Making a Duronze Ferrule

The search for a better ferrule has been kicked about for a long time. Many would say, "Nickel silver ferrules have been around for over a hundred years. They're time-tested, rugged, reliable, work great, and suit the rod-maker's tradition. Why bother changing?" The answer is that it's important to minimize weight and proportions in the ferrule to obtain the "purest" action from the bamboo itself. So, finding a lighter, stronger, non-galling ferrule with good visual lines would seem to be a worthwhile endeavor. The Duronze ferrule seems to fit this bill quite nicely. Besides, Duronze costs only a tiny fraction of the more expensive nickel silver tubing. But, the real beauty of this ferrule is that it's machined from solid rod-stock, requires no soldering, and its manufacture seems to be within the ability of most rod-makers. The natural color of Duronze is somewhere between nickel silver and bronze, but it can be blued very easily to create a lovely luster.

Critical issues

Your lathe setup must be calibrated or verified to ensure that the tail-stock and head-stock are in precise alignment so that parts are concentric, parallel and properly centered. This is the baseline that must be checked before you can produce precision high-quality parts! Take the time to do this first. It will save you many frustrating hours and hold your cursing in check!

Several tools are essential to the machining process. A few additional jigs and materials make the work more efficient, pleasant and fun. Below, is a handy listing of what's needed to make your own high-quality ferrules.

Necessary Tools and Supplies

Duronze (a bronze alloy) rod	(Alloy 642: Sizes 5/16" and 3/8" are most useful)
STP engine additive, or cutting-oil	(this is your turning lubricant and cooling system)
Shot-glass or small container	(container for STP during turning process)
½" "acid" brush	(apply lubricant while machining parts)
Dial Caliper and Micrometer	(the latter is easiest to read if it has a digital display)
HSS drill bits in std. 64^{ths}	(carbide bits have not been tried to date)
HSS drill bits in thousandths	(to drill female barrel 0.008" smaller than final I.D.)
HSS reamers	(final, finished I.D. in the female barrel)

Carbide, 60-degree cutter (lightly “soften” the point to 0.010" radius)

Parting-tool

Center-drills (for starting perfectly-centered holes – sizes 1 – 4 are useful)

Flat, Mill-bastard files (10" and 8" will do)

Jeweler’s files (Grobet #4 and #6 seem about best)

Emory cloth/polishing paper (for final finish on exterior portions of ferrule)

Jeweler’s saw (1" or1½” Dia. X 0.008" or 0.010" thickness, ~90 teeth/inch)

Mounting-arbor for jeweler’s saw

Jacobs chuck, mounted on hexagonal rod-stock (to hold ferrule in cross-slide when slitting tabs)

Small diamond file or stone (to slightly radius the 60-degree carbide, cutter tip)

De-burring bit or tool

Machinist scribe (marking & scribing)

Mandrels--machined to perhaps 0.001" smaller than the finished I.D. of each intended hole, and 3/8" longer than each hole’s depth. The mandrels should be made from drill-stock or brass, and “dimpled” at one end with a center-drill. The dimple receives the Morse-taper center (either “live” or “dead”).

Q-tips

Paper Towels

Safety glasses

Common sense and safe machining practices

Niceties (the fun stuff)

Drill-bit stops (set/maintain precise drilling depths)

Depth Marker (the tail-end of your dial caliper can do this too)

Adjustable hole-gauges (for precision verification of hole sizes & concentricity)

Organized work area

An apron or machinist smock

An easy method to stay organized is to use zip-lock sandwich bags, with each ferrule size clearly marked on the outside. Store all the required drill bits (with stops fixed at their proper lengths), the reamer, and mandrels in the zip-lock bag corresponding to each size. Now, you have everything together to make any size ferrule you desire. No hunting for your “stuff,” and no fussing with each set-up. Open the “right” bag and get to work.

The Process

The overall process is not messy; in fact, it's relatively clean and straightforward. There are many machining steps that an experienced operator would take for granted, but our approach is meant for uninitiated machinist/rod-maker, so every detail will be explained.

The basic procedure is to complete the female part first, then machine the male slides.

Note: ***Your lathe should operate at relatively high speeds for all face-surfacing, while low speed (approx 450 RPM) is best for all drilling and parting operations. In all cases, use a slow rate of feed. Your 60-degree cutter must be prepared with a diamond file to gently radius the front point of the cutter about 0.010". If you can see a radius easily with the naked eye, it's about right. This creates smooth, clean cuts, with no chatter or gouging on this tough material.***

Now, for the female ferrule. Mount the Alloy 642 rod in the head-stock (a good three-jaw chuck will work as nicely as a collet system). Expose enough material to accommodate the female ferrule length, plus additional space for parting-off. Rough measurement or "eyeballing" will suffice. Tighten the rod stock in the chuck (or collet).

1) First, you need to face-off the exposed end of the rod. Move the cross-slide and 60-degree cutter into position, being certain the cutter will pass across dead-center at the rod's end. Turn on the lathe. Apply STP to the surface and your cutter, using your brush. A little bit lubricates and helps keep things cool. Advance the cutter to face-off the end of the rod. Squaring and surfacing will allow the center-drill (our next step) to enter the stock accurately. An un-turned surface may be out-of-square, and can deflect the point off- center. Turn off the lathe. Carefully remove the "nipple" from your surfaced end with a file.

2) Mount a center-drill in the tail stock chuck. Advance the tail-stock up the ways until the center-drill nears the rod end; tighten things down. Back the cutter and cross-slide away from the ferrule stock. Double-check that the center-drill is centered on the end of the rod. Turn on the lathe. Apply STP to the surface and the drill. Advance the center-drill into the material slowly until the shoulder of the bit has cut a small taper. Turn off the lathe. Back the tail-stock and center-drill down the ways. The result is a nice, little, counter-sunk hole in the end. This ensures that the following drilling operation will be accurate.

3) Measure and mark the final OAL (overall length) of the finished female, using your caliper. A scribe or pen/pencil is helpful here. Remove the 60-degree cutter from the cross-slide, and mount a parting-tool. Position the tool just at the left edge of your scribed mark. When advancing the tool, it must pass through the center-line of the stock. Turn on the lathe. Apply STP with your brush. Advance the parting-tool into the material slowly--backing out occasionally, clearing chip, and applying more STP to the cutting area. Continue until the ferrule stock is parted-off. (Note: a small container under the cutoff

area will catch the part so it doesn't bounce onto the floor or elsewhere.) Turn off the lathe. Clean up any remaining burr/nib/nipple on your ferrule stock with your file. You now have the female ferrule stock.

4) Remove the larger rod from the head-stock, then insert your ferrule stock into the chuck with its center-drilled end facing inward, and the newly-parted end facing outward. Remove the parting tool from the cross-slide. Mount the 60-degree cutter on the cross-slide, and position it to square-off the "new" end of the ferrule stock. Double check alignment, and be certain that your cutter passes across dead-center at the ferrule's end. Turn on the lathe. Apply STP to the surface and the cutter. Advance the cutter across the rod's end, squaring-off with the thinnest cut possible. Turn off the lathe. Carefully remove the small nipple and any burrs on the edge with your file.

This exposed end will become the barrel that accepts the male slide. First, we need to center-drill this end, just as we did for the end that's presently mounted in the chuck. Following the center-drilling, the next step is to bore the barrel to accommodate the male slide. We will drill slightly under-sized first, then finish the bore with a perfectly-sized reamer.

Note: ***Your lathe should remain at low RPM for drilling. The material is relatively hard and requires a little pressure to drill. Higher speeds create more heat, so advance the bit slowly, and lubricate and cool frequently with STP.***

5) Select a HSS drill bit with an O.D. approximately 0.008" smaller than the barrel's finished I.D. Mount this bit in the tail-stock chuck. The shaft should have a drill-stop (or tape) that marks the exact depth of the finished barrel; check your length. Double-check both this length and the stop position with your caliper. Move the tail-stock up the ways until the drill bit nears the center-drilled hole, and tighten things down. Turn on the lathe. Apply STP to the surface and the tip of the HSS bit. Advance the bit into the material slowly. ***Take things in small steps/bites; pull your bit out frequently and clear the chip; lubricate/cool, then proceed again in small bites.*** Advance the HSS drill bit into the material until you reach the drill-stop. You are now at full depth for the barrel. Turn off the lathe. Back the drill bit and tail-stock down the ways. Dip a Q-tip in STP and clean out and cool the hole you just cut.

6) Next, remove the HSS bit from the tail-stock, and mount your final-dimension reamer into the chuck. Move the tail-stock into proper position, and tighten things down. Double-check alignment (parallel/level of the reamer). The reamer will create a silky-smooth inner surface area in the barrel, and you want perfectly parallel walls. Turn on the lathe. Apply STP liberally to the surface and the reamer. Advance the reamer into the material slowly and smoothly. Avoid "bottoming" the reamer in the hole, and feel for the end of the hole with a light touch. You'll know when you are at full depth. (Marking the reamer's intended depth with tape is also a good solution.) Turn off the lathe. Back the reamer and tail stock down the ways. Dip a Q-tip in STP to clean out and cool the bore you just cut. You now have a finished barrel to accept the male slide. Your hole-gauge (if you have one) will confirm that you have a nice straight (non-tapering) hole of proper dimension.

We do not cut down the outer surfaces yet. Instead, we will switch the ferrule stock end-for-end in the chuck, and drill the hole that accepts the rod section. After this second hole is bored, we'll shape the O.D. surfaces.

7) Loosen the chuck and reverse your ferrule in the head-stock. Check the alignment and tighten the chuck on your ferrule stock. Remove the reamer from the tail-stock chuck, and mount a standard, HSS drill bit. Because this second hole will receive the bamboo rod section itself, it needs no reaming. Thus, the bit must be sized for the finished I.D. The drill will leave the hole with a slightly scored, inner surface, and this will provide a good glue-joint between the metal and the bamboo.

Adjust a drill-stop (or tape) to the exact depth of this bore; check your length. Double-check both this length and the drill-stop position with your caliper. Move the tail-stock up the ways until the bit nears the center-drilled hole, and tighten things down. Turn on the lathe. Apply STP to the surface and the tip of the HSS bit. Proceed slowly. ***Take things in small steps/bites; pull your bit out frequently and clean the chip; lubricate/cool, then proceed again in small bites.*** Advance the HSS bit slowly into the material until you reach the drill-stop. You are now at full depth. Turn off the lathe. Back the drill bit and tail-stock down the ways. Dip a Q-tip in STP; clean out and cool the hole you just cut.

8) Next, we will establish the various O.D. surfaces. The hole that accommodates the rod section is presently exposed, so the O.D. along this area will be taken down first. Slip a prepared mandrel (see "Supplies" above) into the bore that you just drilled. The mandrel should have been "dimpled" with your center-drill. This setup will serve to stabilize and support the stock as you turn the outer surface to size.

Remove the chuck from your tail-stock, and replace it with a Morse-taper center (live or dead). Move the tail-stock up the ways until the center engages the mandrel's dimple. Tighten tail-stock in place. Apply STP to the point of contact. Move the 60-degree cutter and cross-slide into position at the tab-end of the ferrule, checking alignment. Now, measure the length from the tab-end of your ferrule up to the "step." Double-check this length, and scribe a mark on the ferrule stock where the step begins.

You must now set the head-stock for a high RPM. Set your auto-feed to move from right-to-left at its slowest speed. Move the cross-slide and cutter into position at the end of the ferrule. Turn on the lathe. Apply STP to the surface and cutter with your brush. Using your auto-feed, start your cut at the ferrule's outer end, and work inward toward the scribed line. Stop precisely at the line. Make repeated passes, advancing the depth-of-cut by no more than 0.005" per pass. ***Reminder: advancing 0.005" on your crank handle cuts 0.010" from the full outer diameter.*** The shape of the 60-degree cutter will leave a small angle where you stop. This small angle (as opposed to a sharp lip) helps to dissipate flexing stresses when casting. ***Stop often and measure with your micrometer to determine your progress.*** (It's easier to get a good reading with micrometer than with the caliper.) Continue turning, lubricating and checking until you reach the final O.D. Turn off your lathe.

(An option at this point: If you want a smoother final finish, stop cutting when you reach an O.D. that's perhaps 0.003" oversized. In this case, we will work down to the finished O.D. as a final step, with files

and emery cloth. When you reach this point, back the cutter away from the ferrule stock somewhat so you can use the cross-slide as a support for the file. Turn on the lathe. Brush STP liberally. Take care to hold the file flat, and keep it constantly in motion across the area. Use emery cloth as the last step for a nice, smooth finish. Your caliper or micrometer will confirm you are at correct O.D.)

9) Next, we will feather the tab area. Back your tail-stock (and Morse taper center) down the ways. Remove the mandrel from the ferrule hole. Now, determine the length of the tabs by referring to the charted data. (Typically, the length of the slots will equal the O.D. of the male slide.) Mark this point on the ferrule stock. Then "eyeball" or measure approximately half of this tab length, and make another mark. This second mark is where the tab feathering will blend into the ferrule's full O.D. Turn on your lathe. Apply STP with your brush. Use a hand-held file to feather the tab ends. Proceed slowly and watch closely so you don't damage/deform the thinned tab area. Keep the file moving over the surface a little. Turn off the lathe.

Using your hole gauge, again confirm that you have nice straight walls of proper dimension on the inside. Your I.D. and O.D. should differ by 1/32" (0.03125") over the entire length of this hole; the wall is 1/64" (0.015625"). Having a "trued" head and tail-stock makes this possible.

10) Re-insert the mandrel into the hole you just drilled, and loosen the chuck. Now, reverse your ferrule stock in the chuck, leaving the mandrel in place. The mandrel will prevent the chuck from deforming the thinned walls on hole you've just completed, and will support the stock when turning the slide area to size. The small, angled step should be exposed in front of the chuck's jaws just far enough to allow room for your 60-degree cutter to move across the full length of the stock. Check the alignment, and tighten the chuck on your ferrule stock. Now, insert your second mandrel into the exposed barrel. Move the tail-stock and Morse taper center up the ways, and fit the point into the mandrel's dimple. This further stabilizes the ferrule stock as you turn the outer dimensions. Apply STP with your brush.

Recall, the O.D. of the exposed barrel is still the "raw" dimension of the rod stock. You need to establish both the welt at the end of the barrel, and the O.D. of the barrel itself. First, the welt. In cutting this, you will machine the welt's final O.D. across the entire exposed surface. Move the 60-degree cutter and cross-slide into position at the end of the barrel, checking alignment.

The head-stock should still be set at a high RPM. The auto-feed must move the cross-slide from right-to left, and at its slowest speed. Turn on the lathe. Apply STP to the surface and the cutter. Using the auto-feed, make repeated cuts. Advance your depth-of cut no more than 0.005" per pass. ***Reminder: advancing 0.005" on your crank handle cuts 0.010" from the O.D. Stop often and measure with your micrometer to determine your progress.*** Lubricate repeatedly, and check until the O.D. of the finished welt is reached. (Again, for a finer finish, machine to within 0.003" of final O.D. Finish later with files and emery cloth.) Turn off the lathe. Measure with your micrometer; it's easier to get good readings than with a dial-caliper.

You're almost finished with female ferrule.

11) Now, we'll cut the final O.D. for the barrel up to the welt area. Reverse the direction of your auto-feed to move the cross-slide from left-to-right. This means you will start the 60-degree cutter at the angled step near the chuck jaws, and cut down the ways toward the line where the welt begins. (When complete, you should have a barrel with 1/64" walls.)

Mark or scribe the end of the ferrule for the desired length of your welt. This may be around 0.062" (or something less for smaller ferrules). Move the cross-slide and 60-degree cutter into position near the chuck, checking alignment. Turn on the lathe. Apply STP to the barrel surface and the cutter. Using the auto-feed, make repeated passes. Stop your cuts precisely at the welt's scribe-line. Advance the depth-of-cut by no more than 0.005" per pass. ***Reminder: advancing 0.005" on your crank handle cuts 0.010" from the O.D. Stop often and measure with your micrometer to determine your progress.*** The shape of the cutter will create a small angle at the welt. The welt adds immensely to the hoop-strength at the end of the barrel, while its angled edge helps to dissipate flexing stresses. Continue cutting, lubricating and checking until you have reached the barrel's final O.D. (Or, for the finer finish, stop cutting when you are still 0.003" oversized.)

If you have opted for a finer finish, you are now ready to work down to the final O.D. with files and emery cloth. Back the cutter away from the ferrule stock somewhat so you can use the cross-slide as a support for the file. Turn on the lathe. Brush STP liberally. Take care to hold the file flat on the ferrule surfaces, and move it constantly across the areas. Use emery cloth as the last step for a nice, smooth finish. Check your progress carefully. Your caliper or micrometer will confirm when you are at correct O.D. Turn off the lathe.

You can now lightly chamfer the outer corner of the welt with a fine file or emery cloth. Back the cross-slide and cutter away from the ferrule. Turn on the lathe. Apply STP to the welt, and with a fine, hand-held file and a very light touch, chamfer the corner. Turn off the lathe. Confirm final dimensions with your micrometer.

Move the dead-center and tail-stock down the ways. Remove the mandrel. Use the de-burring bit/tool to relieve the burr on the inside lip of the welt. A very gentle hand twirl is all that's needed to "break" this sharp edge. Loosen the chuck jaws and remove your female ferrule. **You're finished!**

The turning process leaves a fine satin/matt finish on the ferrules which is pleasing as is. But it can also be blued/blackened very nicely using "Brass Black" or some other bluing agent. Obviously, a finer finish will create a deeper luster. Duronze has a nice patina of its own and, if left unvarnished, over time, it will oxidize to a lovely bronze-black, antique-look.

Machining the Male Ferrule

Note: ***Your lathe should operate at low speeds (approximately 450 RPM) for all drilling and parting-off operations. The feed-rate must also be slow. High RPM is required for all surface cutting, while the feed-rate remains slow. Your 60-degree cutter must be prepared with a diamond file to gently radius the front point of the cutter about 0.010". If you can see the radius clearly with the naked eye, it's about right. This creates smooth, clean cuts, with no chatter or gouging on this tough material.***

The process for the male ferrule is very similar to making the female, but a bit easier. Although the procedure has fewer steps, and the ferrule stock is never reversed in the chuck, dimensioning the O.D. of the slide is highly critical. Be sure to leave the slide approximately 0.002" - 0.003" oversized. The final fit of the slide into the barrel will be done when the ferrule is mounted on a rod.

1) Mount the Alloy 642 rod in the head-stock. Enough material must be exposed to accommodate the final length of the male ferrule, plus some additional room to part-off the stock. Rough measurement or "eyeballing" will suffice. Tighten the rod stock in the chuck (or collet).

We will face-off the end of the rod first. Drop your lathe RPM down to the low setting. Move the cross-slide and its 60-degree cutter toward the end of the stock, checking that the cutter will pass across the rod's center-point. Turn on the lathe. Brush a little STP on the surface and on your cutter; a little bit lubricates and helps keep things cool. Advance your 60-degree cutter to square the end-surface of the rod. Turn off the lathe. Squaring and surfacing ensures that the center-drill will make a clean entrance. A raw, un-turned surface can cause the point to move off center. Carefully remove any burrs as well as the remaining "nipple" with your file.

2) Back the cutter and cross-slide away from the ferrule stock. Mount a center-drill of appropriate size in the tail-stock chuck. Move the tail-stock up the ways until the drill bit almost touches the end of the rod. Tighten things down. Double-check that the center-drill meets the center of the rod stock. Turn on the lathe. Apply STP to the surface and the drill bit. Advance the center-drill slowly into the material. Pull out occasionally; clear the chip and lubricate. Continue drilling until the shoulder of the bit has created a small taper. Turn off the lathe. Back the tail-stock and center-drill down the ways. The result is a nice, little, counter-sunk hole on the end. This ensures that the following drilling operation will be accurate.

3) You are now ready to drill the ferrule's hole. Back the parting-tool and cross-slide away from the ferrule stock. Remove the center-drill bit from the tail-stock chuck. Replace with a HSS drill bit, properly-sized to accept the bamboo rod section. Because this hole will not be reamed, the size of the bit should match the finished I.D. The slightly-scored surface left by the drill will help to form a good glue-joint between metal and bamboo. Adjust your drill-stop (or apply tape), marking the exact depth inside the finished male ferrule; check your length. Double-check both this length and the drill-stop position with your caliper.

Advance the tail-stock up the ways until the bit nears the center-drilled end of the ferrule. Tighten things down. Your lathe should remain at its slow RPM setting. Turn on the lathe. Apply STP to the surface and the tip of the HSS bit. Proceed slowly. ***Take things in small steps/bites; pull the bit out frequently and***

clean the chip; lubricate/cool, then proceed again in small bites. Advance the HSS drill bit into the material until you reach the drill-stop. You are now at full depth, and have a finished hole for the male ferrule. Turn off the lathe. Back the drill bit and tail-stock down the ways. Dip a Q-tip in STP; clean out and cool the hole you just cut. Do not ream. Your hole-gauge will confirm that you have a nice straight hole of proper dimension.

4) Now, insert a properly-sized mandrel into the hole you just drilled. This setup will support and stabilize the ferrule stock as you turn to final dimensions. Remove the drill-bit from the tail-stock, and mount a Morse-tapered center (live or dead). Move the tail-stock up the ways until the point of the center engages the "dimple" in the mandrel. Apply STP to the contact area.

Recall, the exposed material is still the "raw," outer dimension of the rod-stock, but before beginning to machine the ferrule's O.D., we need to locate and mark the male-slide end of the ferrule. Measure the final OAL (overall length) of the male ferrule, using your caliper. Scribe this line on the ferrule stock, or use a pen/pencil. Remove the 60-degree cutter from the cross-slide.

Next, mount a parting-tool in the cross-slide and move it into position, touching the left edge of your scribed line (that is, toward the head-stock). Check to see that the tool will pass through the ferrule stock at the center of its circumference. ***You will not actually part the material at this time, but will cut ONLY until you reach a point that's perhaps 0.005" deeper than the O.D. of the finished slide area. (Example: On a size 14 ferrule, the O.D. of the male slide will be 0.250", so cut with the parting-tool only down to 0.245".)*** The idea here is to create a "valley" that will become the end of the ferrule. You will complete parting-off later, but for the time-being, the little valley will serve as an end-point when surfacing the O.D. across the ferrule. You'll see.

The lathe must remain at its slow speed. Turn on the lathe. Apply STP with your brush. Advance the parting-tool into the material alongside the scribed line. Proceed slowly in small steps or bites; clear chip frequently, and re-apply STP to the cutting area. Measure carefully as you advance the tool, until you reach a point that's 0.005" deeper than the finished O.D. of the male slide. Turn off the lathe.

5) We're now ready to cut the various outside surfaces to their final O.Ds. The first step is to establish the O.D. of the shoulder. This dimension will be cut from right-to-left across the entire length of the ferrule – that is, from the tab-end to the "valley." The shoulder itself will be marked in a following step, then the areas on either side will be measured and taken down afterward.

Move the cross-slide and 60-degree cutter into position at the bamboo-end of the ferrule, checking alignment. Your cross-slide will be cutting from right-to-left. Stop each pass when your 60-degree cutter moves into the "valley" that your parting-tool created earlier. Now, set the head-stock RPM to its high speed. Set the auto-feed to move slowly. Turn on the lathe. Apply STP to the surface and the cutter. Using the auto-feed, cut from the end of the ferrule right into the valley, and stop. Make repeated passes, and lubricate often. Advance the depth-of-cut no more than 0.005" per pass. ***Reminder: advancing 0.005" on your crank handle cuts 0.010" from the O.D. Stop often and measure with your***

micrometer to determine your progress. Continue turning, lubricating and measuring until you have the final O.D. of the shoulder across the full length of the ferrule.

(***An option at this point***: if you want a smoother finish, leave the outer surface 0.003" oversized. The remaining material will be taken down to final O.D. later, with files and emery cloth. This would become the last step in finishing your ferrule.)

6) Next, use your caliper to measure the exact location and overall length of the shoulder. Scribe marks on the ferrule stock to represent each outer edge of the shoulder. In the following step, you will turn the tab-end of the ferrule to its final O.D.

Again, the cutter and cross-slide must feed from the ferrule's outer end toward the shoulder (that is, from right-to-left). Move the cross-slide and 60-degree cutter into position at the end of the ferrule, and check alignment. Turn on the lathe. Apply STP to the surface and the cutter. Using the auto feed on the lathe, cut exactly to the scribed line, and stop. The shape of the cutter will leave an angled edge at the shoulder. Stop each successive pass exactly at this same point. Lubricate often. Advance the depth-of-cut by no more than 0.005" per pass. ***Reminder: advancing 0.005" on your crank handle cuts 0.010" from the O.D. Stop often and measure with your micrometer to determine progress.*** Continue turning, lubricating and checking until you reach the final O.D. (Or, for a finer finish, stop cutting when you are within 0.003" of final O.D. The remaining material will be taken down to final O.D. later, with files and emery cloth.) Turn off the lathe.

7) Finally, you will surface the O.D. for the male slide. You will cut this last area from the "valley" near the chuck toward the scribed line that marks the shoulder. The O.D. of the male slide is highly critical to its final fit within the female barrel. ***In the following step, you will reduce the O.D. only to within 0.002" - 0.003" of the intended, final O.D. The remaining reduction will be done only when you're ready to mount the ferrule on a rod. Your work in this step is no more difficult than anything else you've done, but it must be as precise as possible.***

Back the cutter and cross-slide away from the ferrule stock. Reverse the direction on your auto-feed (that is, the cross-slide must move from left-to-right). Move the 60-degree cross-slide and cutter to the middle of the valley near the chuck. Turn on the lathe. Brush STP on the work area and the cutter. Using the auto-feed, cut exactly to the scribed line, and stop. Again, the shape of the cutter will create an angled edge at the shoulder. Make successive cuts, advancing the depth-of-cut by no more than 0.005" per pass. ***Reminder: advancing 0.005" on your crank handle cuts 0.010" from the O.D. Stop often and measure with your micrometer to determine progress. Take your time and proceed cautiously; you can't put metal back on!*** Continue turning, lubricating and checking until you reach a measurement that's between 0.002" and 0.003" greater than the intended, final O.D. **Then STOP.** Turn off the lathe.

(The smooth-finish option: If you have elected a smooth finish, now is the time to file the outer surfaces to their final O.D., but **do nothing** to the male slide. Finishing with fine emery cloth will give a high luster. Back the cutter and cross-slide away from the ferrule, and use the cross-slide to steady your file. Turn on the lathe. Apply STP liberally to the work surface. Begin filing, taking care to hold it absolutely flat to the

surface. Keep the tool moving as you work across the areas being dressed. Use your micrometer to check your progress frequently. Re-apply lubricant, and stop exactly at the final O.D. for each area. Turn off the lathe.)

8) You're now ready to feather the tab area. Measure the length of the slotted tabs against the charted data, and mark the ferrule stock at this point. (Typically, the tab slots will equal the O.D. of the male slide.) Now, measure or "eyeball" about half this length, and make another mark on the stock. This second mark is where the feathering will blend into the full O.D. of the ferrule.

Back the dead-center and tail-stock down the ways. Remove the mandrel from the hole. Turn on the lathe. Apply STP to the end of the tabs. Hold the file by hand, and use a light touch to take the material down. Check your progress frequently and re-apply lubricant. Take special care not to damage or deform the thinned end. Turn off the lathe.

8) The ferrule is now completed, and the last step is to part it from the rod-stock. Set your lathe to slow RPM. Remove the 60-degree cutter from the cross-slide, and mount your parting-tool. Move the cross-slide and tool into position, aligning the parting-tool in the "valley" you created in an earlier step. Check to be sure that the parting-tool will pass through the center-line of the rod stock. Place a container under the head-stock to catch the parted ferrule.

Turn on the lathe. Apply STP to the work area and parting-tool. Advance the tool into the valley slowly. Proceed with small, repeated bites. Back the tool out frequently to clear chip, re-apply STP, and cool the surfaces. Do not rush this cut, as the surface areas in contact are large and can bind, creating friction and heat. When the ferrule is parted, turn off the lathe.

Remove the rod-stock from the chuck. Break the sharp edge at outer corner of the ferrule with fine emery cloth. File the small "nipple" on the parted end. The final fit of the male slide will take place when you're ready to mount the ferrule on a rod. At that time, use fine Grobet files. Fine-grit paper or emery cloth work well too. It's your choice to hand fit or lathe fit.

You now have beautiful male and female ferrules, and they're almost ready for bluing and gluing.

One last thing to do on both the male and female ferrules – serrate the tabs!

Serrating the Ferrules (Sawing the tabs)

As an overview, this operation will be done with a fine jeweler's saw. This will be mounted on an arbor and chucked into in the head-stock. Additionally, you will need to make a "jig" for mounting a Jacobs

chuck in the tool-post on your cross-slide. This chuck will hold the ferrule, and the cross-slide will align the ferrule tabs with the saw's teeth.

The simplest way to make the jig is to screw a Jacobs chuck on a 3/8" hexagonal, aluminum rod. One end of the rod needs to be threaded to accept the chuck. A simple die with the appropriate thread can be purchased locally. When threading the rod (to become an arbor), hold it securely in your lathe head-stock, and with care and plenty of lubricant, the die can be turned by hand. (Cut the threads slowly, backing off, clearing chip, lubricating, and advancing again.) When the arbor and chuck are mounted to your tool-post, the rod's hexagonal shape will allow you to rotate the chuck (and ferrule) one flat at a time to saw perfectly-divided, indexed tabs.

Before making this jig, however, do a rough check to determine that your tool-post will accept the hexagonal rod (arbor). Additionally, you must be able to align the chuck vertically to meet the center of the jeweler's saw. Shims may be needed to adjust the required height. Before buying the materials, do a "dry run" to be sure this set-up will fit properly in your machine.

1) Mount your jeweler's saw on its arbor, and mount the arbor in the head-stock chuck. Tighten the chuck. Next, mount the hexagonal rod and its chuck in the tool-post. ***Most Important: Perform an alignment-check in the following manner:*** Mount a machinist point or scribe in the chuck, with its point extending beyond the jaws approximately 1". Next, adjust the hexagonal rod and chuck in the vertical plane. Be certain that the machinist point meets the saw's circumference at dead-center. Now check the angle of feed on your cross-slide, being certain that the aluminum rod and chuck will move **exactly** parallel to the saw, and perpendicular to the saw's arbor. Finally, move the cross-slide and machinist point into position at the saw's teeth. Adjust the cross-slide such that the machinist point meets the exact center of the saw's thickness. Lock the cross-slide to prevent lateral movement, and tighten things down.

2) Back the cross-slide and machinist point away from the saw. Remove the machinist point. Mount your ferrule in the chuck, with its tab-end facing the saw's teeth. Take care not to tighten the chuck too much, as this could deform the ferrule. Sawing the tabs creates no "rotation" issues, so the ferrule only needs to be mounted with secure-but-gentle pressure from the jaws.

The saw will spin at high RPM, and you will advance the end of the ferrule into the saw. The hexagonal mandrel will allow you to rotate the chuck (and ferrule) one flat at a time, and this will index your cuts perfectly. With the ferrule centered on the saw, obviously, only three such cuts are required.

The length of the tab slot is measured according to the charted data. Typically, this length will equal the O.D. of the male slide. (An example: a size 14 ferrule has a slide O.D. of 0.250", so the tab-slit should be a quarter-inch in length.) Mark your ferrule stock at this point. Double-check your alignment by advancing the tab area against the saw's teeth. The saw should touch the exact center of the ferrule's O.D. Now, back the ferrule away from the saw once again.

Set the head-stock RPM to high speed. Turn on the lathe. Apply STP to the end of the ferrule. Advance the cross-slide, moving the ferrule into the saw until you reach your mark. Retract the cross-slide and ferrule from the saw. Turn off the lathe.

3) Now, for the magic of the hexagonal, indexing chuck! On the tool-post, loosen the hold-down screws that secure your chuck arbor. Rotate the hexagonal rod to its next flat (either direction). Tighten the hold-down screws. AUTO-INDEXING and no math!

Once again, check the ferrule's alignment against the saw's edge. Turn on the lathe. Apply STP to the tab area. Advance the cross-slide, moving the ferrule into the saw until you reach your mark. Retract the cross slide and ferrule from the saw. Turn off the lathe.

4) Repeat the steps above to make one, final cut. With care, three identical cuts will give you 6 perfectly-spaced tabs!

5) Follow these same steps to cut the tabs for the female ferrule, again establishing the slot-length to match the final O.D. of the male slide of the ferrule (or the I.D. of the female barrel – same thing). The tabs on both halves of the ferrule will be identical.

You've now completed a set of male and female Duronze ferrules, and they're ready for bluing and gluing. You have, not just a "good," but a superior product made by your own hands! The truncated-like design is shorter and lighter in weight than the standard ferrule, and very pleasing to the eye. Additionally, Duronze itself offers something like a 15% weight reduction (and greater strength) over its nickel silver counterpart. Finally, Duronze is as "cheap-as-dirt," and will not gall with repeated assembly/disassembly. The advantages multiply when used on multi-piece rods. **Is this one step closer to the rod-maker's Holy Grail?**