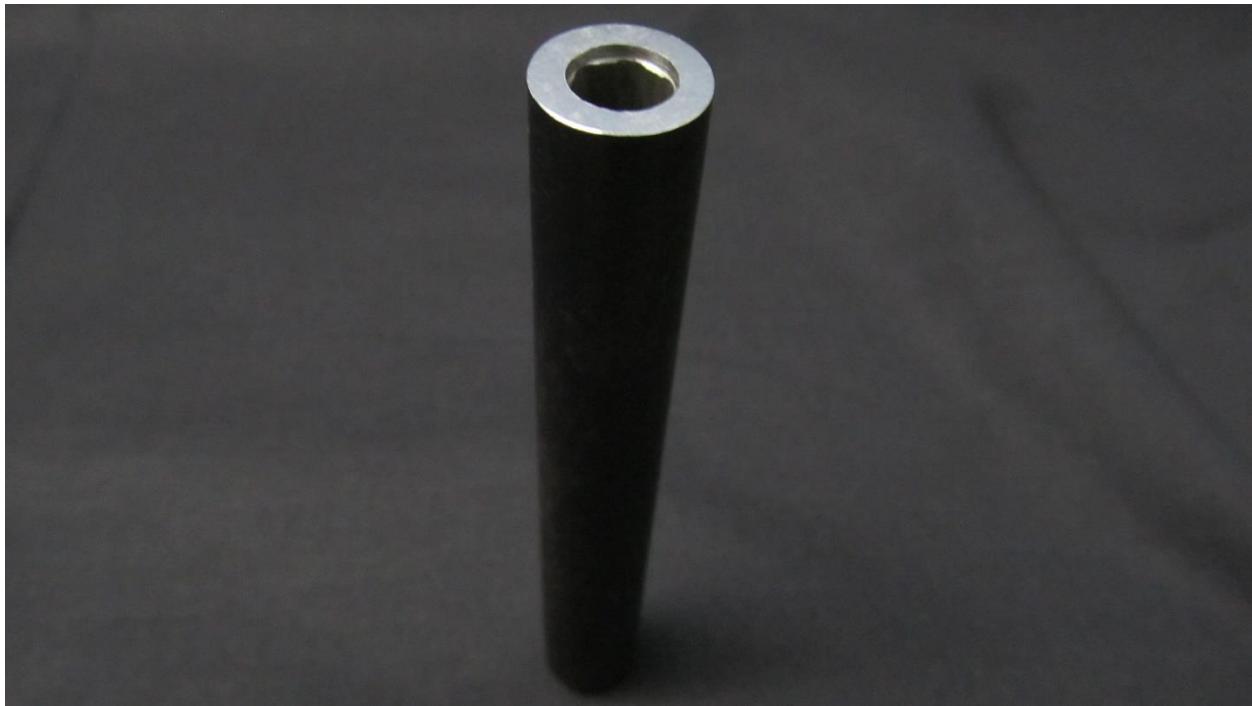


ECM Barrel Tutorial –9x19mm

By IvanTheTroll



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Introduction:

Crafting a barrel using the ECM process is easy, affordable, and can offer excellent results when done properly. This tutorial will help the end user understand how to set up, run, and check their progress as they cut a barrel via ECM. There are four main sections (Tooling Creation, Tooling Setup, ECM Process, Non-Destructive Inspection, Troubleshooting) and a preface (which is mainly words of wisdom regarding the process) to this tutorial – I recommend you read all of it before you start with any actual work on the ECM setup. The size of this tutorial may seem daunting, but don't let that scare you – the tutorial is thorough and aims to help you avoid as many errors as possible.

Key words/Definitions:

Reservoir: container for holding liquid.

Electrolyte: fluid that can conduct electricity.

Suction Side: the side of the pump that sucks in fluid from the reservoir.

Pressure Side: the side of the pump that pumps out fluid to the barrel/ECM head.

Sludge: a nasty mixture of metal ions, trapped oxygen/hydrogen gas, and electrolyte. AKA barrel coffee.

Boring – increasing the bore (inner diameter) of the barrel.

Rifling – adding rifling grooves to the barrel.

Throat Cutting – cutting a throat in the barrel to allow rounds to seat fully in the chamber without the bullet engaging in the rifling.

Chambering – adding a chamber to the barrel.

Hill – In polygonal rifling, lands are referred to as hills. Hill to hill measurement should be the same as bore diameter (8.82mm).

Valley – In polygonal rifling, grooves are referred to as valleys. Valley to valley measurement should be around 9.30mm.

Preface

There are a few tips I've picked up from ECM rifling that I think everyone will benefit from knowing – I want to include them at the start so that people don't miss them.

- 1.) It's easier to stop cutting and measure than it is to cut too much and must restart a barrel.
- 2.) Off-spec barrels should never be intentionally hand-fired – it's easier to make a new barrel than a new hand.
- 3.) The ECM process may take you a couple tries to master – but it is straightforward and cheap enough that anyone can learn to do it just by trying.
- 4.) ECM-ing any steel that contains chrome releases Chromium into your ECM fluid. Chromium can cause horrible issues if ingested – both for yourself and animals. Do the world a favor and don't pour your ECM sludge out. You can take your leftover sludge to a waste treatment facility, you can call nearby chrome plating shops to see if they would take it (some might even pay you for it), you can mix the used solid waste from the sludge in with your used motor oil and take it to your local auto parts store that collects used motor oil – they treat it for chrome. Be smart, we're trying to make a better world, we don't get that by poisoning groundwater.

Now – another note about the waste products – if left alone, your sludge will settle. The solid waste (which will settle to the bottom of your ECM fluid container) is the only harmful part of the waste. If you're planning on making another barrel, let the sludge settle, then pour or pump out the water from the top of the container. You can reuse the saltwater mix at least 10 times – though your cutting rates may vary slightly if you reuse the fluid over 10 times. The solid waste is much easier to manage if it isn't under several gallons of saltwater.

As another addendum, be sure to cover your sludge after you are done cutting your barrel – animals may find the smell of the saltwater enticing and either fall into the sludge container and drown, or they may spill the container. Just a simple sheet of plywood or whatever else to cover the top of the container would work.

- 5.) The ECM process can be a little messy – especially if a hose manages to blow loose or leak. You can do this process in a house or apartment, but I'd stick to places with tile floors that are easy to clean. Unfinished basements would be great, bathrooms would be great, you could potentially even use your bathtub, but be careful to make sure that the ECM sludge won't stain your bathtub. If it does, or if you are worried, use a plastic drop cloth underneath the ECM setup. In addition, the process releases hydrogen and oxygen gas (which can be flammable in the right situations) as well as trace amounts of chlorine gas. So long as your pump is running while you are cutting, there shouldn't ever be enough chlorine gas to cause any issues – but if you feel a painful itching in your eyes and throat and it isn't just the saltwater – turn the power supply off. Now, as far as the flammability goes, I've cut many barrels and only ever had a tiny flare-up. It occurred when I connected the power supply leads AFTER I had turned the power supply on. This created a spark which caused a tiny poof of hydrogen gas to burn. Avoid connecting a live lead and you should be fine. If you can use a well-ventilated area (a back porch, room with a window), that would be a good idea. I cut my barrels in a dingy shed full of wasps and mice – it doesn't need to be fancy.

Tooling Creation

This section covers how to create the various tools you will need for the ECM process. While most of these tools are very straightforward to assemble, I'll include full documentation just in case it helps someone. Note that all the tooling images shown here are of used tooling, but the instructions should still guide you through assembling your own tooling.

Some of the parts you will buy via the ECM shopping list ([./ Get current shopping list from the Keybase team \.\.](#))

The other parts you will need to print – the link to the CAD is here: ([./ Get current CAD from Keybase team \.\.](#))

The printed parts include:

1x Fixture

1x Rifling Mandrel

1x Chambering Insulator

1x End Pilot

I recommend printing at least 1 extra end pilot for the event you drop one into the reservoir and one extra rifling mandrel for if you butcher the first one when attaching the wire.

Barrel Stock Creation

Cut your barrel stock from your hydraulic tubing by using a hacksaw to cut a 4.5" (114mm) section from the hydraulic tubing.

Fitting/Fixture Creation



First off, we have the fixture. Once printed (refer to the README for print info), you will remove supports from this part.



Next, screw the fitting into the threaded end of the fixture. The threads may be hard to start at first, so you may need to use a wrench to help get it going. If you do use a wrench, there should be no resistance at all – if you’re getting resistance when using a wrench, you probably have the fitting cross-threaded into the fixture. Optionally, you can use blue RTV (or other silicon sealant) if you are going to be conscious about stopping any leaks.



Screw the fitting down until it is flush with the fixture – not snug, not tight, just flush. DO NOT OVERTIGHTEN. I cannot stress this enough – a fitting that large with an amply large wrench will provide far more force than is needed – you do not have to get this tight.



This is what happens when you are a gorilla and didn't read the instructions. I will make fun of you.



Optionally at this point, you can spray-seal the fitting/fixture combo to keep it from leaking – during the higher-pressure operations, some fluid will spray out from between layer lines in the fixture. Any spray paint/sealant/coating should work fine to fix this – just give it 24 hours to dry after applying, and let it dry in the orientation shown in the above picture. It doesn't need to be a thick coat (avoid runs in the coating), just enough to thinly cover the part.

Boring/Chambering Rod Creation



The boring rod is simply a ~6.5" (16.5cm) long rod cut from your 0.250" or 6mm bar stock. If your bar stock came coated, use sandpaper to remove the coating – you want bare metal exposed.



The chambering rod is a ~3.25" (8.3cm) long rod cut from your 0.250" or 6mm bar stock. If your bar stock came coated, use sandpaper to remove the coating – you want bare metal exposed.



Optionally, you can taper the chambering tool in order to add a taper to your chamber. This process is recommended, but not necessarily required. You'll note that in picture A, the rod is a 0.2470" (6.3mm), and in picture B, the rod tapers down to 0.2315" (5.9mm). When using a 6mm rod stock, this would be proportional to a taper from 6mm (the max width of your rod stock) down to 5.62mm.

This taper approximates the taper found on 9x19 casings. I added this taper by chucking up the rod in a drill and spinning the drill while holding a metal file against the rod – spending more time holding the file to the rod in the area where the taper is more narrow, and less time where the taper isn't narrow. The picture below shows that I tapered the rod along roughly 0.400" (10.16mm) of length – the taper should be about 0.630" (15.95mm) long, but this was a proof-of-concept approach. If you choose to do this, I recommend you tape off the rod as the point you wish for the taper to end, so that you have a constant point of reference as to how far along the rod you are meant to be cutting.



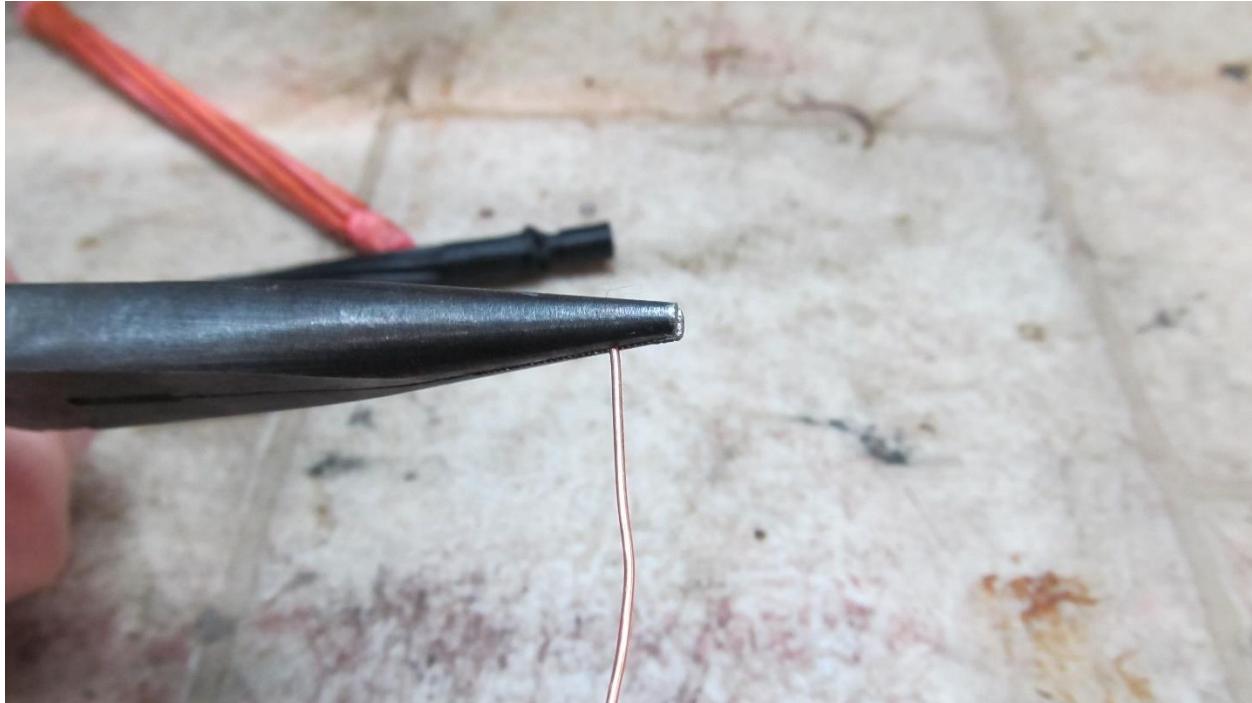
Rifling Mandrel Creation



For setting up the rifling mandrel, you will need to print the mandrel (refer to the README for print info). You will also need to cut 6 lengths of your 20ga wiring, about 7" (17.8cm) long. It is worth taking the time to get the wire straightened out now – you can do this by yanking on one end of the wire while the other is held in a vise, or by going along the wire and undoing any small bends.



Tuck each of the wires into the printed mandrel's chamber insulation. Your mandrel won't look like this one, but it will have the same section to slide the wire under.



If you have trouble getting the wire to slip under the mandrel's insulated section, you can try flattening one end of the wire by crushing it in a pair of pliers.



Once the wire is under the insulated section, pull it through so that about 1" (2.5cm) sticks past the end of the mandrel. At this point you will take your soldering iron and carefully heat the wire and melt it into the mandrel – you must take care not to melt the walls of the valleys the wires sit down in. You just want to heat up the wire while gently pushing down with the soldering iron until you feel the wire move – as soon as it has moved, you can release pressure with the soldering iron and blow on the area you were just heating – the wire should be retained by the mandrel.



I usually stake four places along each wire – next to the chamber insulation, at the opposite end, and two places in between. As you stake each wire, ensure that you don't leave any slack in it – that is, make sure that each wire is uniform in its inserted depth, and that no wire has any bulges or humps sticking up. If a wire has slack, you can heat up the areas where it is staked down and redo that wire.



Once all 6 wires are staked in place, you can gently give the end of the wires a twist to form a pig tail – don't try and get this too tight, as it can rip the wires out of their staking and you'll have to start over.

Once you have the mandrel in this state, carefully go back over it, looking for areas where you damaged the walls of the mandrel valleys when staking the wires. If such areas exist, try and repair them. Using your soldering iron, try and smooth out the damaged walls – this is easier than you may think. Keep the soldering iron moving while you smooth (don't let it sit in once place) and blow on the mandrel often to keep it cool – remember that printing a new mandrel doesn't take long, is cheap, and the wires can be swapped from one mandrel to another – if you butcher your first mandrel, you can practice repairing on it, print another, swap your wires over, and be set to patch the next one up.

Tooling Setup

This section covers detailed steps on how to assemble each tooling setup – become familiar with this section, as it will be important to getting the ECM process correct.

Boring Setup



The boring setup – this setup consists of your barrel, boring rod, end pilot, and fitting/fixture combo. Begin by installing one or two zip ties around the base of the end pilot (not on the fingers). Only tighten them down one or two clicks past snug.



Insert your boring rod into the matching recess inside the fixture.



Slide the barrel over the boring rod, seating it fully into the fixture.



Slide the end pilot over the end of the boring rod, then slide the fingers up over the barrel.

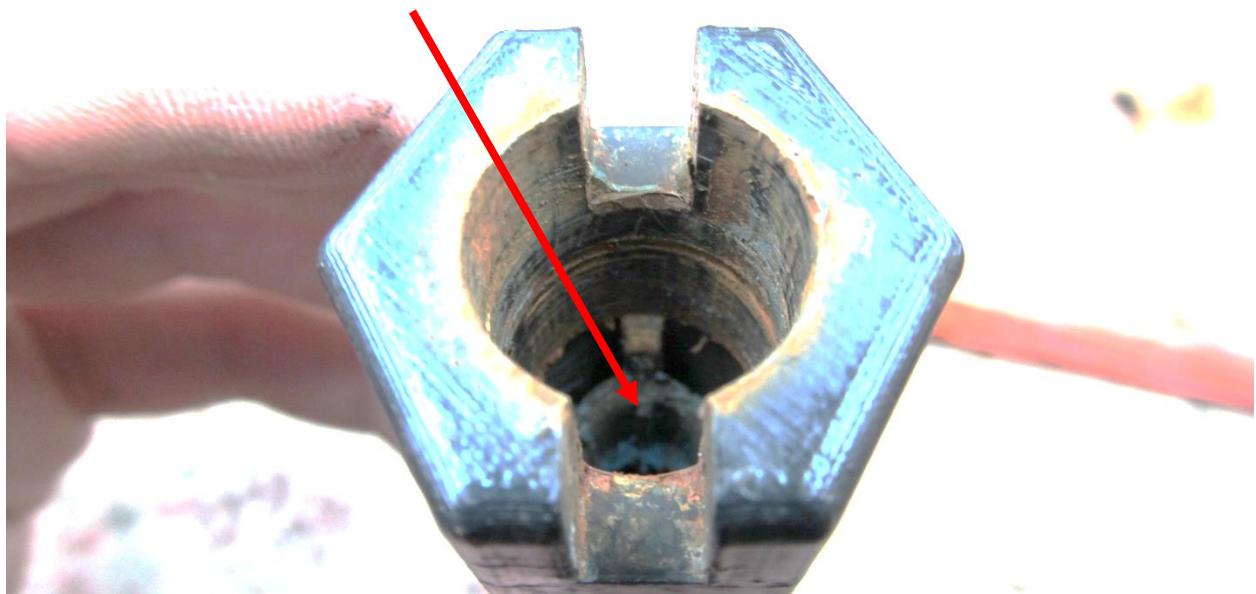


Slide the zip ties up to the end of the end pilot. This will lock the end pilot in place, keeping the boring rod and pilot from slipping off. Note the size of the gap left between the barrel and the end pilot – this is a good target for the gap size you want to attain. Too small a gap can cause overpressure issues for the fluid flow, and too large a gap could cause low pressure issues that could starve certain areas of the barrel of the fluid it needs.

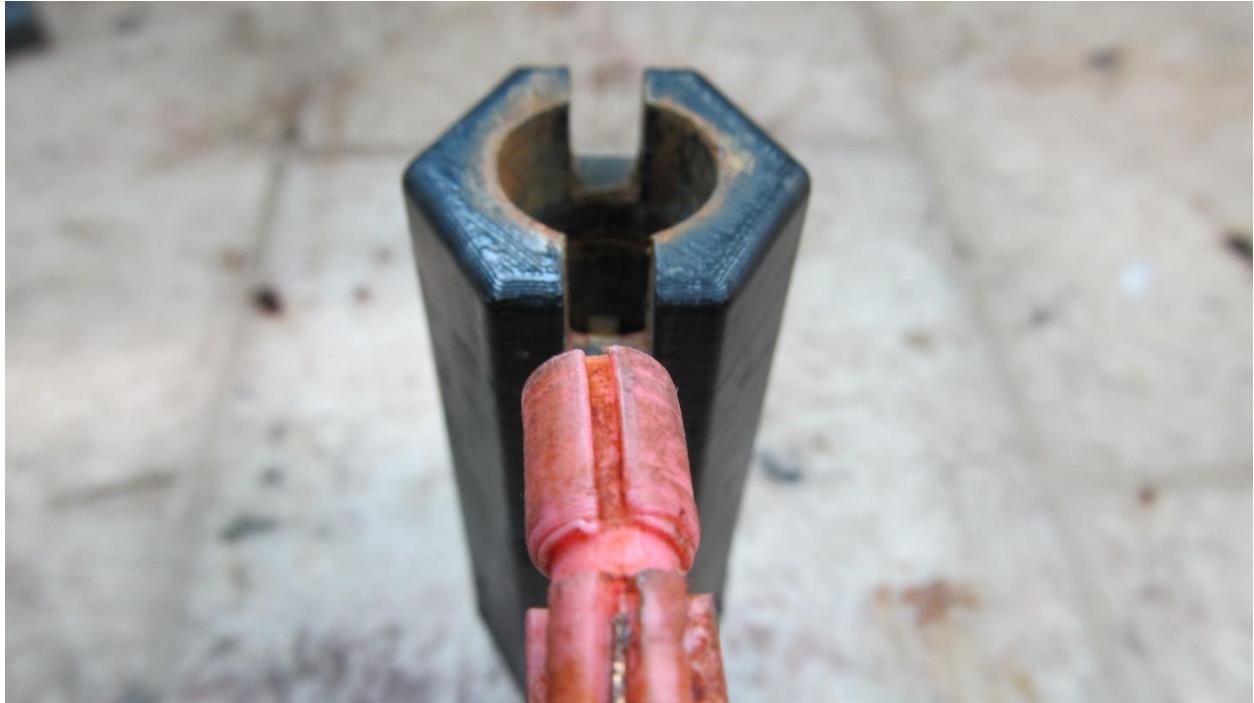
Rifling Setup



The rifling setup – this setup involves a bored barrel, a rifling mandrel, and a fitting/fixture combo.



This picture is intentionally oversaturated in order to show the alignment notch located inside the fixture. The arrow above is pointing to it. Remember where this notch is located (it is also marked on the outside of the corresponding side of the fixture to help you remember).



This picture shows the slot on the rifling mandrel which will index with the notch in the fixture. This notch/slot setup allows the fixture and rifling mandrel to stay indexed properly – maintaining this index is **VERY IMPORTANT** to the rifling process (as described later, in the ECM process section).

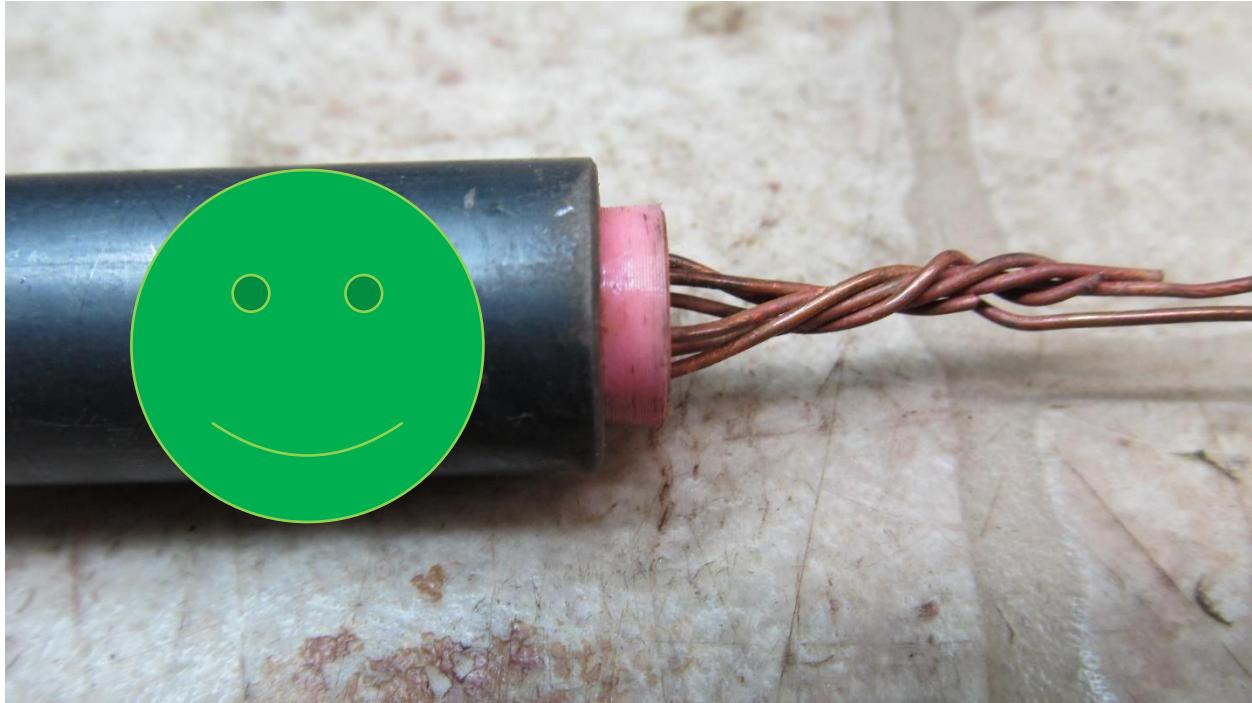


This is how the mandrel looks when fully seated with the slot/notch aligned.

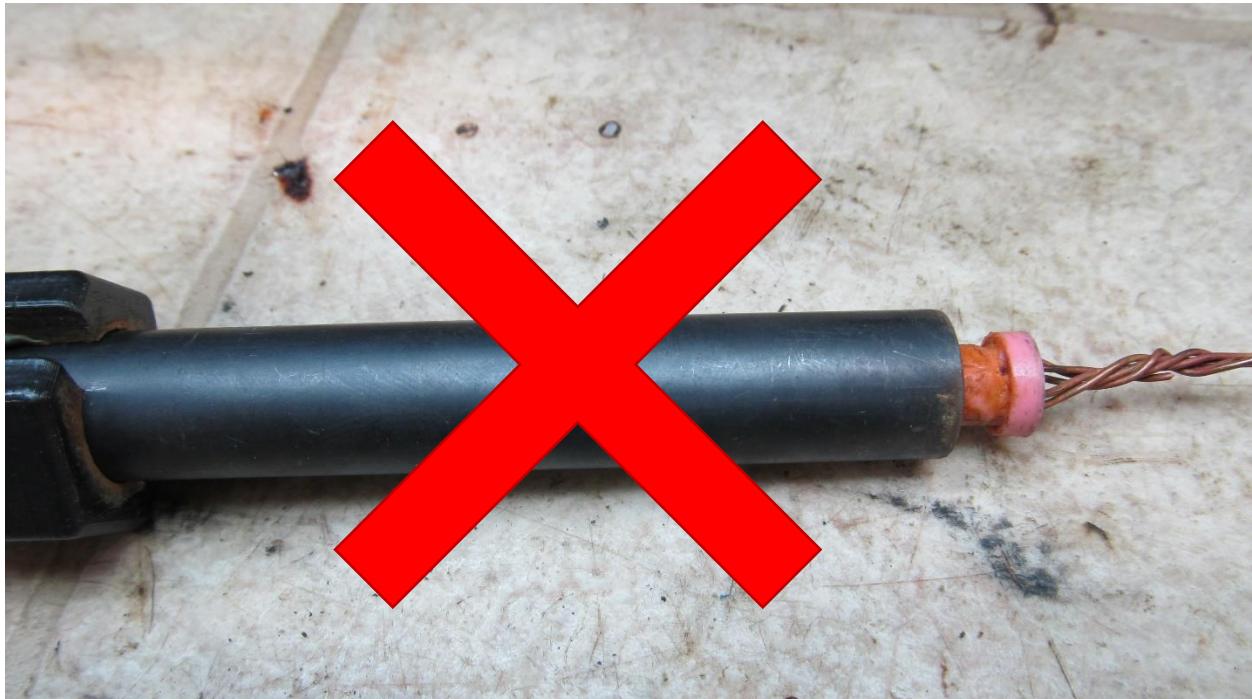


Removing the mandrel from the previous setup, slide the mandrel into the bored barrel. If the mandrel is having a hard time fitting into the bored barrel, you may have a barrel that isn't bored wide enough, or your mandrel printed slightly too large – you can sand down the mandrel to get it to fit, or bore the barrel out to spec.

With the mandrel slid inside the barrel, insert them together into the fixture. You will want to get the mandrel to seat fully – not the barrel. That is, with the slot and notch aligned, you will insert the mandrel all the way, but you will keep the breech of the barrel flush with the seat of the mandrel (as shown in detail in the following pictures).



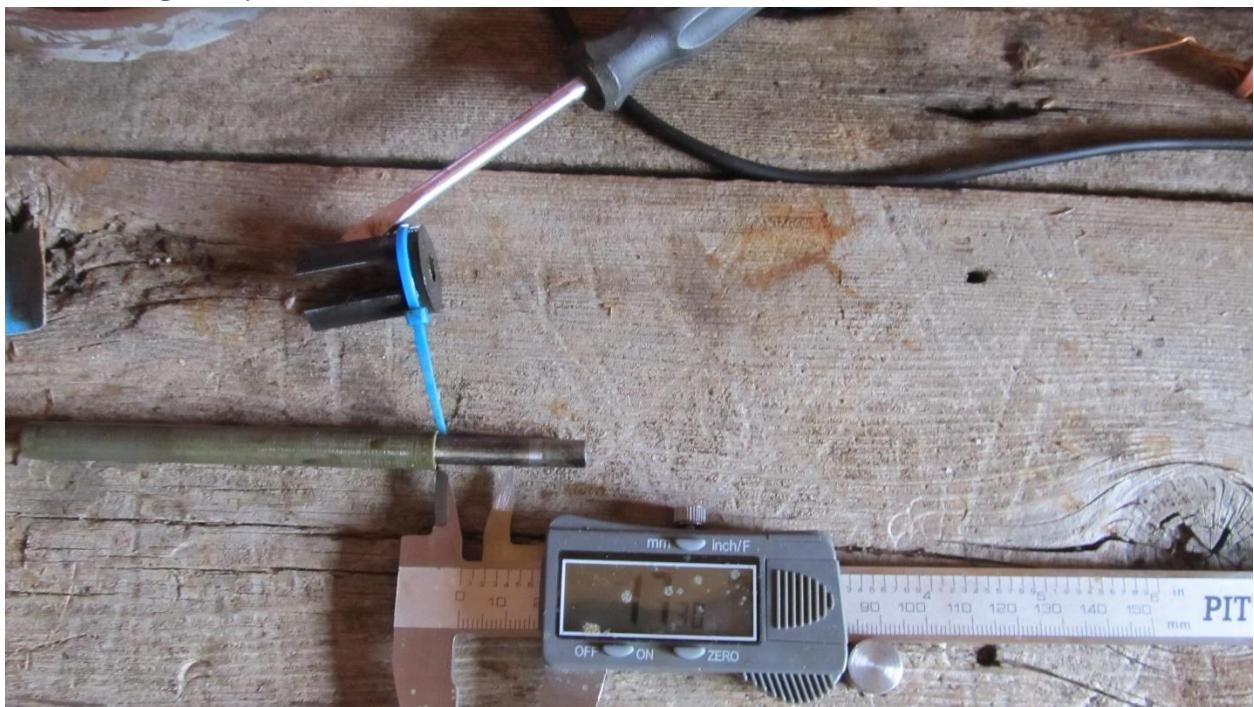
This is how the breech end of the barrel should fit with against the seat of the mandrel – the mandrel will be fully inserted to the fitting, but the barrel will not be.



With the barrel inserted fully into the fitting, the breech end of the barrel will not be flush against the seat of the mandrel – THIS IS WRONG!

For information on indexing the barrel, go [HERE](#).

Chambering Setup



The chambering setup – this setup involves a rifled barrel, a chambering rod, a chambering rod insulator, an end pilot, and a fitting/fixture combo. In the [main ECM process guide](#), there are instructions for how to mount and mark the chambering rod/insulator.



The chambering tool mounts up just like the boring tool. The main ECM process guide has detailed instructions on how to properly align the tool to get the setup right. If your chambering insulator will not fit into the bore, you may need to sandpaper it some, or your bore may be too tight.

ECM Process

Preparation Work



Step 1: PREPARING RESERVOIR - First, pour 11.3L (3 Gallons) of tap water into your bucket/reservoir.



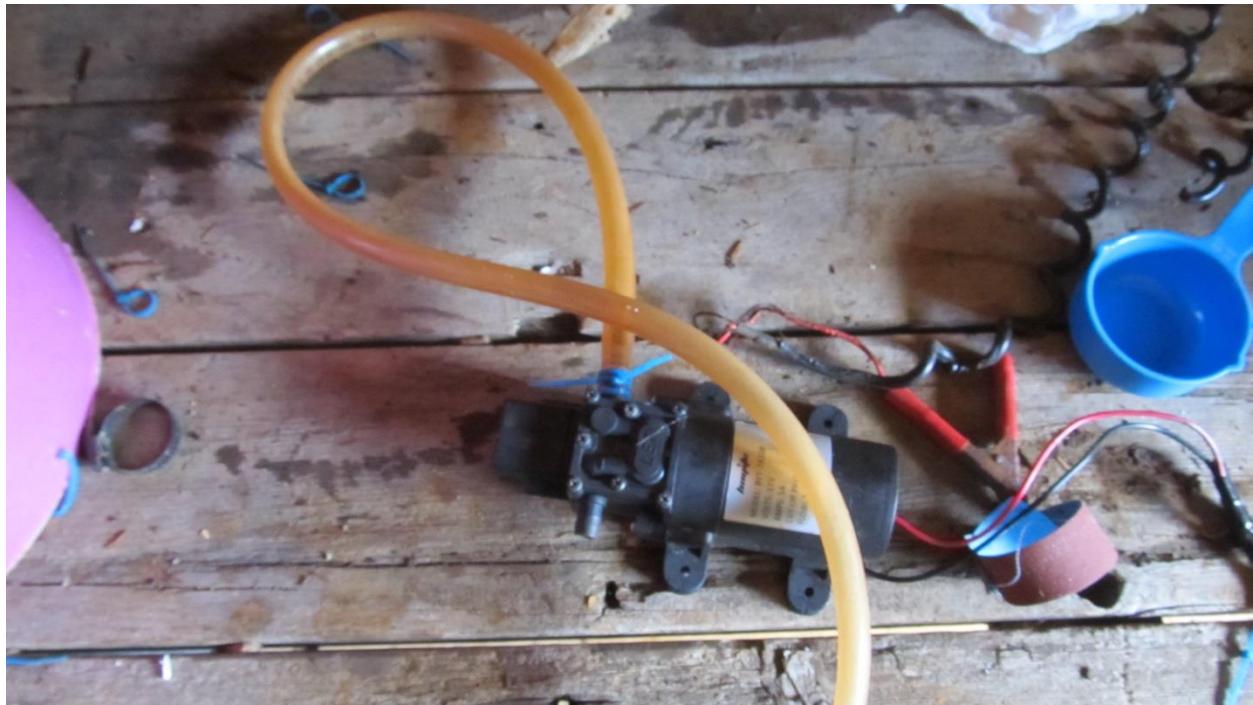
Step 2: MEASURING SALT - Measure out 304g of salt. There are tools online to convert mass of salt to volume of salt. I had been using one cup of salt. It isn't imperative to nail the amount of salt, but if you undershoot the electrolyte will have too high resistance and if you shoot too high the exposed metal of the barrel will begin to rust in a matter of minutes.



Step 3: PREPARING ELECTROLYTE - Pour your salt into the reservoir. Mix it in.



Step 3 continued: MIXING ELECTROLYTE - I just used my hand to mix the salt in. Mix until you cannot feel any rough salt on the bottom of the reservoir. This may take a while depending on the size of your salt grains and the hardness of your tap water.



Step 4: PREPARING SUCTION TUBING - Take your pump and connect a ~5ft section of tubing to the SUCTION side. You can cut the tubing from the stock using scissors, a knife, boxcutter, etc. Length does not need to be precise. I recommend adding a couple zip ties over the tubing around the barb on the pump – this prevents leaks when the pump runs at high pressure.



Step 5 (optional but recommended): PREPARING SLUDGE FILTER - Cut two 3in x 3in squares from screen door material.



Step 5 continued: PREPARING SLUDGE FILTER - Take the end of the tubing from the previous step that isn't attached to the pump and lay it on top of the two squares of screen. Lay the screens on top of each other at a 45-degree offset as shown in the image.



Step 5 continued: PREPARING SLUDGE FILTER - Wrap the screen material up and around the tubing. Zip tie it in place. This will serve as a filter that keeps sludge from being sucked through the tubing. It won't filter out fine particulate, but it will keep the head of sludge that this process creates from being recirculated.



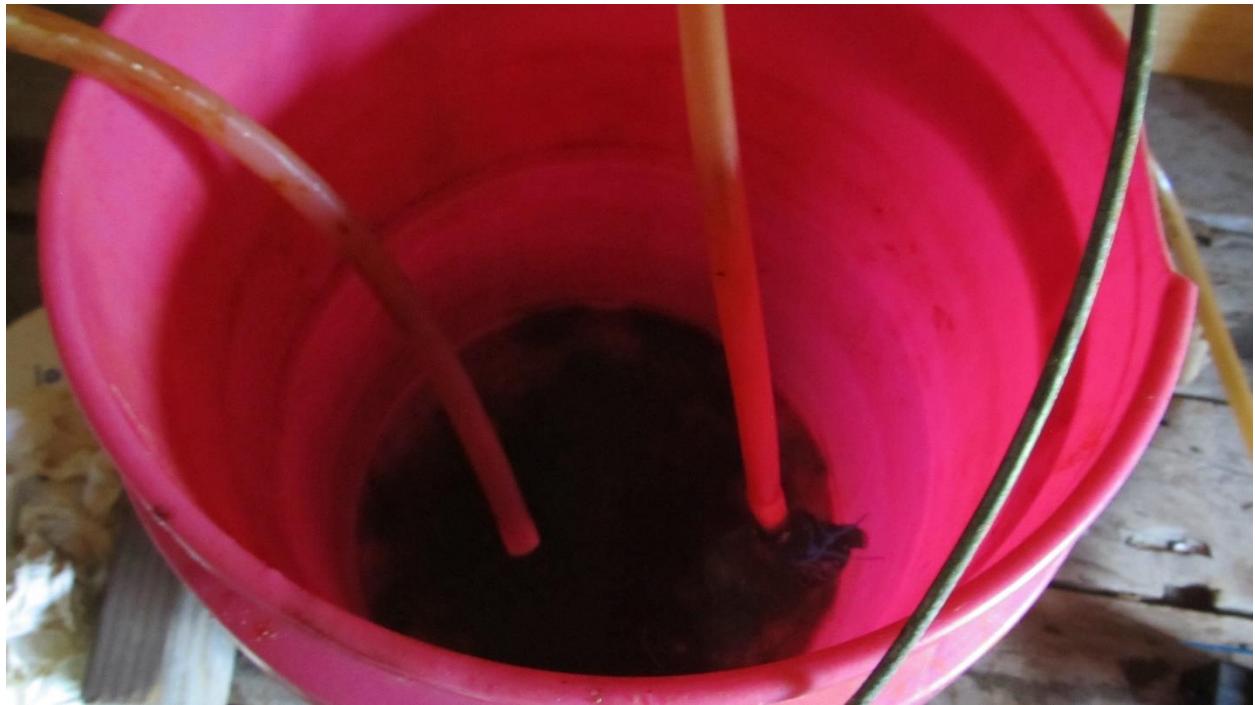
Step 6: INSTALLING SUCTION TUBE - Insert the end up the suction tube into the reservoir. Ensure the tubing is long enough to allow you room to position the pump on your table while not pinching the tubing.



Step 7: INSTALLING SUCTION TUBE - secure your suction tubing to your reservoir. I used a zip tie around the tube to and handle on my reservoir. Any setup that can hold the tip of the suction tube roughly halfway between the bottom of the reservoir and the level of the electrolyte should be good.



Step 8: PREPARING PRESSURE TUBING - Take your pump and connect a ~5ft section of tubing to the PRESSURE side. You can cut the tubing from the stock using scissors, a knife, boxcutter, etc. Length does not need to be precise. I recommend adding a couple zip ties over the tubing around the barb on the pump – this prevents leaks when the pump runs at high pressure.



Step 9: INSTALLING PRESSURE TUBE - Insert the end up the pressure tube into the reservoir. Ensure the tubing is long enough to allow you room to position the pump on your table while not pinching the tubing.



Step 10: CHECKING THE PLUMBING SETUP – At this point, you have completed the plumbing setup. Ensure that the lines are not kinked/too short, and that your basic setup matches this image.



Step 11: TESTING THE PLUMBING – Plug in your pump in order to start it. If you have an extension strip with an on/off switch you can use that as a start for your pump. I just unplugged it to turn it off.



Step 11 continued: TESTING THE PLUMBING - check the system for leaks. Ensure that electrolyte leaving the PRESSURE tube isn't full of air bubbles. If it is, you probably have a leak in your SUCTION tube. Once you are satisfied that the system is free of leaks, you can shut off the pump.



Step 12: INSTALLING PRESSURE TUBE - secure your pressure tubing to your reservoir. I used a zip tie around the tube to and handle on my reservoir. Any setup that can hold the tip of the pressure tube roughly above the middle of the reservoir will work.

Boring Operation



Refer to [HERE](#) for instructions on setting up the tool.

Step 13: BORING SETUP – Lay out your supplies for this setup. You will need your dressed fitting, boring rod, barrel blank, and end pilot.



Step 14: POWER SUPPLY SETUP – Lay out your power supply. You will be using the the alligator clips that it comes with.



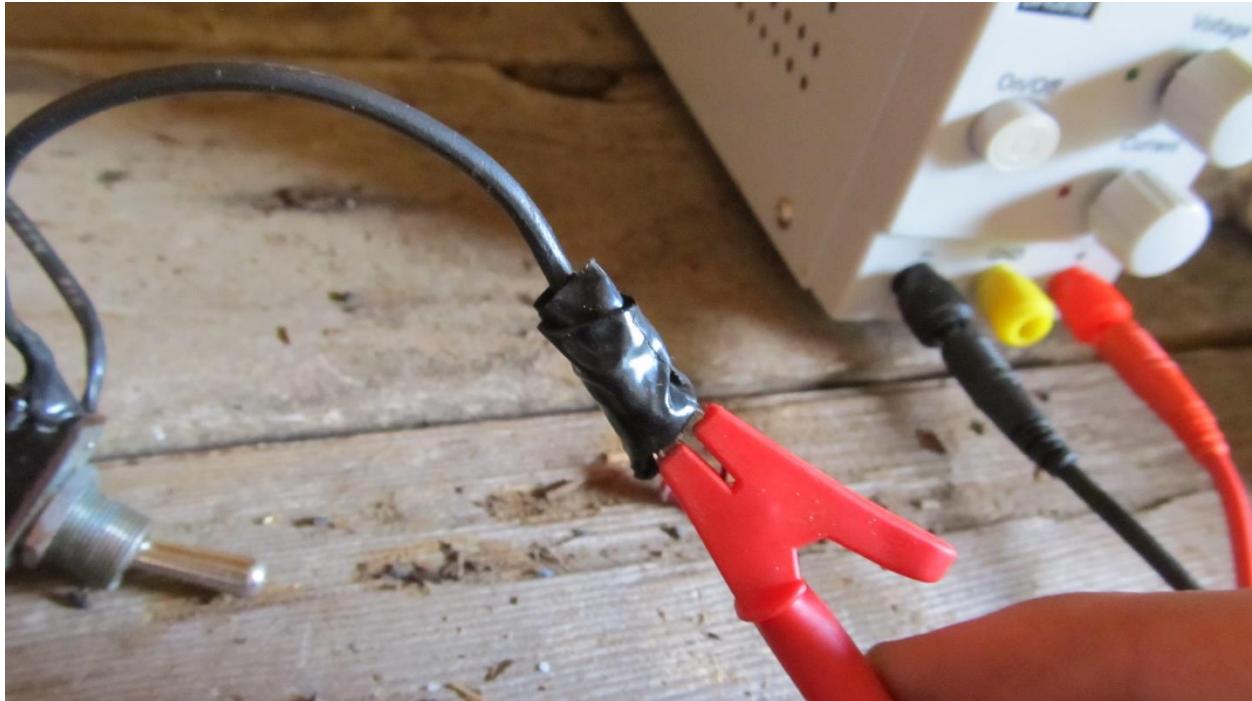
Step 14 continued: POWER SUPPLY SETUP – Switch your power supply on. Ensure that the alligator clips are not in contact with one another. The display should read some number of volts and zero amps. Spin both knobs on the power supply as far counterclockwise as they will go.



Step 14 continued: POWER SUPPLY SETUP – Touch the two ends of the clips together. They will quickly begin to heat up, so do this step quickly. Turn your CURRENT knob until the display reads around 7.5A. You don't have to nail this value at this time, just get it close. When you are close, remove the two clips from each other. After disconnecting the clips, you can turn the voltage knob counterclockwise until it reads 20 volts.



Step 14 continued: Turn the power supply off. It is now set to be close to the values you will need while cutting the barrel. Do not touch the knobs until instructed to later in this tutorial.



Step 15: POSITIVE LEAD WIRING SETUP – Using a ~5ft length of your spare wire, strip one end, exposing the bare copper underneath the insulation. You can do this with wire strippers, scissors, a box cutter, etc. Clamp the exposed copper in the clamp for your positive lead (red wire). Wrap the clamp in electrical tape as shown in the image above.



Step 15 continued: POSITIVE LEAD WIRING SETUP – Strip the other end of your spare wire. You will be using zip ties to secure this wire to the barrel itself, with the exposed copper of the wire touching the barrel.



Step 15 continued: POSITIVE LEAD WIRING SETUP – Example of how to secure the positive lead to the barrel. Note using two zip ties, one to hold the insulated section of the wire and another to hold the bare wire against the barrel.



Step 16: NEGATIVE LEAD WIRING SETUP – Using a ~5ft length of your spare wire, strip one end, exposing the bare copper underneath the insulation. You can do this with wire strippers, scissors, a box cutter, etc. Clamp the exposed copper in the clamp for your negative lead (black wire). Wrap the clamp in electrical tape as shown in the image in the first part of step 15.



Step 16 continued: NEGATIVE LEAD WIRING SETUP – Strip the other end of your negative lead wire. Splice on your extra clamp. I recommend soldering and taping the splice, but a pigtail twist and tape should work. If your clamp cannot grab on to the end of the steel rod shown above, you may have to hammer the jaws of your clamp flat.



Step 16 continued: NEGATIVE LEAD WIRING SETUP – Clamp the clamp on to the end of the boring rod. It doesn't need to clamp tight but shouldn't fall off on its own.



Step 17: MOUNTING THE TOOLHEAD – slide the PRESSURE side outlet tubing over the barb on the toolhead. Use a zip tie to ensure the toolhead stays connected to the tubing. If using a bucket similar to the one in this tutorial, you can zip tie the pressure side to the top of the handle and have the toolhead hang above the bucket.



Step 17 continued: MOUNTING THE TOOLHEAD – example picture showing the toolhead hanging above the bucket. Note position of zip ties.



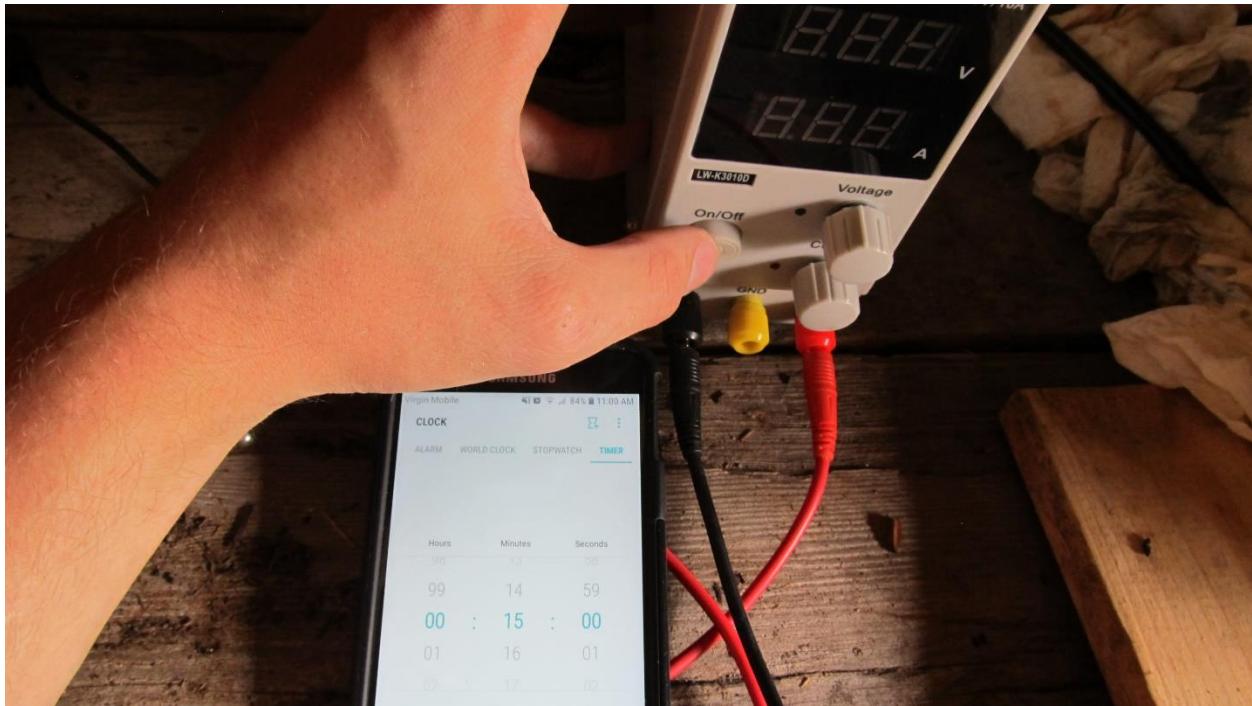
Step 17 continued: MOUNTING THE TOOLHEAD – Example picture showing using a block of wood (2x4) to prop up the handle of the bucket to hang the toolhead above the bucket.



Step 18: BEGINNING BORING OPERATION – Connect the clamp to the bottom of the boring rod. Double check your plumbing and wiring, ensure it matches up with the diagram.



Step 18 continued: BEGINNING BORING OPERATION – Turn on your pump. The fluid should flow consistently and without too many air bubbles. Take this time to ensure the SUCTION side of the tubing is about halfway down into the bucket's fluid.



Step 19: BORING OPERATION – READ THIS STEP BEFORE BEGINNING IT. Turn your power supply on. ENSURE THE PUMP IS RUNNING STILL. Running the power supply without the pump running can pit your barrel, burn up your power supply, or cause a fire. Once you turn the power supply on, you will need to do three things. First – check that the fluid pumping out of the toolhead changes color. It should become a lighter color and you should notice a hissing sound. This is good. Second – start a timer for 15 minutes. I recommend cutting in intervals of 15 minutes until you get close to the correct barrel bore, then cutting in smaller time increments. Obviously the longer time interval you cut for, the more material will be removed. Third – check the AMPERAGE read on the power supply. You set this to 7.5 before, but it may shift once you are using the actual setup. Adjust it to 7.5A again if it isn't still 7.5A. NOTE: the boring operation can take up to 1 hour and 15 minutes. Don't waste a barrel by cutting without measuring periodically. Step 20 will detail how to measure/check that you are done.



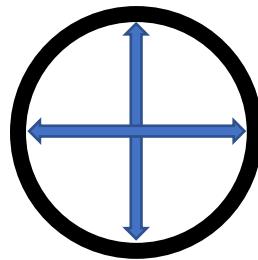
Step 19 continued: BORING OPERATION – Example of the lighter color of the fluid once the power supply is turned on. A hissing sound may also be heard.



Step 19 continued: BORING OPERATION – Example of amperage changing slightly once the cutting starts. Adjust this to 7.5A and leave it be for the rest of the operations.



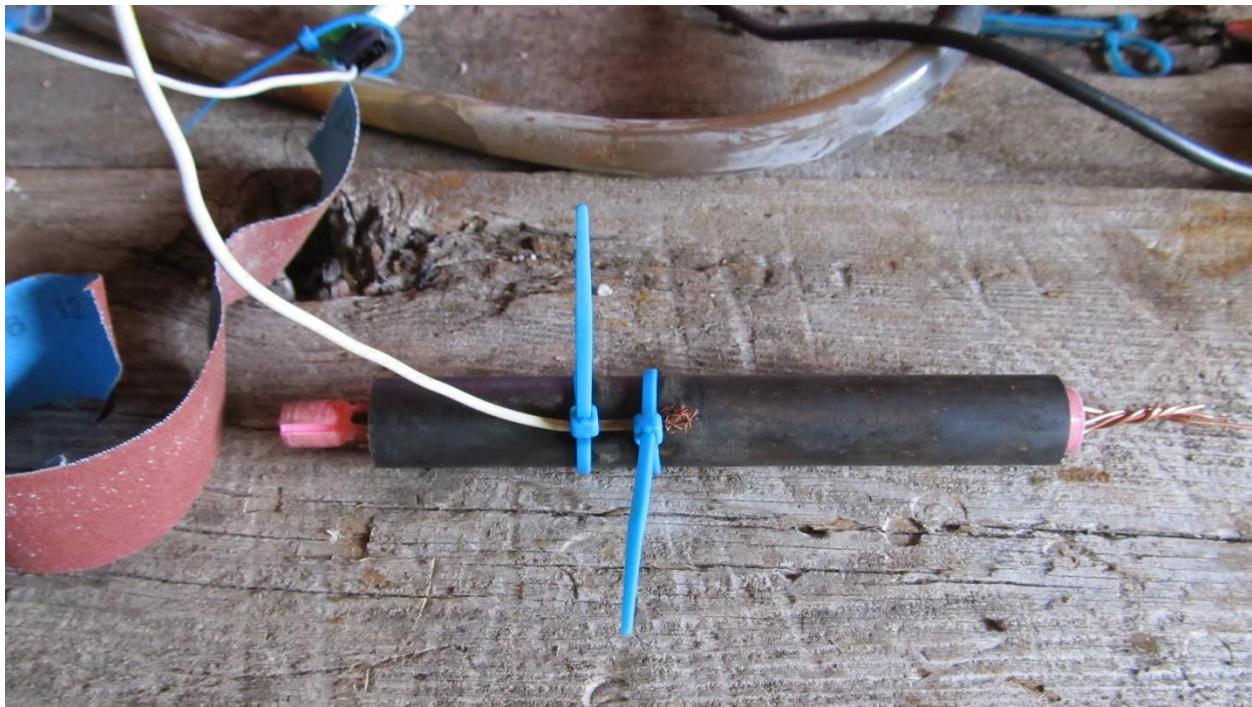
Step 20: MEASURING THE BORE – After cutting for 15 minutes, demount the barrel and measure the bore. You can use calipers to do this. In order to most accurately measure the bore with calipers, twist them around in the bore as you measure. Ensure that the caliper jaws are parallel to the bore. Whatever number you see as your peak number is the size of the bore. Confirm your bore measurement by measuring the bore in two places 90 degrees away from each other:



Your final bore size should be 8.82mm. You can overshoot this by a little (8.85mm is still acceptable), but don't undershoot it.

You will likely have to cut for over an hour. Your first 15 minutes may not cut very much because the barrel stock has a coating that takes a long time to wear away. Once it is gone the cutting will go a little quicker. Keep a notepad where you track how long you have cut and what the size of the bore was after the most recent cut. This notepad can help you guess how much cutting will need to be done when you get close. I found that 1 hour and 10 minutes worked to get an 8.82mm bore two times out of three (the third time it took 1 hour and 25 minutes). It is best practice to cut then measure, and not just cut for 1 hour and hope you don't overshoot.

Rifling Operation



Refer to [HERE](#) for instructions on setting up the tool.

Step 21: BEGINNING RIFLING OPERATION – After the bore reaches 8.82mm, the rifling tool should be able to fit snug in the barrel. If your barrel is 8.82mm on the money, the tool might be a little tight. If it is, use sandpaper to gently sand down the outside of the mandrel until it fits snug in the bore of the barrel.



Step 22: RIFLING OPERATION – THIS IS IMPORTANT – READ THIS BEFORE STARTING: The rifling operation requires the operator to pay some attention to what they are doing. You will need to maintain INDEX of the barrel to the toolhead between demounting the barrel. If you fail to do this, your rifling will overlap and your barrel will be ruined. Read these instructions close in order to know how to maintain index of the barrel.

First and foremost – make indexing marks on the barrel. Note the cutout on the toolhead. This cutout is meant to be used for indexing the barrel. What I did was scratch the barrel's coating off along the edges of the cutout. Then, when remounting the barrel, I would make sure the scratch marks lined back up with the cutout in the toolhead. This ensures the barrel and toolhead always go back together in the same orientation. The following subsection will detail how to do this with pictures.

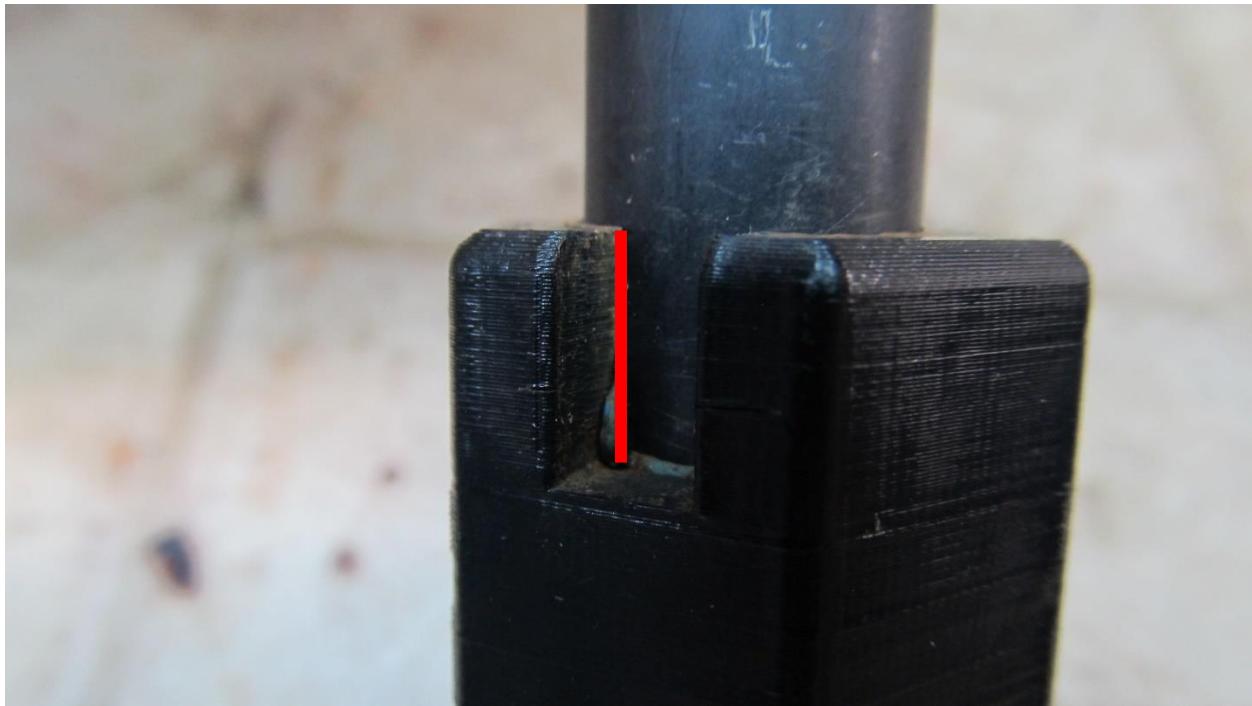
Detailed Barrel Indexing Help



Grab some tool capable of marking the finish on the barrel – A boxcutter, screwdriver, etc.



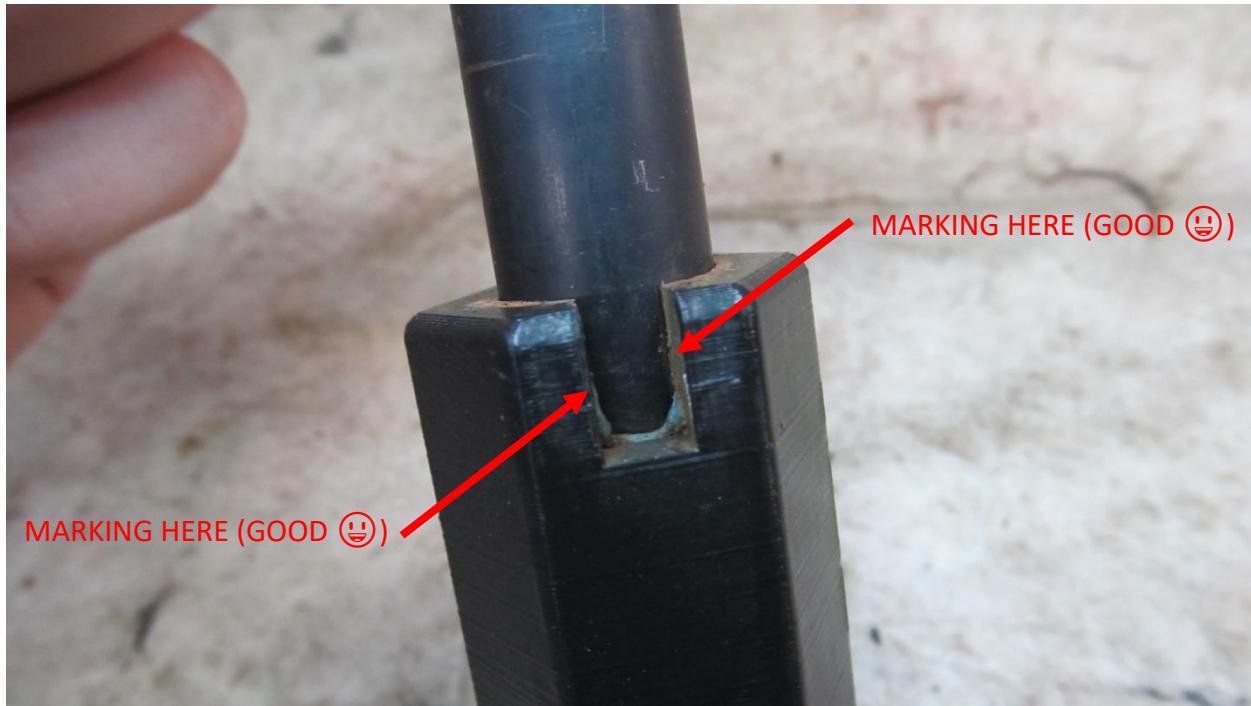
Make two marks, one flush with the sides of either side of the square cutout.



The mark will go here, and mirror on the other side.



An example of the two markings.



When re-mounting the barrel during the rifling operation, be sure to mount the barrel with the two markings aligned with the cutout – in person you can very easily see your markings and notice when they are and are not lined up.

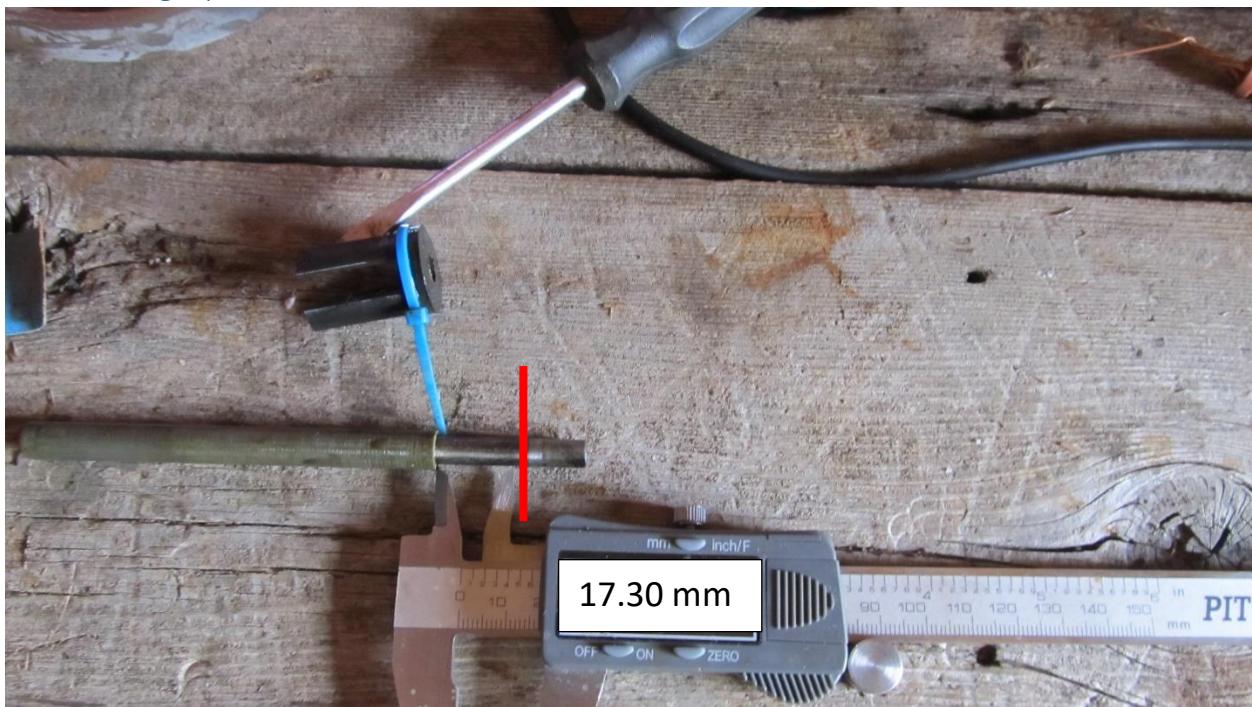


An example of a way out of index barrel – the marking line isn't aligned with the cutout.



Step 23 continued: MEASURING THE RIFLING – After cutting and measuring in increments of 5 minutes, a valley to valley distance of 9.30mm -.2mm + .1mm should be achieved. As in step 20, measure in more than one place (more than one valley to valley) and rock the caliper around to find the largest measurement while the caliper jaws are parallel to the bore. If your valley to valley distance isn't big enough yet, cut for another 5 minutes (unless you're very close to an acceptable distance, then cut for 1 minute). [BE SURE TO INDEX THE BARREL WHEN REMOUNTING.](#)

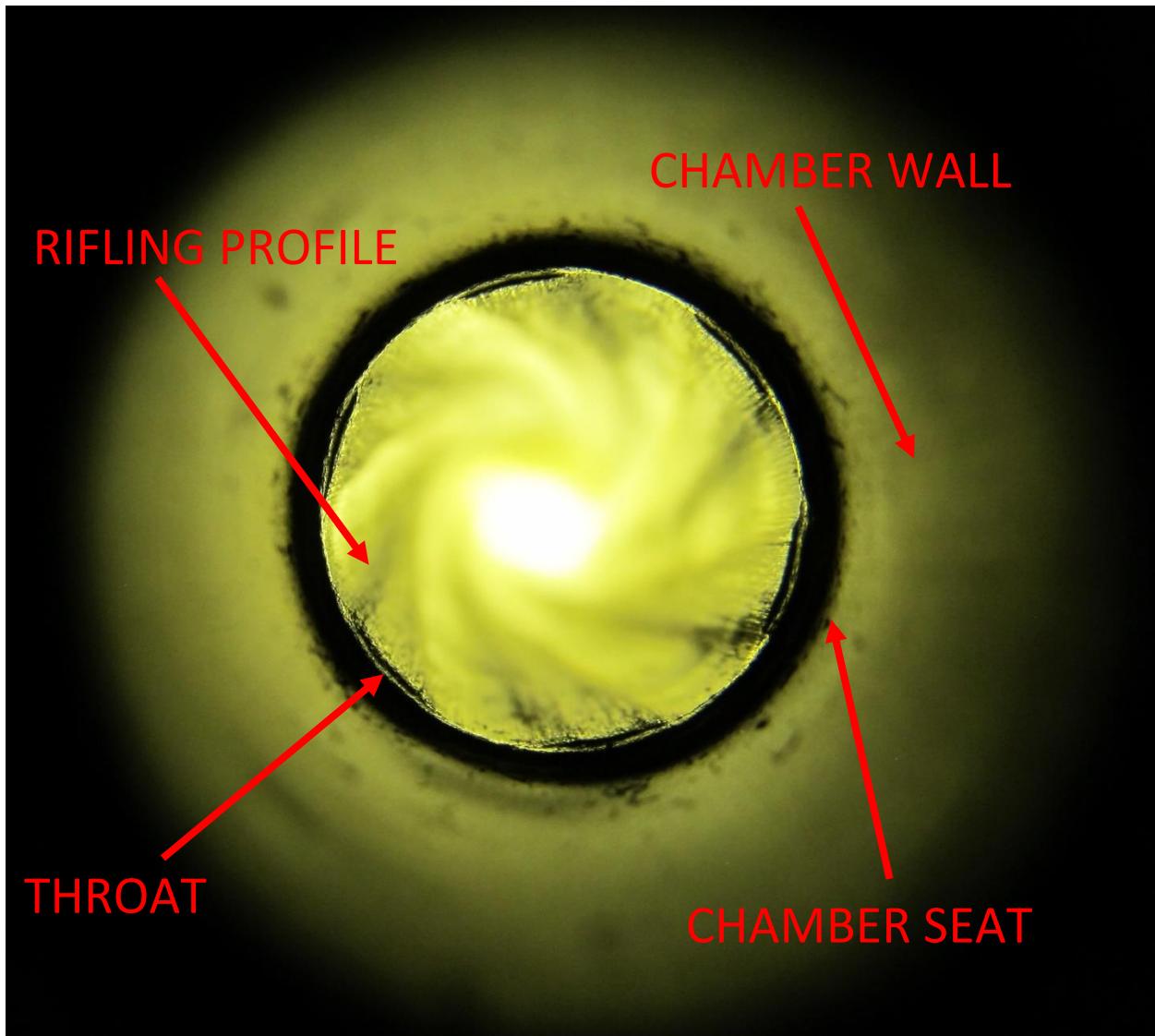
Chambering Operation



Refer to [HERE](#) for instructions on setting up the tool.

Step 24: BEGINNING CUTTING THE THROAT – After the rifling is cut to spec, you are ready to cut the chamber – the first step of cutting the chamber is cutting the throat of the chamber. The throat is the section of the chamber where the round itself will sit. If you don't cut the throat, rounds (and potentially casings) will interfere with the rifling, causing extraction issues.

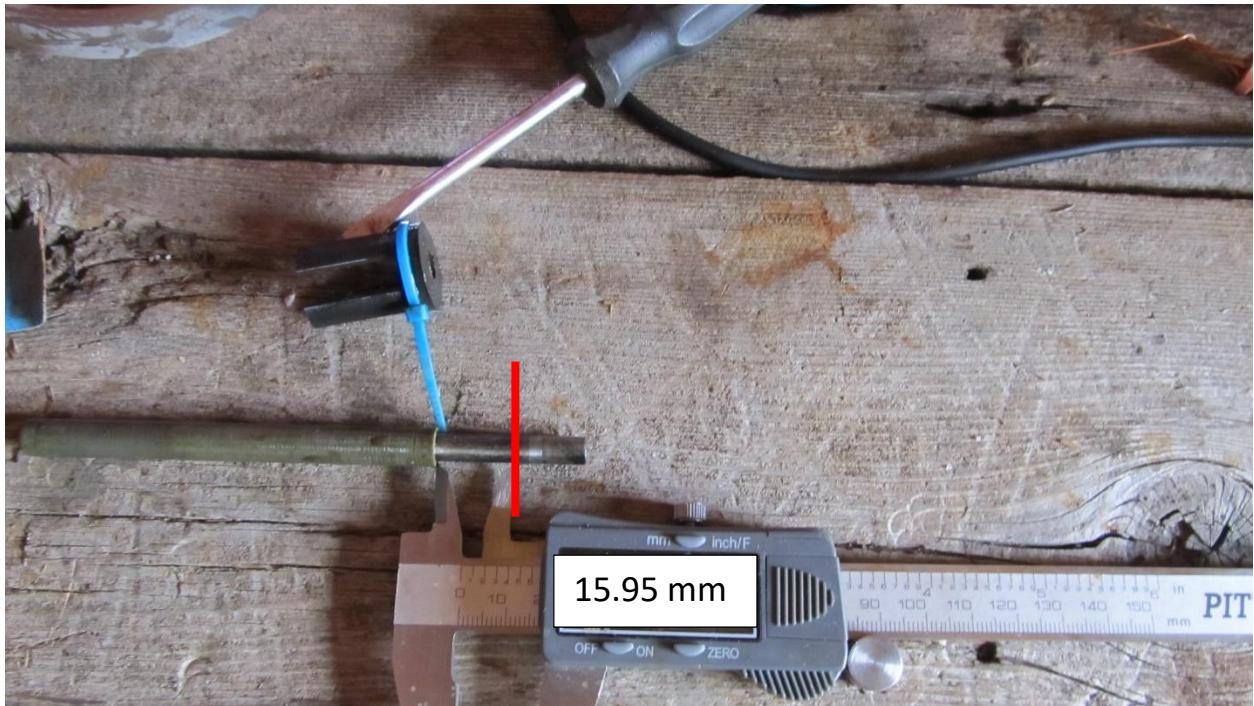
Now – in order to cut the throat, you will take your chambering tool and set your calipers to 17.30mm. This measurement is important to get spot-on. Mark the steel of the chambering tool 17.30mm away from the insulation, as shown in the picture above.



This is a picture of a freshly cut barrel that you can use for reference. You can see the primary parts of the barrel – the rifling profile, the throat, the chamber seat, and the chamber itself. The bore quality is a little rough, but what you're seeing is embrittled metal (metal that has been mostly ECM-ed away and is a weak, sponge-like structure) that can either be polished out, or shot out – after using the barrel the roughness will smooth out.



Step 24 continued: BEGINNING CUTTING THE THROAT – Mount your barrel and install the chambering tool. Line up the mark you made on the chambering tool with the breech face of the barrel. You should cut with this setup in 1-minute increments – you want to get the diameter of the chamber to over 9.09mm. You don't want to overshoot this measurement – this is the most delicate part of the ECM operation. Measure the diameter of the chamber just as you did in step 20 for the bore. Once you have cut the chamber to 9.09mm, a 9mm bullet (not the casing, just the bullet) should be able to fit inside the chamber up until the rifling.



Step 25: BEGINNING CUTTING THE CHAMBER – After the throat is cut to spec, you are ready to cut the chamber itself – the actual area where the cartridge will go.

Now – in order to cut the chamber itself, you will take your chambering tool and set your calipers to 15.95mmmm. This measurement is important to get spot-on. Like in Step 24, mark the steel of the chambering tool – but this time, mark it at 15.95mm away from the insulation.



Step 27: CUTTING THE CHAMBER – Mount your barrel with the chambering tool set to 15.95mm (follow the same process as in Step 24 to mount the barrel, only this time your chambering tool won't be as deep in the chamber). I cut in 2-minute increments until a live round could chamber fully into the barrel without having to force it. Once you think you are at this point, chamber the round, tap it as if you were really trying to get it to chamber all the way, then try and take the cartridge out. It should be easy to remove the cartridge even after you have tapped it into the chamber – if it is too tight after tapping it, either your chamber is too tight or your throat is too tight, or both. The picture is of a round chambered in a 15.95mm deep chamber.



A finished barrel just after the chamber was cut. Note the rough finish on the breech face – this can be stoned or filed flat if you desire it make it pretty. The ECM process will leave a nice radius at the mouth of the chamber, which aids in feeding – thus no work should be needed to remove sharp edges on the barrel.

Non-Destructive Inspection

Non-Destructive Inspection (NDI) is a process where you can gauge the effectiveness (and proper craftsmanship) of your barrel without actually firing it – doing NDI first can save you from blowing a barrel up when doing “destructive inspection” (which really just means firing it).

I recommend “slugging” the barrel as your NDI – there are other ways to do this, but sluggering is a cheap and effective way to do this. In order to slug your barrel, you will need:

- 1.) A finished barrel (or barrel that you think is close to finished and you want to check)
- 2.) A 9mm *bullet* (or whatever size bullet your barrel is meant to fire)
- 3.) A pushrod of some sort – you can use a flat punch, or your 0.250/6mm rod you used for the boring operation.



First, take your bullet and set it down into the muzzle of the barrel. I like to slug muzzle to chamber, but you can slug chamber to muzzle – it really doesn't make a huge difference.



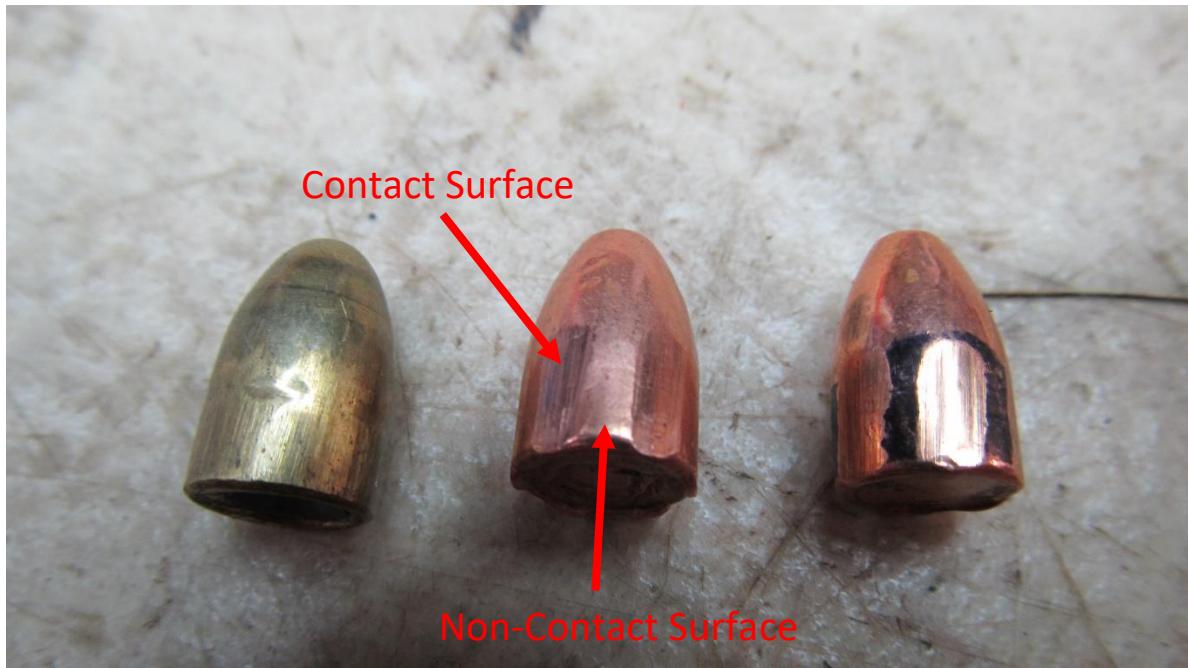
Tap the bullet down the muzzle and into the bore – it might take a little bit of force to get it to start, but it shouldn't require too much effort – I am able to start 9mm bullets using a flat punch like seen in the picture and a rubber mallet. You SHOULD NOT see the copper jacket on the bullet peeling off – if you do see copper peeling off, stop trying to force the bullet down the bore – your bore is undersized.



Continue tapping the bullet down the bore of the barrel. Once the bullet is into the bore, it should require a very consistent force to tap the bullet down the bore – it shouldn't feel like the round is binding, and it shouldn't take more force than it took to start the bullet.



Tap the bullet down the bore until it comes out the chamber end (if you went muzzle to chamber – in the event you went chamber to muzzle, the round will come out the muzzle). Congrats, you've successfully slugged your barrel. From here, you will be looking at the bullet itself to gain insight as to how the rifling and bore in the barrel are shaped.



Here are examples of three different bullets all slugged through the same barrel at different points in the barrel's rifling procedure. Contact surfaces are where the rifling engages the bullet, non-contact surfaces are where the rifling doesn't engage the bullet.

On the left, you have a bullet slugged with only 5 minutes of rifling cut – you cannot see any pronounced separation between the contact and non-contact surfaces on the bullet.

On the right, you have a bullet slugged with 10 minutes of rifling cut – you can see some difference between the contact and non-contact areas because the bullet was marked with a Sharpie market prior to being slugged (a useful technique for seeing the difference between contact and non-contact surfaces). However, this bullet shows much more contact surface width than we want – you can see the contact surfaces are about twice as wide as the non-contact areas.

In the middle, you have a bullet slugged with 15 minutes* of rifling cut – you can see the difference between contact and non-contact areas, and you can see that the width of the contact area is roughly the same as the non-contact area. This is ideal in my experience – it will prevent the bullet from even impacting the non-contact surfaces when fired (fired rounds deform a little more than slugged rounds will). There's also some minor benefits to the even sized width of contact vs non-contact surfaces – the one most worth mentioning is that the rifling will engage the bullet in a manner that should reduce stress on the barrel – something that the rounded nature of ECM rifling lends itself to.

*This does not mean 15 minutes of cutting rifling is always the perfect amount – some barrels took over 20 minutes to come to the optimal valley depth for me. Follow the ECM guide for cutting your rifling and use this NDI section to double-check that your rifling looks good. Don't think of NDI as a way to measure your barrel until you get the cutting right, think of NDI as a way to tell you "this barrel isn't going to work in a safe manner" – and if you feel comfortable doing more cutting to correct the issue in the barrel, you may do so at your own risk.

Troubleshooting

This section will be split into two sections – troubleshooting the process itself, and the barrels you create with it.

The Process

- My tubing is leaking or the hoses are blowing off
 - Using zip ties over the hoses on the barbs will help fix leaks and prevent hoses blowing off
- My pump sounds like it is running, but it isn't moving any water
 - Your pump could be locked up or might not be self-priming correctly. You can manually suck water into the suction hose so that the pump can prime itself easily.
 - If you've used the pump with saltwater before, there's a good chance it has salt buildups preventing it from priming. Trying to blow water through it can help, but what works best is popping off the top cover (just a few screws) and soaking the rubber plate under the top cover with water. Once this is done, reinstall the top cover and the pump should suck (in a good way) again.
- I have all the connections right, but when I turn the power supply on, current doesn't flow/the barrel doesn't get cut
 - It could be that the barrel is getting cut and you don't notice it. Look for the bubbles showing up in the water leaving the barrel assembly – you won't be able to see sludge in the water that flows out.
 - It could be that you didn't add enough salt or didn't add any salt at all – you need to add salt so that the water is conductive to electricity.
 - It could be that your electrical connections aren't correct – ensure that the wiring lead on the barrel has a good connection, and that the clamp on the electrode is actually in contact with the electrode.

The Hardware

- As covered in the README, your barrel may not fit into your fixture based on your printer/settings. You can either sand/fit your fixture to the barrel, or print one of the “oversized” fixtures.