the scope and wrap it separately. But whichever way you choose to ship it, my expectation is that it will arrive intact. If not, you will buy the damaged scope back and pay the full amount for return shipping*."

I'm not sure if he read the PDF or not, but the scope arrived with everything stripped off and individually wrapped, almost exactly as described in the PDF. *Almost* exactly as described, but not *quite* exactly. The photos below show a small (approximately 35mm diameter) dust cap that was wrapped by itself in a big old bunch of bubble wrap. He did the exact same thing with a 45mm blue filter. These items, which were very well protected indeed, were clearly an excellent testament to his shipping acumen! Then, he decided to toss the two eyepieces and the three objective lenses into a single Ziploc bag and zipped it shut, just like my shipping document says to NEVER freakin' do! He of course wrapped the whole thing in bubble wrap, because once again, you know, shipping damage. Touché, ebay seller. I bow to you, the passive-aggressive master! I offer the photos below as proof of the thesis of my discontent[7]. Oh yeah, I almost forgot. To make matters worse, the rare fiberoptic lamphouse that I really, really wanted was not even included in the package.

[7] Why does this keep happening? Please help me out here. How can I get people to stop doing this? Do I really have to pay them? "*Hey man, there's an extra fifty bucks in it for you if you just don't trash the optics*." If you can provide any insight as to what may be going on in the minds of shippers who do this, then please let me know. So far, it seems that there are more eBay sellers who package and ship this way than not, and I'm at a total loss to do anything about that.

There Really Are Consequences to Being Stupid

So, I paid $120 (including shipping) for a BHTU scope stand advertised to be in good condition. I then sent the seller my shipping PDF, requesting that he package and ship per the PDF, otherwise bad things might happen to the scope. The seller promptly ignored the PDF and shipped the scope, as fools often do, and of course bad things happened. Who could have known? The seller left the lamphouse on the stand, hence the shattered lamphouse seen in the image below (left). He also left the stage on the substage, hence the shattered fine-focus gear shown in the image below (right). And, on the off chance that maybe there wasn't going to be enough damage, he included very little padding in the box, and laid the stand on its side, hence a bent fine-focus shaft (not pictured). When the dust had finally settled, he had issued a partial refund of $75 to cover the damages and to prevent a negative feedback rating. How does that old John Wayne meme go? Oh yeah, "Life is hard, and it's a lot harder when you're stupid."



I've Been Doing This for More Than 25 Years!

I purchased a pair of WHK10X eyepieces from an ebay seller. They arrived, wrapped in a big glob of bubble wrap, and I remember saying "well that's a good sign" as I pulled the bubble-wrap glob out of the shipping box. I began cutting into the glob to retrieve the booty inside, eventually got down to what is shown in the photo below. "Holy freaking crap! Why do they keep doing this?!" I emailed the seller through ebay, telling him he should never package multiple pieces of something fragile, like optics, in a single bag like this, since they need protection from each other. His snarky reply: "*Gee I must thank you. I have been selling and shipping Zeiss surgical microscopes and optical parts worldwide for more than 25 years without knowing what way to pack and ship these highly valuable optical precision parts. I will take your criticism under advisement and let my wife know she did a shitty job."* My reply to him? "Passive-aggressive sarcasm aside, that's all I would ask..."

Toilet-Paper Shortage? What Toilet-Paper Shortage?

Doesn't this just give you a warm and fuzzy feeling? Shown here is what happens when an ebay seller decides to wrap your microscope parts in toilet paper, for shipping. Right or wrong, I think his heart was in the right place, especially since this happened in the midst of the great, viral-induced TP shortage of 2020.

Next Stop, Discount City!

I received a BHT scope, purchased on ebay for $247 (including shipping), in the box shown below. When I first saw this box, I totally had a Scooby-Doo moment. "Ruh-roh!" Inside I found the BHT, not disassembled in the slightest, and simply wrapped with a *single layer* of bubble wrap. Then this skin-tight abomination of a box was carefully fitted to the bubble-wrapped scope and taped over a few times, at which point a label was slapped on it and the scope was sent out into the world to take its chances. I suppose the seller's thinking was that by packing it this way, he had eliminated any additional void space in the box that otherwise would have needed to be filled with something. The downside, of course, was that there was no protection beyond that provided by one layer each of bubble wrap and corrugated cardboard. Amazingly, the only damage sustained was to the lamphouse, as can be seen on the right in the photo below. I cannot imagine how the focus shaft escaped being severely bent, packaged as it was, but somehow it did. This mistake cost the seller $70 and a humbling apology.

The Mother of all Shipping Fiascos

In October of 2019, a guy in Italy posted a BHS scope with a whole pile of accessories for sale on an Olympus Facebook group. I bought a few of the items from the seller, as did my friend, Joe. It took quite a while, but eventually everything we bought showed up and we were both happy. In December 2019, after most of the other bits had been sold off, Joe made an offer to buy the remaining BHS stand and the seller accepted his offer.

The seller dutifully shipped the merchandise, just as before, but this time, things did not go quite so well. The scope arrived at US customs about a month after it had been shipped from Italy and appeared to be hung up in Customs for an additional month. After repeated calls back and forth between Joe and the shipping company, Joe eventually learned that the scope had been sent back to Italy due to a missing signature on the customs paperwork. The seller received the returned scope almost a month later, but by this time was unable to re-ship it since Italy had just gone into lockdown due to the exploding COVID-19 pandemic.

Time passed, as it does, and eventually the infection rates slowed, and Italy emerged from its lockdown. But by this time, the seller had lost the motivation to make good on the deal. Many months went by, and the seller would not respond to Joe's emails, nor would he refund the purchase amount or re-ship the scope. In November 2020, Joe put up a post on the Facebook Olympus group where the seller had originally listed the scope for sale, explaining the situation and warning others not to buy anything from this particular seller. The seller saw Joe's post and quickly responded (publicly) that he was sorry for what had happened, and that he would re-ship the scope ASAP. Joe deleted the Facebook post, since it seemed the situation was about to be resolved.

But old habits die hard, and once again the seller stopped responding to emails and once again the seller did not ship the scope. More time passed, and in mid-December, Joe put up another post on Facebook, similar to the first, but understandably a bit more pointed and blunt this time. Shame is a wonderful thing, and after a few days, the seller once again contacted Joe and once again agreed to ship his scope. And for whatever reason, this time, he in fact *did* ship it. The scope arrived in the US no faster this time than it had the previous time, and in January 2021 was once again in the possession of US customs.

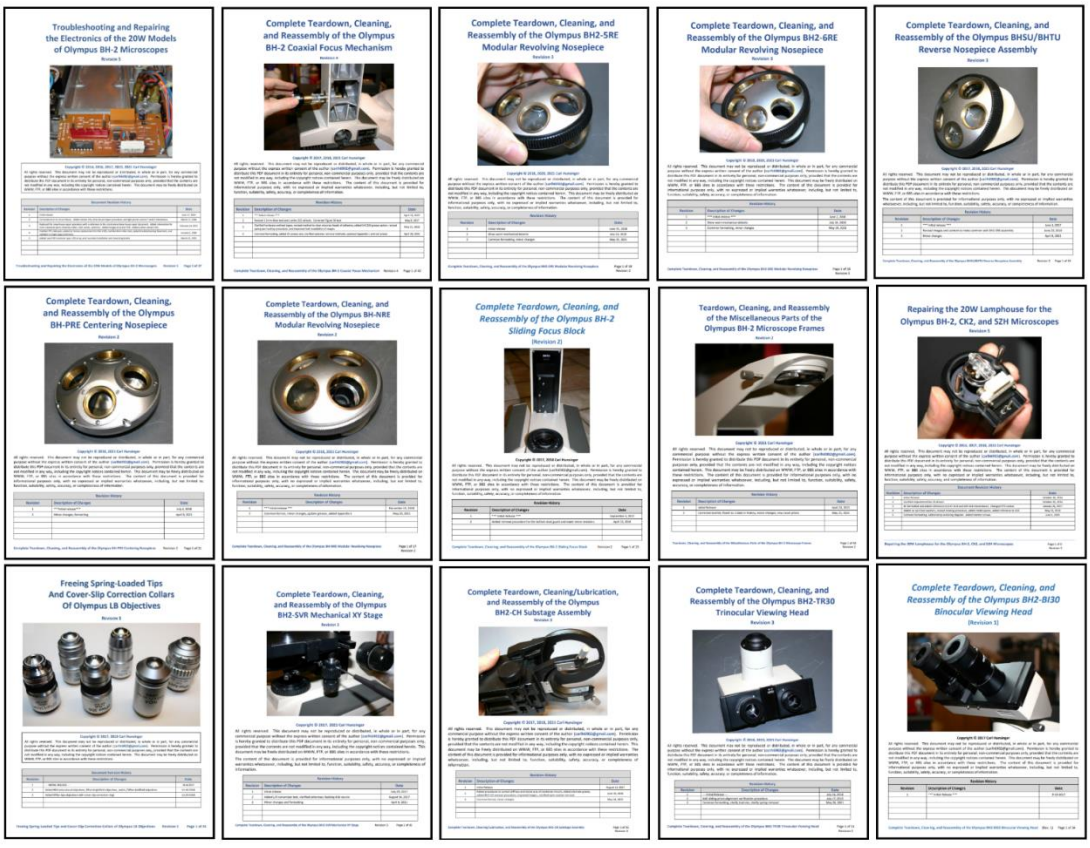
Joe watched the progress of the package via online tracking, as a cat watches a mouse. After a few weeks of unremitting scrutiny, the tracking revealed that the scope had finally emerged from the quagmire that is "United States Customs" and was finally on its way to Louisiana. From that point, the online tracking revealed a very twisted delivery route, with Joe's scope ping-ponging from state-to-state, around the country, like a steel ball trapped in a very sick and twisted pinball machine. After many days of this bizarre shipping activity, Joe once again contacted the shipping company to see what was happening.

I can't help but think it was Joe's call to the shipper that interrupted this vicious cycle, because the *very next day* (a full 468 days after this fiasco had begun) the prodigal scope, in its tattered box, was sitting on Joe's front doorstep waiting for him when he got home. Hooray and fetch the fatted calf! The box of course looked like

hell, and why shouldn't it? A conservative estimate from the tracking history revealed that that this little BHS scope had traveled no less than 15,513 miles on its journey from Italy to the US! And oh yeah, the scope was of course damaged. The microscope gods had a lot of fun with this one.

Olympus BH-2 Hardware Overhaul Documents

Back to the Table of Contents



So, here they are, the BH-2 hardware documents. If you've made it this far, thanks for sticking with me. If you skipped the malarkey and came straight here, shame on you.

It is my intention to keep the documents listed below in the current hosting environment (i.e., Google Drive), for as long as I can. However, given Google's track record of deciding certain things are "no longer fun anymore" and just dropping them, who knows how long they will be available here. Given this uncertainty, I suggest you download the various PDF files and keep them someplace safe if you want to be guaranteed to have future access to them. Be aware that I do update these documents every once in a while, so check back periodically to see if anything is new. The complete list of my BH-2 PDFs, and their current revisions, are listed below.

The contents of these documents represent my efforts at documenting procedures available to the hobbyist to service and maintain their Olympus BH-2 microscopes. My goal with these documents is to show the best practices available to the hobbyist, who almost certainly does not have access to the specialized tools, jigs, and lubricants once (but no longer) available from Olympus for field servicing. Where possible, I have tried to document the complete teardown, cleaning/lubrication, and reassembly of the BH-2 equipment using readily available tools, supplies, and equipment. There are frequently shortcuts that could be used instead of the procedures I present to get a scope "working" again with less time and effort, and these shortcuts are sometimes justified when performing on-site field repairs for time-sensitive or cost-sensitive customers, but THAT IS NOT THE PURPOSE OF THESE DOCUMENTS.

As an avid microscopy hobbyist, I enjoy maintaining my equipment as much as I enjoy using it, and I take pride in performing the best repairs that I can. This usually includes a complete disassembly to thoroughly remove any polymerized grease in the various mechanisms, and then reassembly with the most suitable lubricants available to me. This is the only way to restore that silky-smooth, like-new feel that the Olympus equipment was engineered to provide. If you are in the "*shoot a little Marvel Mystery Oil in there and work it around until it frees up for a while*" club, then these documents are definitely not for you, and you will likely find them to be overkill. If, like me, you are an avid microscopy hobbyist who enjoys all aspects of the hobby, then you are my intended audience.

Feel free to include links to any of the following documents on your website, so long as it's a non-commercial website and the links are used only for non-commercial purposes. You may also directly host these PDFs on your website, subject to these same limitations. Be aware that these documents are periodically revised to include corrections, clarifications, and additions, and as such you should check this list occasionally to make sure any PDFs you directly host on your website are the latest versions.

Here is the link to the *Public Documents* folder in Google Drive which contains a sub-folder (\Public Documents\Olympus BH-2 Scopes\Hardware Overhaul Documents) that includes the BH-2 Hardware Overhaul PDFs listed below.

https://drive.google.com/open?id=1NYBz7VkhIBfb6FL-JxYqZbP4pd4whvvs

BH-2 Miscellaneous Frame Parts

REVISION: 3

LAST REVISED: January 17, 2023

This document describes the procedures to service the various minor sections of the various BH-2 microscope stands.

BH-PRE (Four-Position) Modular Nosepiece Assembly w/ Centering for BHA-P/BHSP/BHTP

REVISION: 3

LAST REVISED: August 6, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff revolving nosepiece mechanism and poor centering of an Olympus 4-position modular centering nosepiece assembly.

BH-NRE (Four-Position) Modular Nosepiece Assembly for Reflected Darkfield for BHA-P/BHSP/BHTP

REVISION: 3

LAST REVISED: August 16, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff revolving nosepiece mechanism of an Olympus 4-position modular reflected darkfield nosepiece assembly (for SB Neo objectives).

Reversed Revolving Nosepiece Assembly for BHSU/BHTU

REVISION: 3

LAST REVISED: April 8, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff revolving nosepiece mechanism of an Olympus BH-2 microscope.

BH2-5RE (Five-Position) Modular Nosepiece Assembly for BHS/BHT

REVISION: 3

LAST REVISED: May 19, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff revolving nosepiece mechanism of an Olympus 5-position modular revolving nosepiece assembly.

BH2-6RE (Six-Position) Modular Revolving Nosepiece Assembly for BHS/BHT

REVISION: 3

LAST REVISED: May 19, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff revolving nosepiece mechanism of an Olympus 6-position modular revolving nosepiece assembly.

BH2-NRE (Four-Position) Modular Nosepiece Assembly for Reflected Darkfield for BHSP/BHTP

REVISION: 1

LAST REVISED: August 23, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff revolving nosepiece mechanism of an Olympus 4-position modular reflected darkfield nosepiece assembly (for LB Neo objectives).

BH2-BI30 Binocular Viewing Head for BHS/BHSP/BHSU/BHT/BHTP/BHTU

REVISION: 1

LAST REVISED: September 9, 2017

This document describes the complete disassembly, clean/regrease, and reassembly procedure to correct stiff interocular-distance slides and stiff helical focusing of the standard binocular head of an Olympus BH-2 microscope. The next revision will correct the spelling of "Jentzsch" and will change the recommended greases to Mobilgrease 28 for the slides and Helimax XP for the inner ocular tubes.

BH2-CH Substage Condenser Carrier for BHS/BHSP/BHSU/BHT/BHTP/BHTU

REVISION: 3

LAST REVISED: May 25, 2021

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff condenser-centering mechanism and condenser-height adjustment of the substage condenser carrier on an Olympus BH-2 microscope.

BH2-SVR/SVL Rectangular Stage for BHS/BHSU/BHT/BHTU

REVISION: 4

LAST REVISED: September 9, 2023

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff/erratic XY-positioning mechanism of the rectangular stage on an Olympus BH-2 microscope.

BH2-TR30 Trinocular Head for BHS/BHSP/BHSU/BHT/BHTP/BHTU

REVISION: 3

LAST REVISED: May 26, 2021

This document describes the complete disassembly, clean/regrease, and reassembly procedure to correct stiff interocular-distance slides, stiff helical focusing, and a stiff light-path selector shaft of the standard trinocular head of an Olympus BH-2 microscope.

Coaxial Focus Mechanism for BHS/BHSP/BHSU/BHT/BHTP/BHTU

REVISION: 5

LAST REVISED: January 21, 2023

This document describes the complete disassembly, clean/regrease, and reassembly procedure to correct the stiff coaxial focus mechanism of an Olympus BH-2 microscope.

20W Electrical Base for 110V/115V BHT/BHTP/BHTU

REVISION: 7

LAST REVISED: January 11, 2023

This document describes the electrical circuitry in the 20W versions (BHT and BHTU) of the Olympus BH-2 microscopes. Note that this does not include the 100W versions (BHS and BHSU), since the 100W electrical circuitry is totally different from the 20W circuitry.

LS20H-M (20W) Lamphouse Repair for BHT/BHTP/BHTU/CK2

REVISION: 5

LAST REVISED: June 1, 2021

This document describes the procedure to replace a malfunctioning lamp socket in the Olympus BH-2 (20W) lamphouse.

Sliding Focus Block for BHS/BHSP/BHSU/BHT/BHTP/BHTU

REVISION: 2

LAST REVISED: April 13, 2018

This document describes the complete disassembly, clean/re-grease, and reassembly procedure to correct the stiff sliding-focus block of an Olympus BH-2 microscope.

LB Objectives – Repairing Sticky Spring Tips and Correction Collars

REVISION: 3

LAST REVISED: November 29, 2018

This document describes the procedure to free sticky spring-loaded tips and cover-slip correction collars in Olympus LB objectives. Revision 3 added a procedure for apochromats with a cover-slip correction collar.

Successfully Shipping Olympus BH-2 Microscopes

REVISION: 2

LAST REVISED: July 8, 2019

This document describes the best way to package BH-2 microscope stands for shipping. I have received way too many that were damaged in transit, so I now send a link to this document to anybody who will be shipping a BH-2 stand to me. This is the way I ship all of my refurbished scopes and have never had any issues. Proper packaging and preparation can make a world of difference!

The following are placeholders for documents that not yet released.

BH-2 Substage Lighting Collimation (Revision 0)

Not yet available

BH2-PC/PCD Phase Condenser for BHS/BHSU/BHT/BHTU (Revision 0)

Not yet available

BH2-PA Polarizing Intermediate Tube for BHSP/BHTP (Revision 0)

Not yet available

BH2-KPA Simple Polarizing Intermediate Tube for BHS/BHSU/BHT/BHTU (Revision 0)

Not yet available

BH2-SRG Circular Stage for BHTP (Revision 0)

Not yet available

BH2-SRP Circular Stage for BHSP (Revision 0)

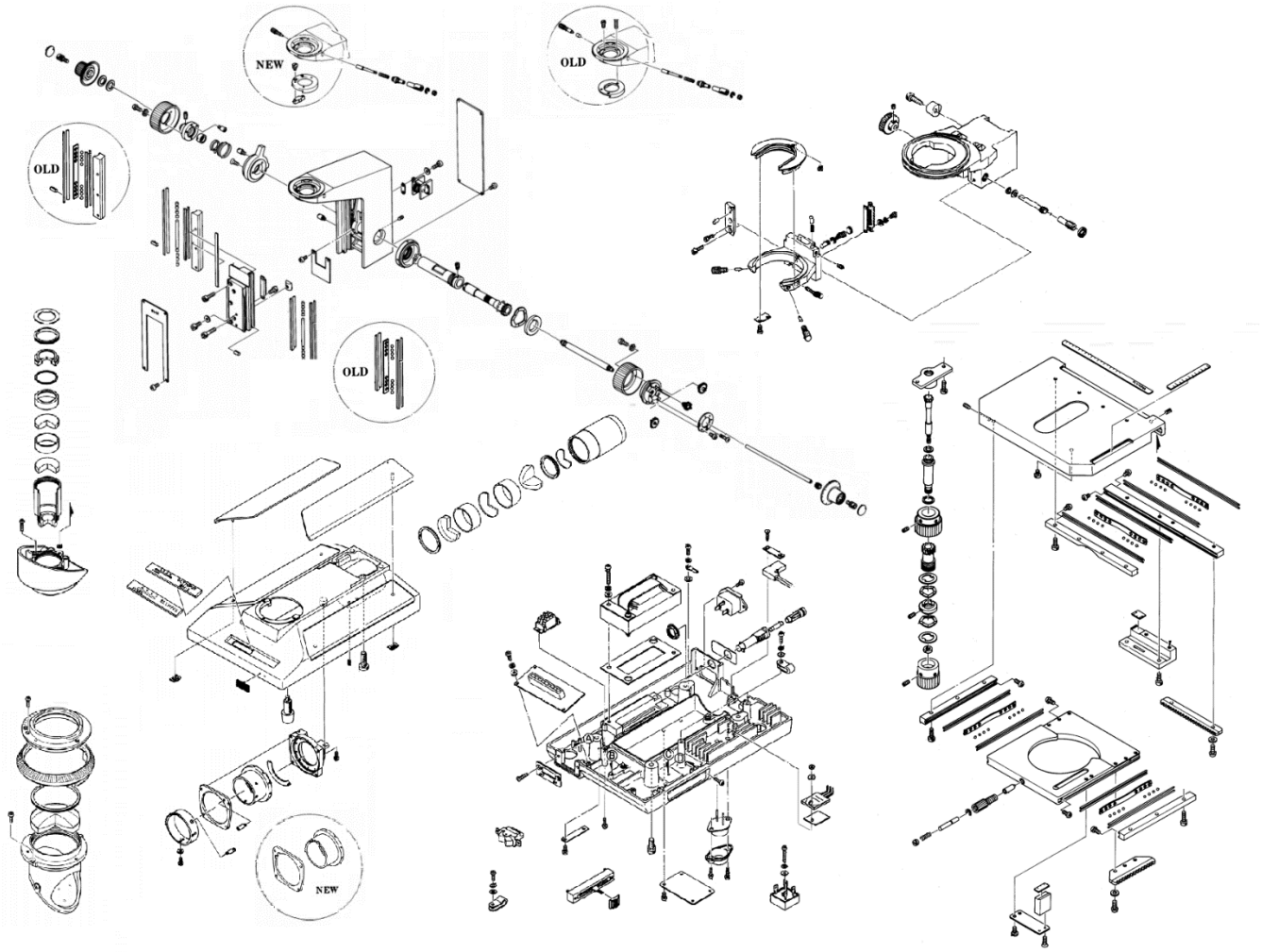
Not yet available

BH2-SW Super-Wide Trinocular Head for BHS/BHSP/BHSU/BHT/BHTP/BHTU (Revision 0)

Not yet available

Olympus Service / Repair Manuals

Back to the Table of Contents



Here is the link to the *Public Documents* folder in Google Drive which contains a sub-folder (\Public Documents\Olympus BH-2 Scopes\Olympus Service-Repair Manuals) that includes the Olympus service/repair manuals (in PDF format) listed below.

https://drive.google.com/open?id=1NYBz7VkhIBfb6FL-JxYqZbP4pd4whvvs

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Condensers

BH2_Condensers_Compilation.pdf: Parts lists for Condensers
BH2_UCD_Univeral_Condenser.pdf: Repair manual for BH2-UCD Universal Condenser
BH2_Condensers_AAC_CD.pdf: Partial repair manual for BH2-AAC and BH2-CD Condensers

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Electrical Bases

BH2_Electrical_Bases_Compilation.pdf: Parts lists for Electrical Bases
BH2-RFL-T3_Power_Supply.pdf: Repair manual for BH2-RFL-T3 Fluorescence Power Supply
Olympus_BH2-MJL_Electrical_Manual.pdf: Repair manual for MJL Electrical Base
Olympus_Troubleshooting_BH2_Electrical_Bases.pdf: Repair manual for BH-2 Electrical Bases

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Fluorescence

BH2_Fluorescence_Compilation.pdf: Parts lists for Fluorescence Equipment
BH2_RFCA_Fluorescence_Head.pdf: Repair manual for BH2-RFCA Fluorescence Attachment
BH2-RFL-T3_Power_Supply.pdf: Repair manual for BH2-RFL-T3 Fluorescence Power Supply

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Frames

BH2_Frames_Compilation.pdf: Parts lists for Microscope Frames
BH2_Repair_Manual.pdf: Repair manual for BH-2
BH3-MJLA-T_Inspection_Microscope.pdf: Repair manual for MJLA Inspection Microscope
Olympus-BH2_BHS_Repair_Manual.pdf[1]: Repair manual for BH2 (BHS) Microscopes (on steroids)

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Intermediate Heads

BH2_Intermediate_Tubes_Compilation.pdf: Parts lists for Intermediate Tubes
BH2_RFCA_Fluorescence_Head.pdf: Repair manual for BH2-RFCA Fluorescence Head

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Lamphouses

BH2_Lamp_Houses_Compilation.pdf: Parts lists for Lamphouses

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\LB Objectives

Olympus_LB_Objective_Parts_Diagrams.pdf: Olympus Parts Book #17 Parts Lists for LB Objectives

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Multi-View

Multi-View_Components_Compilation.pdf: Parts lists for Multi-View / Dual-View Equipment
BH2-MDO_Multi-View_Attachment.pdf: Parts list for BH2-MDO Multi-View Attachment
BH2-DO_Dual-View_Attachment.pdf: Repair manual for BH2-DO Dual-View Attachment
BH2-TET_Quad-View_Tube.pdf: Repair manual for Quadruple BH2-TET Trinocular Head with C-Mount

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Stages

BH2_Stages_Compliation.pdf: Parts lists for Stages
BH2-SVR-SVL_Stages.pdf: Repair manual for BH2-SVL and BH2-SLR stages
BH3-SIC_Wafer_Stage.pdf: Repair manual for BH2-SIC wafer stage

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Vertical illuminators

BH2_Vertical_Illuminators_Compliation.pdf: Parts lists for BH-2 vertical illuminators
BH2-RFCA_Repair_Manual.pdf: Repair manual for BH2-FRCA fluorescence attachment

\Public Documents\Olympus BH-2 Scopes\Olympus Service - Repair Manuals\Viewing Heads

BH2_Viewing_Heads_Compilation.pdf: Parts lists for BH-2 viewing heads
BH2_Heads_BI30_TR30.pdf: Repair manual for BH2-BI30 and BH2-TR30 viewing heads
Olympus_BH2-BI30_Binocular_Head.pdf: Repair manual for BH2-BI 30 binocular viewing head

\Public Documents\Olympus CH Scopes\Microscope Stands

Olympus_CH_Repair_Manual.pdf

Microscope Projects

Back to the Table of Contents

Here is the link to the *Public Documents* folder in Google Drive which contains a sub-folder (\Public Documents\Microscope Projects) that includes the microscope projects in PDF format listed below.

https://drive.google.com/drive/folders/1Y3md0ZgHjsJvAJ4lMVs4FAL1WcIUXTJj?usp=sharing

A Darkfield/Rheinberg Accessory Kit for Olympus BH-2 Microscopes (Revision 1)

This describes the construction and usage of the BH2-DFR Accessory Kit, which adds darkfield and Rheinberg capabilities to the BH-2.

https://drive.google.com/drive/folders/1YmmqtSaPhHaZnf6zRctKjqlMN-LYlQj4?usp=sharing

An Oblique Accessory Kit for Olympus BH-2 Microscopes (Revision 1)

This describes the construction and usage of the BH2-OBL Accessory Kit, which adds oblique lighting capabilities to the BH-2.

https://drive.google.com/drive/folders/1wKxMaP5twPII6M3lNmaLdvGt6SjgwwLo?usp=sharing

Adding Darkfield Stop to Nikon Condenser (Revision 2)

This shows one way to add a darkfield stop to the standard Nikon Abbe condenser used in the Labophot / Optiphot scopes, as published in Issue #54 of Microbehunter magazine. I developed this since these condensers can also be used in Olympus BH-2 scopes and this provided an easy way to do simple darkfield on my BH-2 before I obtained a true darkfield condenser.

https://drive.google.com/drive/folders/1mvhNXUWzL--6iXnJk6tBX5GcehSbTC8_?usp=sharing

A Padded Storage Box for Microscope Condensers (Revision 1)

This shows the construction of a padded box which works really well to store of a pair of BH-2 condensers, as published in the June 2018 issue of Micscape online magazine. This uses a pre-made Vaultz 4”X6” index-card box and is a really quick and easy project to do. I have three of these made up: one for the regular Abbe and AAC condensers, one for the swingout and ultra-low power condensers, and the third for the two darkfield condensers. Now I just need to figure out a good way to store the phase contrast condenser.

https://drive.google.com/drive/folders/1HuQiSBeV0Tt7mAYtEsx7gqhLwvkmJ5aL?usp=sharing

3D Printed Intensity Knob for Alpha Slide Potentiometer

The file *Brightness_Knob.zip*, which is available at the Google Drive location linked below, contains STL (3D model) files for the parts needed to make a replacement intensity knob which fits the Alpha 1K replacement intensity potentiometer. These parts can be made using any low-cost, 3D FDM printer. Listed in the table below are the included STL files.

https://drive.google.com/file/d/1d4r_UtSoWZ1Yy1uQzpGf7sZ5N_21yLKh/view?usp=drive_link

Description	Filename	Comments
Piece #1 for Alpha intensity knob	Brightness_Knob_1.stl	Press piece #2 into piece #1.
Piece #2 for Alpha intensity knob	Brightness_Knob_2.stl	

3D Printed Adapter to Add T-Mount to MTV-3 Shell

The file *“MTV-3 T-Mount Adapter.stl”,* which is available at the Google Drive location linked below, contains the STL (3D model) file for the part needed to add a T-Mount onto the bare shell of the MTV-3 adapter. This part can be made using any low-cost, 3D FDM printer.

https://drive.google.com/file/d/1QKRWjFzZ4sazdvOuNoQ--03YBkJ4EnMG/view?usp=drive_link

3D Printed Knob for the BH2-TR30 Trinocular Head

The file *"BH2-TR30 Knob.stl",* which is available at the Google Drive location linked below, contains the STL (3D model) file for a replacement knob for the prism-slide shaft on the BH2-TR30 trinocular head. This part can be made using any low-cost, 3D FDM printer.

https://drive.google.com/file/d/1rT9jWH7jeiqp-ofmNhrJan0DOuS654N_/view?usp=drive_link

Miscellaneous 3D Printed Components for the Olympus BH-2

The file *BH2_3D_Components.zip*, which is available at the Google Drive location linked below, contains STL (3D model) files for various parts and accessories I have designed for the for BH-2 scopes. These parts can be made using any low-cost, 3D FDM printer. Listed in the table below are the included STL files.

https://drive.google.com/drive/folders/1oN8eD72GbzTjFOVYqNd6tC1FVx04f-97?usp=sharing

Description	Filename	Comments
Dust cap for trinocular port	Trinocular_Cap.stl	Fits BH2-TR30 and BH2-SWTR30 heads
Dust cap for 23mm eyepiece tube (Slip Fit)	Eyepiece_Cap_23_Slip.stl	Slip-fit cap for 23mm eyepiece tubes
Dust cap for 23mm eyepiece tube (Friction Fit)	Eyepiece_Cap_23_Friction.stl	Friction-fit cap for 23mm eyepiece tubes
Dust cap for 30mm eyepiece tube (Slip Fit)	Eyepiece_Cap_30_Slip.stl	Slip-fit cap for 30mm eyepiece tubes
Dust cap for 30mm eyepiece tube (Friction Fit)	Eyepiece_Cap_30_Friction.stl	Friction-fit cap for 30mm eyepiece tubes
Dust cap for field lens	Field_Cap.stl	Fits the field lens on BH-2 stands (under the stage)
Dust cap for viewing head dovetail	Head_Dovetail_Cap.stl	Fits BH2-BI30, BH2-TR30, and BH2-SWTR30 heads
Dust cap for viewing head recess	Head_Recess_Cap.stl	Fits the recess for the viewing heads on BH-2 stands
Adapter to use CT5 in SWHK heads	CT5_30mm_Adapter.stl	Use 23mm phase telescope in 30mm heads
Eyepiece rack for WK/WHK oculars	Eyepiece_Rack.stl	Holds pairs of WK and WHK eyepieces
Adapter to use Vanox DF condenser on BH-2	Vanox_DF_Adapter.stl	Adapts the Vanox wet darkfield condenser to the BH-2

Miscellaneous Microscopy Stuff

Back to the Table of Contents

Here is the link to the *Public Documents* folder in Google Drive which contains the stuff in PDF format listed below.
https://drive.google.com/open?id=1NYBz7VkhIBfb6FL-JxYqZbP4pd4whvvs

My Story

This is my story of how I got into microscopy and microscope repair as a hobby, as published in the June 2017 edition of Micscape online magazine. Oh, and the *seven* scopes mentioned at the end? My wife wishes it was only seven. Or even seventeen…
https://drive.google.com/open?id=1OI2tf5c4aoN7CVnJqFBLFB730M9gMaxV

Köhler Illumination on the Olympus BH-2 Microscopes

CURRENT REVISION: 2
LAST REVISED: May 5, 2021
This document describes the proper procedure to setup Köhler illumination on the BH-2.
https://drive.google.com/file/d/1Hd5lqcZaq2r61fwR35uiVn34f2QxRWXL/view?usp=sharing

Phase Contrast on the Olympus BH-2 Microscopes

CURRENT REVISION: 1
LAST REVISED: May 5, 2021
This document describes the proper procedure to setup phase contrast on the BH-2.

https://drive.google.com/file/d/1L4HXJ_5t1zIl1enXqCYEV1wL3gZUD1-F/view?usp=sharing

Basic Optical Microscopy FAQ

This is an FAQ covering questions relating to basic optical microscopy. These topics are not specific to the BH-2.
https://drive.google.com/open?id=1bC7gVC4nYEhoCIkjGjqon90CvKcPxeK0

Sub-Folders of the Public Documents Folder on Google Drive

Here is the link to the *Public Documents* folder in Google Drive which contains various sub-folders containing PDFs relating to various Olympus microscopes.
https://drive.google.com/open?id=1NYBz7VkhIBfb6FL-JxYqZbP4pd4whvvs

Equipment and Accessories for the BH-2

Back to the Table of Contents

Here is the link to the *Public Documents* folder in Google Drive which contains a sub-folder (Public Documents\Olympus BH-2 Scopes\Hardware Spreadsheets) that includes the BH-2 hardware spreadsheets (in PDF format) listed below.

https://drive.google.com/open?id=1NYBz7VkhIBfb6FL-JxYqZbP4pd4whvvs

BH2_Camera_Adapters.pdf
https://drive.google.com/file/d/1j5qv6UZH4xVzPEW1JUOtqU7nUPWNaMQY/view?usp=sharing

BH2_Condensers.pdf
https://drive.google.com/file/d/1CilAeS6VFYv1EFaeGc7WNedtlyzrjt-q/view?usp=sharing

BH2_Eyepieces.pdf
https://drive.google.com/file/d/1agImR4CXAiui1lRk7ip_IJdsI--B_j-2/view?usp=sharing

BH2_Frames.pdf
https://drive.google.com/file/d/14q0J2oI9_IQGLyRxlqLSXumZQ9sj7xHq/view?usp=sharing

BH2_Intermediate_Attachments.pdf
https://drive.google.com/file/d/1dQpsTQ0LqISMXgrbe3mxUQuGiVmaCfTw/view?usp=sharing

BH2_Lamphouses.pdf
https://drive.google.com/file/d/1LAUND7hK6lQBsKQx3nhNCp9XeIB1YsFR/view?usp=sharing

BH2_LB_Objectives .pdf (Biological)
https://drive.google.com/file/d/191X1KxZU8k5PNRd_o_PRK-SRvW4vO9Zo/view?usp=sharing

BH2_LBM_Objectives.pdf (Metallurgical)
https://drive.google.com/file/d/1AGzKRtgf4BGHpl3o7aijuwFMulj0Mzk-/view?usp=sharing

BH2_Multi-View_Equipment.pdf (multi-view and dual view)
https://drive.google.com/file/d/1zZgfZjjVqHLAd3dtyi58NV01Jh1rWgti/view?usp=sharing

BH2_Nosepieces.pdf
https://drive.google.com/file/d/1cBoggH8O9-BENJZoxSQDy0x99qBtfRB_/view?usp=sharing

BH2_Power_Supplies.pdf
https://drive.google.com/file/d/1uvv8gdthD3szoK_MQVla1EM4sXYb8zmz/view?usp=sharing

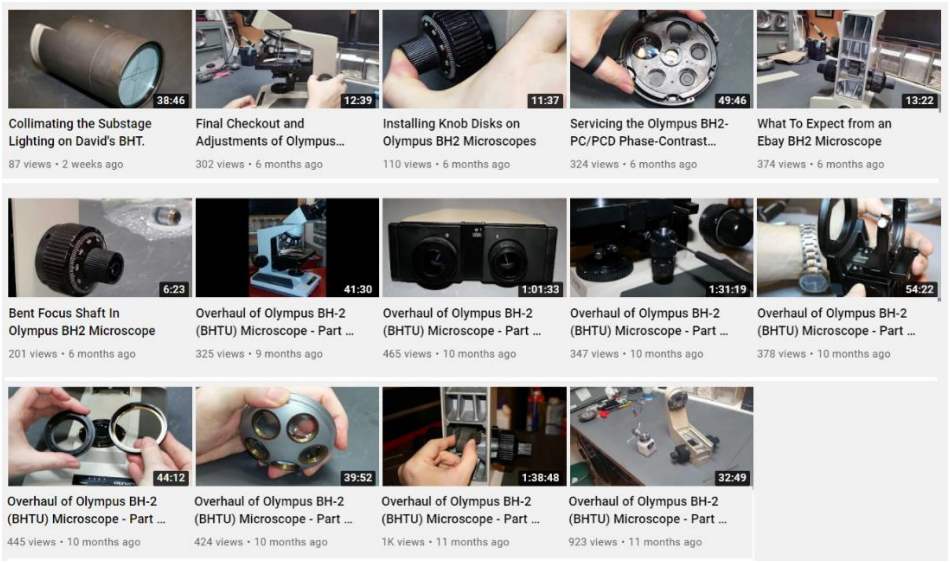
BH2_Stages.pdf
https://drive.google.com/file/d/1XsGhKMhTPqNW-iSl5CGjxiQ7KRfwwjwl/view?usp=sharing

BH2_Vertical_Illuminators.pdf
https://drive.google.com/file/d/11UEp0mkPwBcwXVAN3jaBtTbBD0odJYP2/view?usp=sharing

BH2_Viewing_Heads.pdf
https://drive.google.com/file/d/1ET0Q4Mdda9vnSnIBwnut_PUPGfP9VG7m/view?usp=sharing

YouTube Videos for the BH-2

Back to the Table of Contents



Here are the links to my various BH-2 videos on YouTube. This is an 8-part series showing complete teardown, cleaning, and reassembly of a BHTU scope.

Part 1 of 8 – Sliding Focus Block
https://youtu.be/SI4w1pPphgY

Part 2 of 8 – Coaxial Focus Mechanism
https://youtu.be/iCtTmBb5Uq4

Part 3 of 8 – Reverse Nosepiece and Viewing Head Thumbscrew
https://youtu.be/LwRWVEa5jcU

Part 4 of 8 – Substage Lighting
https://youtu.be/Yaw_n5Up414

Part 5 of 8 – Electronics, lamphouse, and Substage Assembly
https://youtu.be/2mJ03i9ktnM

Part 6 of 8 – BH2-SVR Rectangular Stage and Specimen Clip
https://youtu.be/eOlRlCOGyKY

Part 7 of 8 – BH2-BI30 Binocular Viewing Head
https://youtu.be/c4DXsIXbmhQ

Part 8 of 8 – Reassembly and Setup
https://youtu.be/AbVLZbCOZj8

These are miscellaneous BH-2 videos.

Servicing an Olympus BH2-TR30 Trinocular Head for a BH2 Scope
https://www.youtube.com/watch?v=YavVuxACcdw

Fixing A Sticky Tip on an Olympus BH2 Objective
https://www.youtube.com/watch?v=aN3LEllKmSE

Final Checkout and Adjustments of Olympus BH2 Microscope
https://youtu.be/qUoTIpfSPlU

Installing Knob Disks on Olympus BH2 Microscopes
https://youtu.be/OJ4U7TFpDOU

Servicing the Olympus BH2-PC/PCD Phase Contrast BH2 Condensers
https://youtu.be/QSjlgNyfwJw

What to Expect from an ebay BH-2 Microscope
https://youtu.be/DQxVF4rgAvU

Bent Focus Shaft in Olympus BH-2 Microscope
https://youtu.be/j9ckg4L0t_M

Collimating the Substage Lighting on David's BHT
https://www.youtube.com/watch?v=Y5PvIOeYYNI&t=927s

Electrical Modification to Olympus BH-2 Microscope
https://www.youtube.com/watch?v=xPT8B82W6iU&t=2739s

Understanding the Olympus BH2 Stage-Height Preset Lock Mechanism
https://www.youtube.com/watch?v=gx6agYYhYgQ

Adding a T-Mount (T2) Camera to Your BH2
https://youtu.be/vqheqKl7GOw

BH2 Quickie – Missing Knob on Trinocular Head
https://youtu.be/LKPL3AOf_KE

Random Thoughts, 3D Printers, and the World's Cheapest BH2 Microscope
https://youtu.be/JId-tZGPCyo

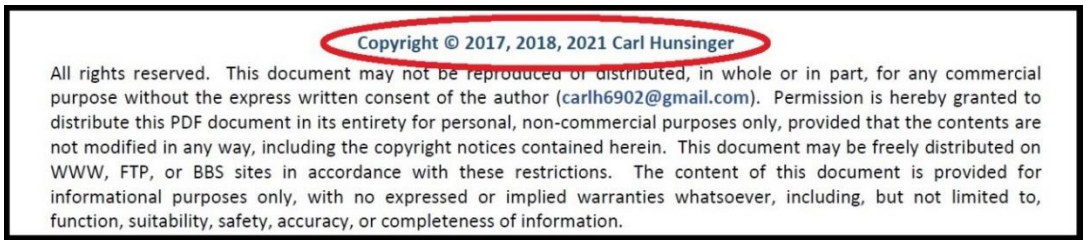
Please Help - This Guy Keeps Stealing My PDFs!

Back to the Table of Contents

A few years ago, I saw a listing on ebay from a guy selling DVD collections of documents related to microscopes. His DVDs include brochures, user's manuals, service manuals, and so forth. Perhaps you've seen them yourself. He makes a really big deal that the documents he is selling are in the public domain and are no longer copyright protected. He goes on to state that some guy in the UK has stolen his PDFs and is now selling them as his own. The truth is, the vast majority of the documents on his DVDs are still under copyright protection, regardless of what he says. They are certainly not *his* documents, even if he did scan them from their original printed sources, as he says. In looking through the list of PDFs in his Olympus collection, I found that he had included many of my BH-2 PDFs in the collection of "his" documents. I have spent many hundreds of hours researching, writing, and revising these documents over the past ten years. My wife would attest to that. I make these PDFs available for FREE to anybody who wants them, so long as they do not use them for commercial purposes. That's all I ask, and this is clearly and unambiguously stated right on the cover page of each and every one of the PDFs. I derive no profit from these PDFs and do this as a way to make some sort of contribution to the microscopy hobby. Given all of this, it really irks me that this guy is doing this. What makes him think *he* should profit from *my* work?

So, I contacted him through ebay and told him to remove my PDFs from his collections, and he promptly ignored me. A week or so later I reported his copyright infringement to ebay, and they must have addressed the issue, as my PDFs were no longer in the list of "his" documents. Did he really take my PDFs off of his DVDs? I don't know, but he at least took them out of the lineup of documents included in the ebay listings. Problem solved, right? Well, not really. Fast forward a year or so, and ***sawmill33606*** is up to his old tricks again. My PDFs are once again proudly back in his lineup and are once again offered for sale to anybody who ponies up the requisite $39. So, I again reported his copyright infringement to ebay, and he again scrubbed his ebay listings to remove any mention of my documents.

Later on (you guessed it) my PDFs were again listed as part of his DVD collection. Upon discovering this in late May of 2020, I contacted him through one of the Facebook Microscope groups where he was selling used microscopes and told him once again to quit selling my work (all of which is clearly marked with my copyright notice). His response? "I am not going to sit for days going through hundreds and thousands of pages 'looking' for that note". For reference, here is the note on one of the cover pages. It's pretty obvious to anybody who cares to look for it.



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After a bit of back and forth, Mr. Ponzio eventually told me to go f*** myself and blocked me on Facebook. So… I went back to ebay and filed another complaint, and, for the third time he responded by removing my PDFs from his listings. By this time, I'm getting about damned tired of this crap. So, why do I write all of this here? Because this morning (4/30/21), I see the listing for his collection of Olympus documents on ebay, and I see that my very own PDF on fixing sticky BH-2 objectives (item 182 – Stuck Spring Repair Manual) is in there (see image below). Again! Son of a freakin' bitch!

176. Olympus K Series / KH / KC / KHC-BI / KHS-BI/mono Microscope Parts Diagram Schematics Manual
177. Olympus KH and KH-2 Exploded Parts Diagram.pdf
178. Olympus KHC Instructions Manual.pdf
179. Olympus LB Objective Series for Biological Use brochure.pdf
180. Olympus LB Objectives 1980 brochure.pdf
181. Olympus LB Objectives Parts Diagrams Schematics
182. Olympus LB Objectives Stuck Spring Repair Manual
183. Olympus LBM Objectives - Prices and Specifications (1993) brochure.pdf
184. Olympus LEXT OLS3000 Confocal Scanning Laser Microscope Manual.pdf
185. Olympus LEXT System Schematic Diagram.pdf
186. Olympus LSGA Epi Illuminator Manual.pdf
187. Olympus LSM 710 / LSM 780 / LSM 710 NLO / LSM 780 NLO / ConfoCor 3 Operating Instructions Manual
188. Olympus Light Guide Illumination System Manual.pdf
189. Olympus MF Metallurgical Microscope Instruction Manual.pdf
190. Olympus MG Inverted Metallurgical Microscope Instructions Manual.pdf

After multiple notifications of infringement, why can't this guy be bothered to look for my copyright notice, which is clearly visible on the cover page of **each and every one** of my PDFs? It almost seems like he doesn't give a damn.

Please let me know if you ever see any of these PDFs included on a CD or DVD collection for sale on ebay or elsewhere, because if you do, the seller is including these in violation of my copyrights. I created these documents to be freely available for all, so long as they are NOT USED FOR COMMERCIAL PURPOSES. Selling them on ebay clearly violates this! I have hundreds of hours of work invested in these PDFs, and since I choose not to profit from them, it really irks me when others try to profit from them.

Please do not pay for these PDFs. They are freely available to anybody who wants them.