Build Your Own Drawbench

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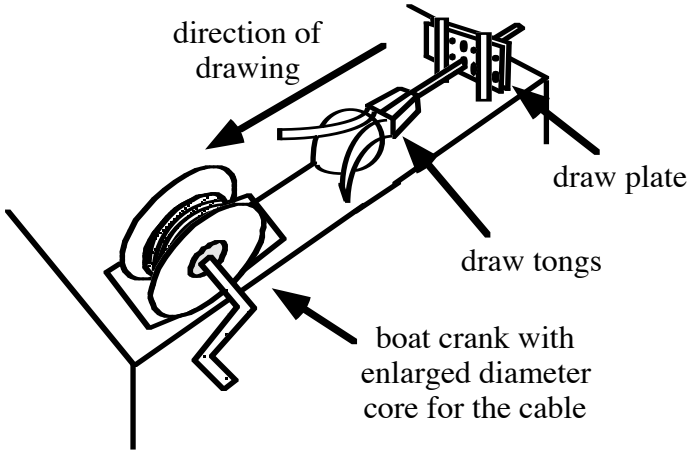
Introduction
This paper describes how to build a basic drawbench. While it discusses several options and approaches it concentrates on one approach, using a boat winch to draw wire or cable through a draw plate. Much information has been drawn from my books "Cheap thrills in the Tool Shop" and "Hinges and Hinge-based Catches for Jewelers and Goldsmiths".

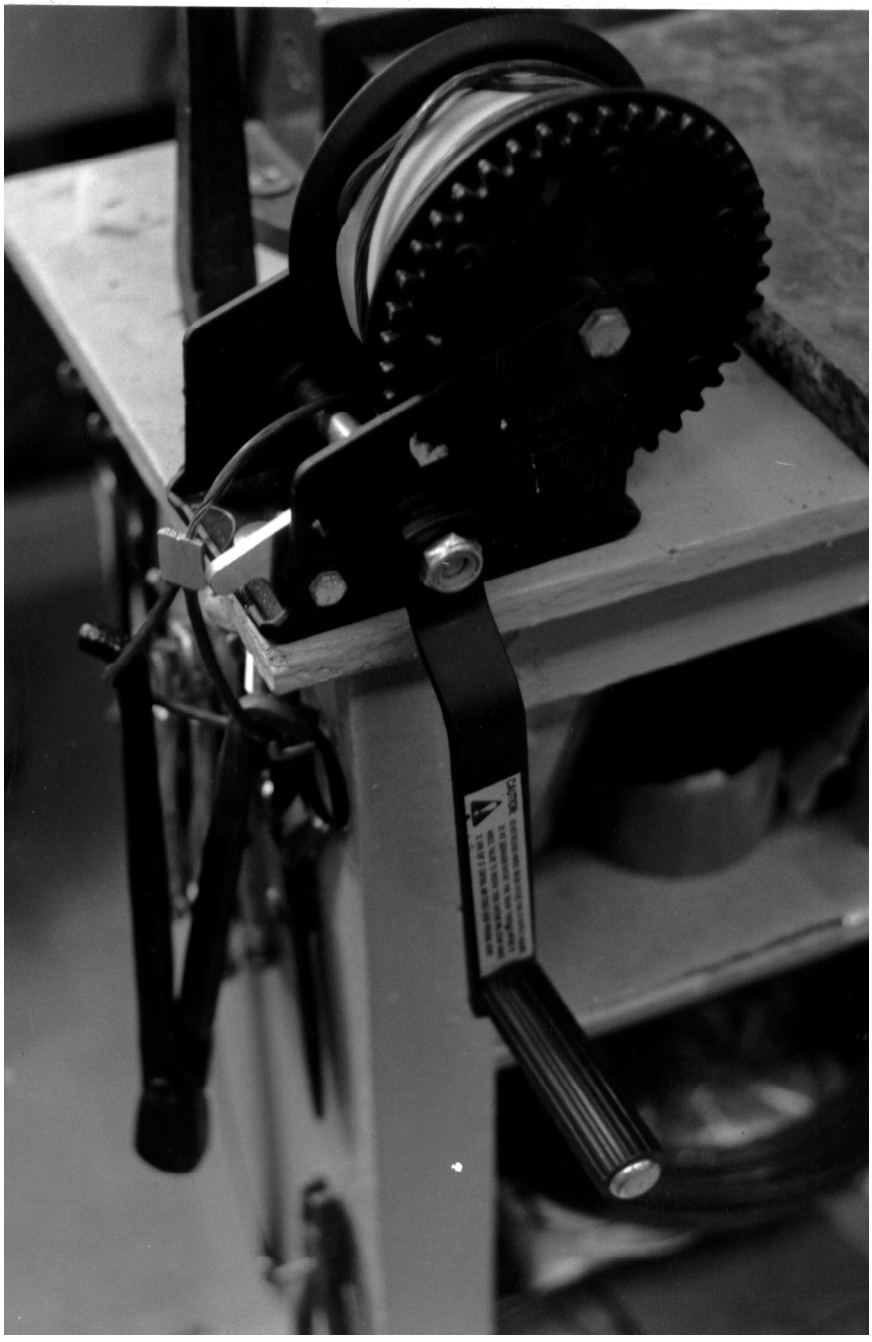
Function Descriptions
A draw bench is a device that allows one to draw wire or tube through draw plates or swages. Since much drawing of wire and small tubes can be more easily and rapidly done by hand a drawbench tends to be used for situations when drawing by hand is too difficult, where a particularly thick wire is being drawn, a complex cross section is being used in the draw plate instead of a simple round hole, or where tubing or wire is too large for one to draw by hand and more force is needed than one can generate with their muscles.

The draw bench has to hold the plate in place against the force of drawing. It has to offer more force than one can obtain by hand. It has to have a way of clamping the wire of tube in place for drawing, most often a pair of draw tongs. It should have a way of detaching the tongs from the system so that one can insert wire, open and close them easily or take them out to clean smeared or torn metal from the jaws. There are some draw benches where the tongs are permanently attached to the cable or strip used to draw them. It has to be long enough that a reasonable length of material can be drawn but not so long that one can't touch the draw plate and position the wire at the same time as using the winch to draw the wire tight against the plate. It has to be stable and sturdy. It may be that a draw bench has to fold up against the wall or otherwise be easy to move about so it is not in the way when you don't need it. I have for instance constructed one on a large plank with a wooden fin sticking out below which could then be clamped in a table vise so that the draw bench itself could be put away when not in use.

The focus of this paper
I recommend making a draw bench using a boat winch. This is because a boat winch is fairly inexpensive. You can purchase a boat winch for about fifteen or twenty dollars, and you can use cable—I use steel clothesline cable around mine—and draw against two posts set into your bench top, some distance away from the cable winch. Don't put it too far away—you often need to be able to hold the draw plate itself and to crank the winch at the same time. To make it work, you have to increase the winch diameter the part the cable winds around. In order to make mine I wrapped a fabric belt around the spindle of the winch so that the hub diameter that the cable wound around was about six inches across. If you don't have a large diameter hub the boat winch requires too much cranking to be a useful tool. (That little observation took me two years to figure out-as obvious as it might seem to some).



This is a picture of the drawbench set up on a bench top work station in my studio. Near the front you can see the steel rods sunk into the wood against which the draw plate sits, the tongs in their cable loop and the winch at the far end with its large hub onto which the cable winds. I've seen one mounted on a thick board hinged to the wall. It lay flat against the wall when put away up, and a leg unfolded from it when it was lifted making it into a horizontal drawbench. Chris Hentz from Baton Rouge has one made using a garage door opener. It has a long track (15 feet or so) which is anchored on the ceiling at the far end and drops down to use it. A simple rope and hook lifts it back up flush to the ceiling when put away. It is operated using a remote control…..

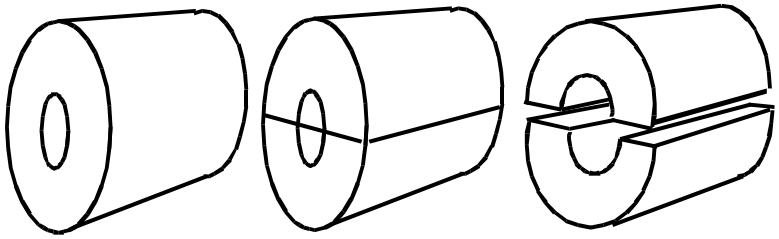


This is a picture of the winch in position on the far end of the bench. You can see that the draw tongs can hang over its end to get them out of the way and keep the top of the bench working surface clear until I need to use the draw bench. This winch was $15.00 on sale.

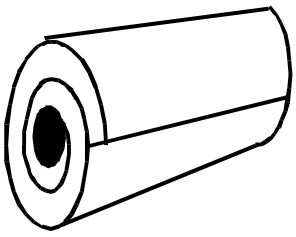
The larger hub
As mentioned above the way that the winch comes from the factory the central axle or hub that the cable winds around has a fairly small diameter. This means that in order to move the draw tongs the circumference of the hub diameter (less than 2" at its smallest) you have to turn the crank all the way around once. This means a horrendous amount of cranking to move the draw tongs any distance. The larger diameter hub means that one turn of the crank handle draws the tongs about ten inches or more and is much more efficient. On a boat winch this means you will have to find some way to increase the diameter of the hub for the cable or belt that draws the tongs to wind around.

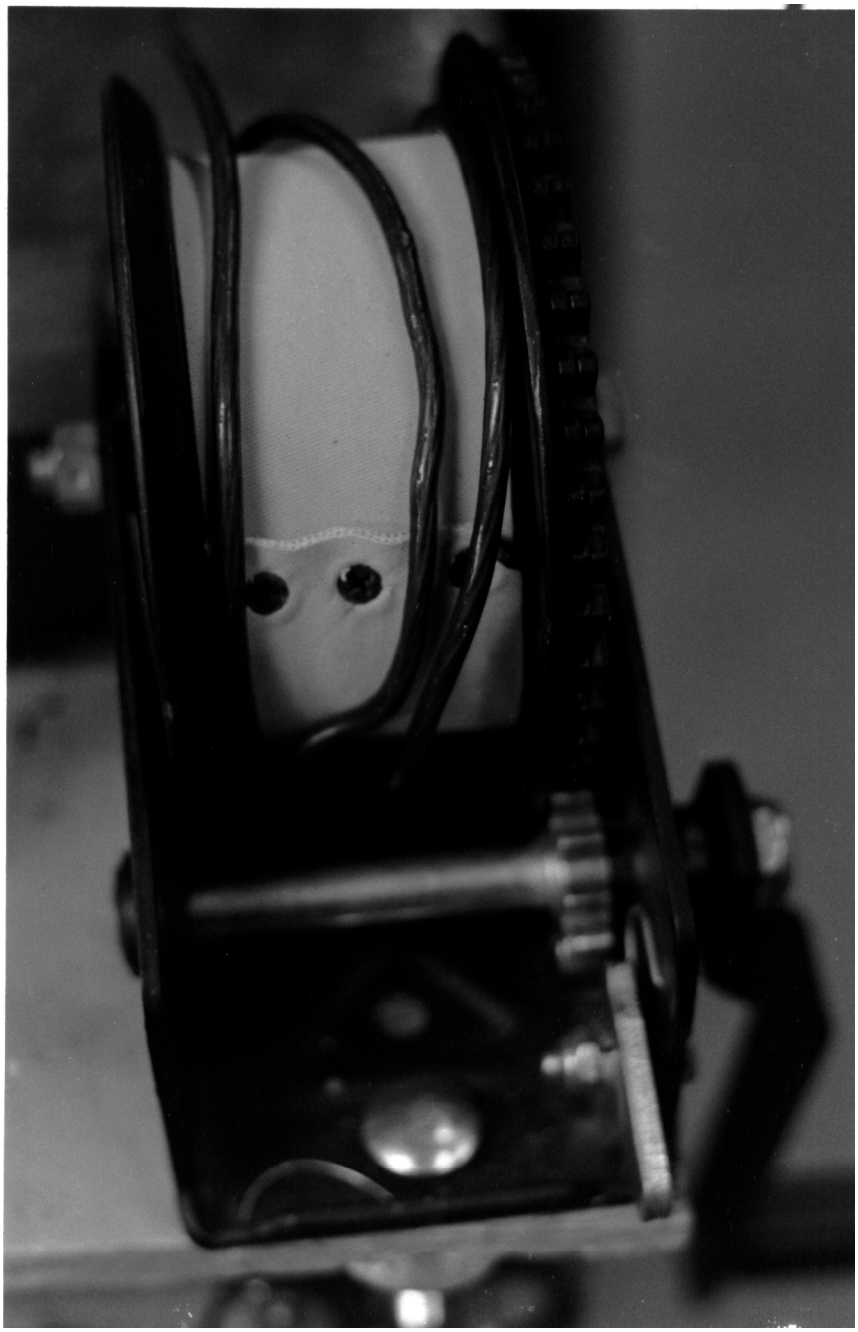
Boat winch Draw Bench

A wooden hub
I recently enlarged the diameter of a boat winch by having a turning made in wood which had a hole in it. After turning and drilling the hub was cut in half, fitted around the steel axle on the winch and then glued together again. It worked nicely.



A rolled up hub
I increased the diameter of mine with some heavy duty fabric belting I had which just fitted the width of the winch. When I had wound it on thickly enough I added glue to the outer layer where it touched the layer below and then sank drywall screws into the roll to fix everything in place. The cable itself was wound around the outside of this hub. You could even use duct tape to build up the axle if you wanted to, just wind it on (probably trickier than it sounds)

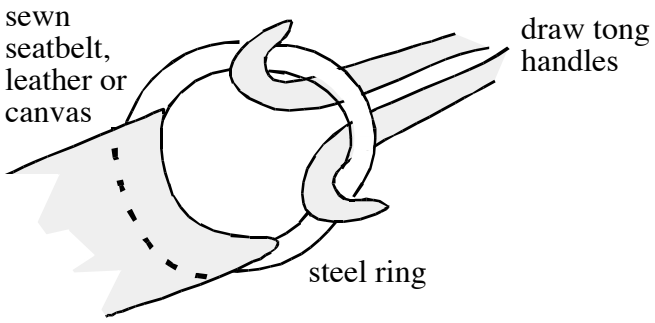




This is a picture of the fabric belting I wound around the axle of the winch and glued and screwed with drywall screws into place to increase the hub diameter on the winch. Note how few coils of cable are necessary for the fairly short drawing distance I chose for the draw bench.

Belt use
While I used a steel cable for mine a belt of some kind works well. A belt has almost no tendency to tangle or snap about when released suddenly in the way that a wire cable can. Traditional draw benches made from wood using a windlass often used a belt of canvas or leather which was wound onto the drum of the windlass to draw the wire. Because a belt is used that just fits the width of the spool on the winch it does not tangle. Seat belt material is designed for great stresses and is available very cheaply (or free) from car junk yards. Various other kinds of heavy duty straps can be used as well as long as they do not snap suddenly (that would be dangerous), and are strong enough to do the job without stretching (you don't want some kind of a rubber band under tension attached to your draw tongs when a wire snaps and things come loose).

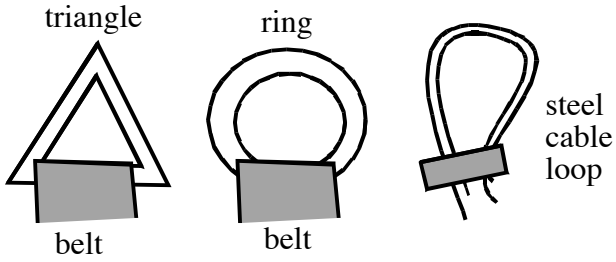
Seat belting (as long as it is close to the width of the spool on the winch) makes sense also because if you use a belt then it winds on smoothly and essentially makes its own hub to wind around, which saves you having to figure out how to enlarge the hub. You can sometimes find belting in climbing shops.



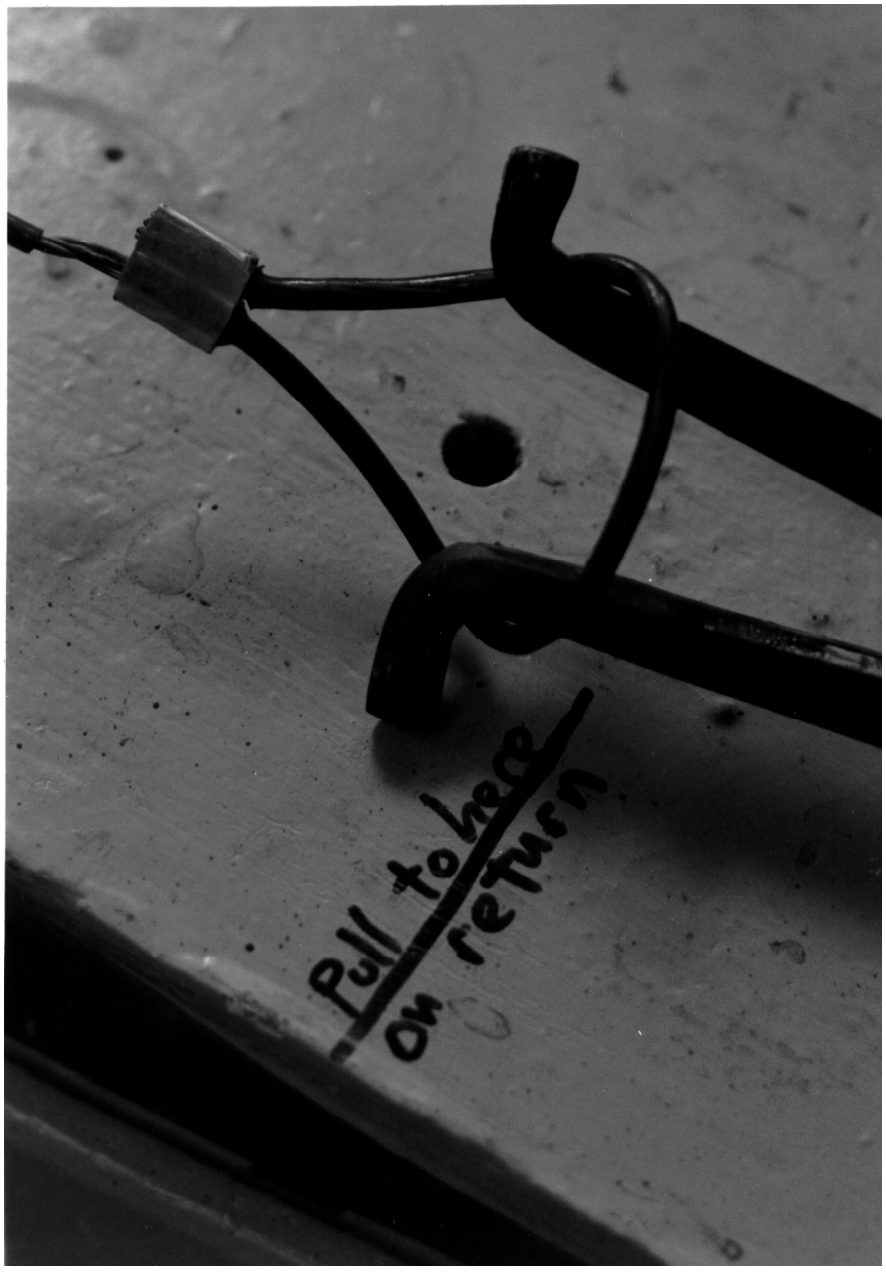
Cable use
I used a steel clothesline cable jacketed with plastic, primarily because it was cheap and available when I was looking for parts to use to build the drawbench with. You have to scrape the plastic off the steel where you want to lock it or clinch it together or it can slip (voice of experience).

The winches normally have a hole in them designed to anchor a steel cable end, which is an advantage of choosing to build it with cable and a large hub instead of with belting and no hub.

Where to get the tongs
One can buy drawing tongs designed for draw bench use which usually have the ends of the arms bent backwards so they are drawn together tightly on the pointed end of the wire by a ring, triangle or cable loop when you draw with them. See the drawing earlier that showed seat belting attached to a ring to see how the ends of the tongs should look.


triangle
belt
ring
belt
steel
cable
loop

I usually buy Indian made draw tongs for hand drawing which run about $17.00 or so. They have one bent over end and one end that is not bent over. You bend over the end of the tong to match the one already bent. Some people construct systems that use Vise-Grip® type pliers attached to a cable or belt as the draw tongs but I prefer ones built with the nice flat, slightly toothed, wide, parallel-meeting jaws of tongs designed for the job.

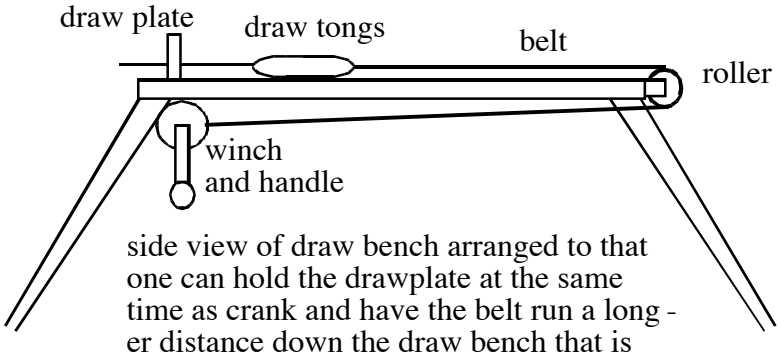


This is a picture showing how one draw tong handle end has been heated and bent over to match the existing one on the draw tongs. You can see how the steel cable has had the plastic jacket peeled back where it needs to be tightly clinched in place with the aluminum cable clinch. The clinch has been hammered around the steel strands to lock them in place. Note also the 'Pull to here on return' mark. This is drawn in on the table surface to let you know how far to pull the tongs back out again after a draw in order to position them correctly for grasping a wire end again though the draw plate.

How to change the tong handles so they clinch on the wire
Use eye protection when doing this procedure. Place the head of the draw tongs into a vise. Heat the place you want to bend with a torch. I usually hold a brick behind the steel that I want to heat up to speed things up by reflecting some heat onto it as well as using the torch flame on the area to be bent. When the area to be bent is glowing red you can grab the still cold very end of the tong handle with vise grips or something similar (you could for instant slip a close-fitting length of steel pipe over the handle end to form a lever to let you bend it over easily) and bend it over. The bends on each handle should be in the same place.

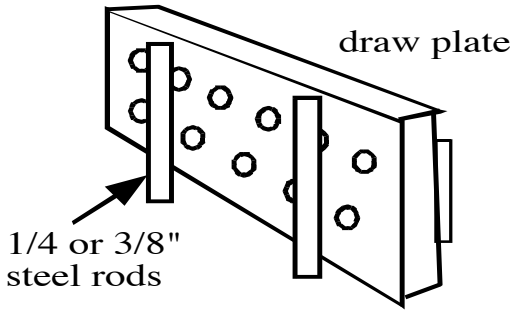
Distance from drawplate to winch
I like to have the draw plate in reach when I am winching, to hold the tongs in place or to hold things when starting to draw. This means that I like to set up the winch within reach of the draw plate, so the whole thing is perhaps four feet long or so.

A longer version for longer single pulls of wire or tubing can be built by incorporating a roller into the other end and mounting the winch on underneath at the end of the bench where the drawplate is located.



side view of draw bench arranged to that one can hold the drawplate at the same time as crank and have the belt run a long - er distance down the draw bench that is longer than ones arms can reach.

How the draw plate is held in position for drawing wire and tube through it
1/4 or 3/8 inch steel rods, round or square, are inserted into holes drilled into the end of the plank or bench where the draw bench is set up. They are sunk into the wooden top of the draw bench for the draw plate to rest against when drawing. The holes should be a good match for the rods. The top ends of the rod are rounded and smoothed off a bit so that you can't easily hurt yourself on them. They are driven in deeply, at least 2" deep for a nice solid stop. One can use long carriage bolts instead of steel rods. I have also used a nail behind them to keep the drawplate upright and in position.

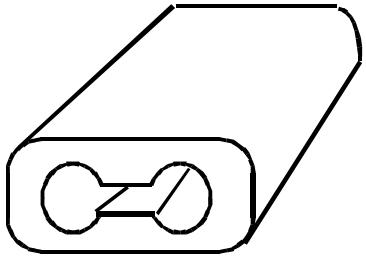


This is a picture of the steel rods sunk into the top of the table. You can just see the nail behind which keeps the drawplate from falling over when there is no tension on it. Some people like two nails or rods behind.

Vertical installation
I have seen a draw bench like this one built vertically on a wall, the winch at the top at easy height to turn the crank while standing and the draw plate holder down below. This used up less space than one that was up all the time. It was mounted next to a door frame.

Materials

A boat winch. Most have ratcheting gears. You won't use the ratchet when drawing.
Lag bolts to mount the winch with. Should be at least 1 1/2" long, can be longer. You can use long wood screws with washers instead of lag bolts.
1/4 or 3/8 inch steel rods, round or square, about 4" long. One can use long carriage bolts instead of steel rods.
If you choose **Cable** then get the length of steel cable (I like clothesline) you will need as well as cable clinching devices that the hardware store sells. Usually these are a kind of clamp. My favorite **cable clinch** looks like the picture below. It is made of solid aluminum. One bares the cable where it passes through the clamp, it is looped through and back as in the picture earlier of a looped end of cable, then it is given a few heavy whacks with a steel hammer to crush it into the strands and thus lock the cable in place. With cable you will also have to make a larger diameter **hub** on the winch and will need materials for that.



If you choose **Belting** then you will need to buy an appropriate size of belting to fit the width of the winch spool, and again, seat belt material has been recommended for low cost and good function. With belting you do not need to increase the diameter of the hub as long as you have enough belting wound on to get the belt winding on with within an inch of the outside of the spool. If you choose belting you may have to fold it over your ring or triangle and hem it tight yourself using a stout twine or even a steel wire to sew the belting together. A leather worker's awl may be useful to make holes in the belt to sew through.

Tools
Drill
Drill bits to fit the 1/4 or 3/8" rods
Drill bits narrower than the lag bolts used to mount the winch. You drill first, then screw them in place.
Hammer to tap rods tight into wood and crush cable clinch if using cable.
Wrench for lag bolts (or driver for screws if they are used instead)
Pliers to manipulate cable.
Separating disc to cut cable if using cable. You can also use large snips for this but the separating disc used with a flex shaft works very well to cut the cable.

Steps to build

1) Decide on place to install bench. Decide how it should be positioned for a left or right handed person. I like the winch on my left to I can use my right hand to position the draw plate and I am right handed. I did however meet one right handed person who liked it the other way with the winch on the right.

2) Install the winch on the bench top or plank. Drill holes, drop the lag bolts in through the mounting holes in the winch mounting plate. I have also used screws and washers to mount a winch instead of lag bolts. It can be easier to drive a screw in to a tight place than trying to torque a lag bolt in a hard to get at spot on the winch frame. I think I used screws and washers on my own version pictured in this paper.

3) If using **belting** attach the ring or triangle to the end of the belt. If using **cable** make your cable loop and clinch it tight. See the picture to get an idea of how large to make the loop. It is a 3 or so inches across.

4) Cut the cable or belt to the correct length to wind properly around the winch hub.

5) If using **belting** attach belt to axle of winch in any way you can. Epoxy may be necessary to bond the first layer tightly around the winch axle. Some axles on winches are designed to attach a belt to as well as a cable. If using **cable** attach enlarged hub to axle of winch and then attach the cable end. You may need to leave a little depression in your hub near the attaching hole for the cable. This is in order to be able to thread it in and lock it in place in the existing hole in the winch frame.

6) Decide on the final position of the draw plate holding rods. Drill holes for them into the bench or plank.

7) Insert and tap in rods so they are tight. Add nail(s) to support draw plate. Leave perhaps half an inch between nail and upright rod. Have the rods sticking out at least 2" above the surface of the bench.

8) Change the handle of the draw tongs if necessary so that they work in the triangle, ring or loop.

That is it, more or less. You should be able to draw immediately!

Appendices

Some hints on drawing wire

The trick to drawing wire by hand is to grasp the tapered end that sticks out the front of the drawplate with the pliers in such a way that there are some 5 mm of play; of movement back and forth to the drawplate. Push the draw tongs up to the plate so that when you start to draw there is a little movement before the wire begins to go through the plate. If it starts drawing with a jerk the inertia carries the wire on and as long as you keep on moving it will not break easily. If you don't start by using this jerk (usually obtained by bending the elbows and throwing your body back until it's weight going backwards starts the wire moving) it can be hard to start it. To find the correct hole to put the wire in next take the *back* end of the wire and test it in the front holes of the drawplate. When you find the hole it *will not* fit into then the correct hole is *the next one down*.

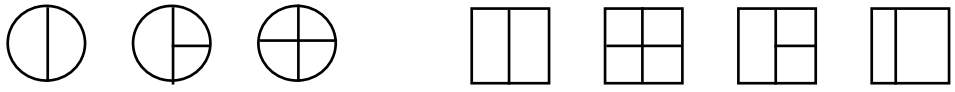
To make the taper on the end of the wire one may file a tapered groove into a flat slope on the bench pin, lay the end of the wire in it and rotate it while one files the wooden slope. This automatically generates a smooth and even taper and is how pinstems are tapered when one only has to do one or two.

An easier method of tapering which simultaneously hardens the point somewhat and prevents its breaking off easily during drawing is to step roll the point in the wire rolls of a hand rolling mill. Roll the end in slightly, back it out and put it in again at 90º to the first direction, then go to the next smallest hole and do the same thing only not as far in on the wire. Continue in this way until you have a smooth tapered point. Tubing too can be step rolled to get a taper on the end for drawing it. One can solder the tapered end for more strength.

People use either beeswax or oil as lubricants. I prefer oil.

If you need only a few holes of an odd shaped drawplate one can be made from an old file, annealed, drilled and burred and filed to shape. The holes must taper to the back and be as polished as possible. A flex shaft is useful for this work. One can however buy drawplates from companies such as TSI (see list) for 10.00 and less which with a little work with a toothpick in the flex shaft and some steel polishing compound can be made acceptable. Eventually one is better off buying a well made one. For larger sizes of tube a hard wood, nylon or Delrin® drawplate can be made for drawing down just a few holes.

One can obtain various shapes by using a square and round drawplate. The wires start out as either round or square and are drawn together with frequent annealings until the proper shapes are achieved. For example a square or round wire is flattened, folded over, soldered to close the 'loop' and drawn through a square hole in the drawplate to produce two triangular wires. One has to work with care to make this technique work well. One can make half round wire by rolling a round wire into a thick sheet of copper on the mill, the round wire then becomes a half round wire albeit with a slight texture to the surface.



round drawplate combinations ***square drawplate combinations***

The back of a drawplate also serves as a tool for shaping tubing to tapers, both square and round if one makes an appropriate mandrel for the hole. Note that the tool is not hammered

in but pushed. Your drawplate is worth more than a bezel forming tool so don't hammer into it. One can also "step draw" both wire and tubing by drawing to a certain point, pulling it back out the way it came in from and then going to the next smallest hole and repeating the process. Richard Mawdsley uses this technique to very good effect in producing stepped tubing for his complex constructed pieces.

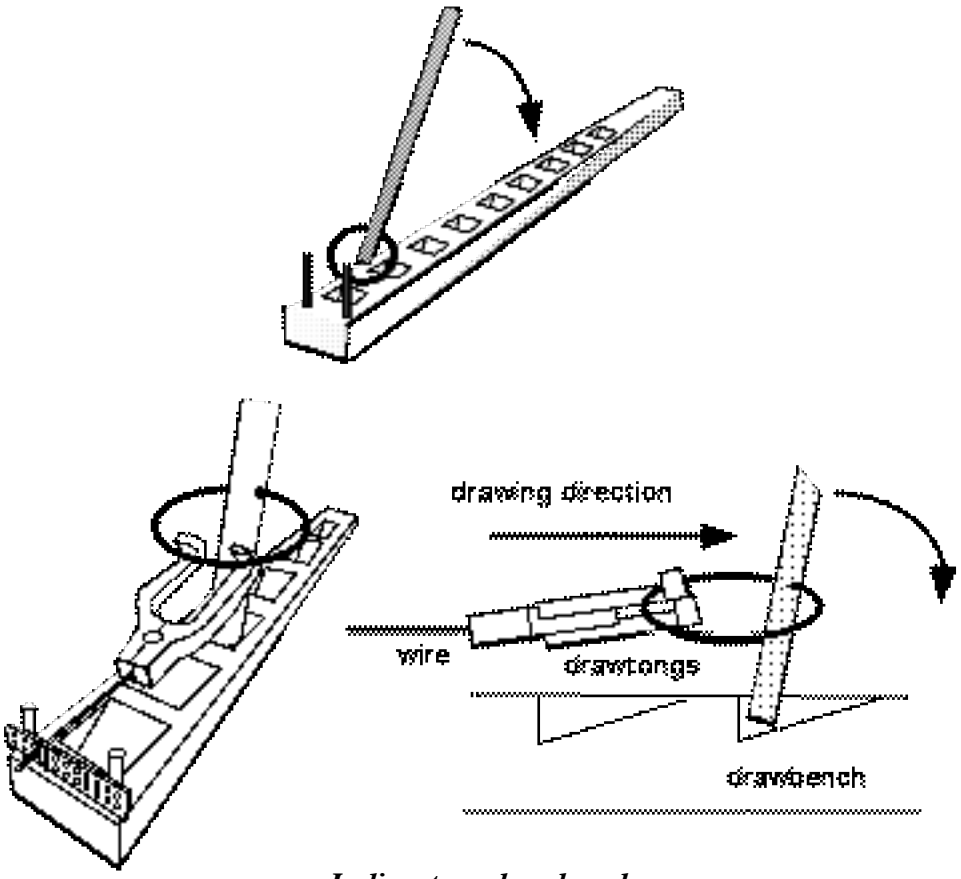
A simple wooden device may be constructed for holding draw-plates on the end of a workbench or it can be as simple as two steel rods inserted in the bench to pull against. This frees the vise for other uses.

In many cultures one sits on the ground, draws the knees up, places the drawplate against your feet and then straightens ones legs to draw the wire. Leg muscles are much stronger than arm muscles and it is quite effective.

Other kinds of drawbenches

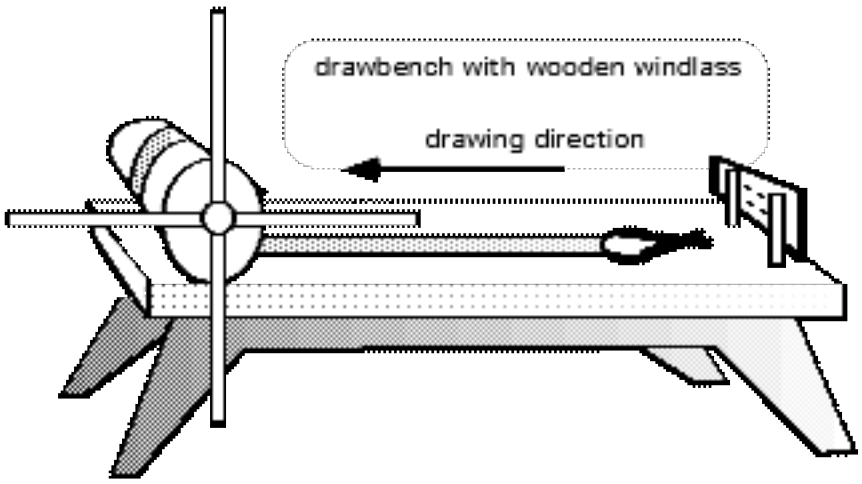
Most commercial draw benches, both hand powered and mechanized use a chain into which the draw tongs attach. The chain runs around a bed of some kind and is operated by a winch handle. And boy those powered ones can be scary-you drop the latch of the tongs into the moving chain in a production situation to engage the drawing action-I was always terrified using one and much prefer a hand powered one.

There are Indian-style draw benches, such as in the following drawing, which use leverage and a ratcheting motion to draw tube and wire on a carved plank on the ground. A long lever has a steel ring attached to it near its bottom end. The draw tongs are held tight and drawn by the steel ring. One lever from one hole to the next in the board to draw with it.

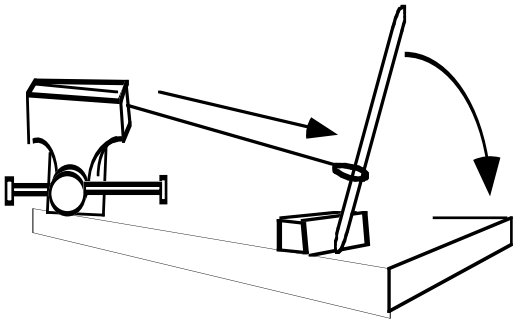


Indian-type drawbench

There are draw benches that can be built out of canvas and leather, wrapped around a drum. One uses a tool like a windlass to turn the drum.



One can straighten (and even draw for short distances) wire very effectively by using leverage in a method similar to the way Indian goldsmiths draw wire. One clamps one end of the wire in a vise and makes a small loop at the other end. Then you take a rod and lever against a wooden block attached to the bench top.



Homemade drawplate alternatives

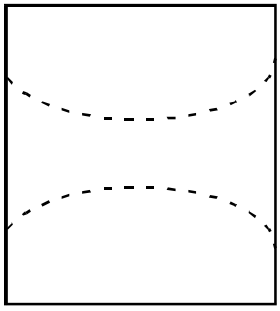
When drawing tubing, there is not necessarily that much pressure against the drawplate, and because drawplates in the larger sizes that are required for tubing are very expensive, it can be an option to make your own drawplates for drawing tubing. One can draw tubing and wire using a wooden drawplate made from a hardwood such as oak or maple or a plastic like Delrin, Nylon or Corian. If one has access to an old sailing tackle block of lignum vitae or ironwood then one can make a good wooden drawplate. Homemade drawplates can be made by drilling through a steel plate and then enlarging the hole to create a taper. I don't recommend this option unless you really have to use it—it is a great deal of work to do. Obtaining tubing drawplate hole sizes are about the only reason you would consider doing this as the accuracy does not have to be as high on the tapers used for drawing tubing as they do with holes for wire.

One can always do as the blacksmiths do, and as most drawplates in Asia are still made—that is, you take a piece of thick steel sheet (often an old file is used), you heat it up red-hot, and with a long, thin, tapered punch, you drive a hole right through the steel. The

punch is immediately jerked back out and cooled to avoid losing its temper. Because you're using a tapered punch, this gives you the taper for the drawplate instantaneously. The plate then has to be properly hardened and tempered.

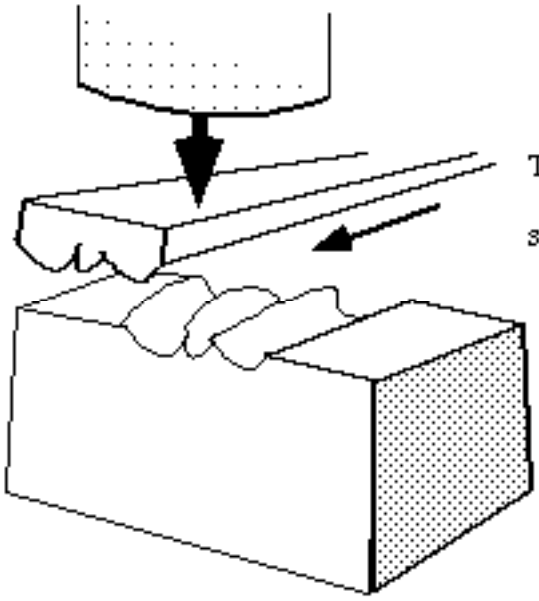
Swages

Swages are a form of die for making wires of odd cross-section. They are like having a single shaped hole in a draw plate but each half can be moved closer together or apart as metal is drawn through it or hammered by the swage to shape it. Shaped rods and wires with complex cross sections can be made by swaging them. many swages are operated by hammering them over a wire or a wire into them. Swages may be made from high-carbon steel and should be curved slightly towards the bottom on each side and edge. They should be highly polished.

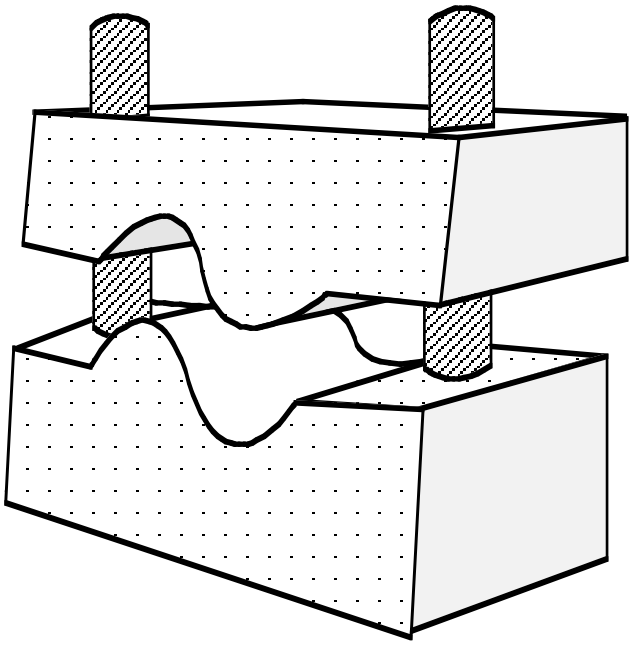


side view of swage, note the curve, ideally with a flattish area in the center of the swage

Metal strip may be hammered right into a single part swage as it is moved steadily through it by hand to obtain a complex cross section.



If a piece of steel is clamped over the wire and tightened repeatedly as the wire is drawn through the swage a smoother effect is produced than with the hammer. Here is where the draw bench becomes useful. The kind of swages used with a drawbench need registration rods as well as a way to tightening the top upon the bottom as the wire or sheet is drawn through it. In the drawing that follows the rods are threaded and the only thing missing from the drawing is large wind nuts or other nuts to force the top down upon the bottom as one draws the material through repeatedly.



Note that last part, and remember that swages were a popular method of creating complex mouldings and gallery wires back when labor was cheaper, rolling mills were not all that common and there were apprentices around to do that kind of work. If one were a silversmithing shop using a lot of such molding wire and sheet it would be worth investigating swages.

German companies produce four sided roller swages which allow one to draw any combination of two flat sided wire or narrow sheet from 1x1mm up to about 2cm x 2m, or 2cm x 1mm, whatever combination one wants. Each roller can be set differently to allow numerous square and rectangular cross sections to be drawn. The drawback seems to be fiddly resetting time-but definitely a cool tool (always wanted one).

Hints on making tubing

Not all sizes and wall thicknesses of tube come seamless from a factory or refiner. Especially when working in gold it is not cost effective or timely to order in a specific tube size, material, or wall thickness. There are many times when you need a piece of tubing, you don't have it, and you can't wait a day or so to order it in or run across town and buy it. In general, it is possible to make the length of tubing you require for an object in about fifteen minutes. When compared with the time required to go across town to buy the tube, or order it in, as well as paying more than the cost of the material for the privilege of buying ready-made tubing, it is clear that making your own is a cost-effective, rapid way of obtaining it. When you need very thick walls it is particularly important to be able to make your own tubing.

To make tubing you have to define your needs: what wall thickness what outside diameter what inside diameter what material type you need. Did you plan for the material and structural requirements when in use in your hinge?

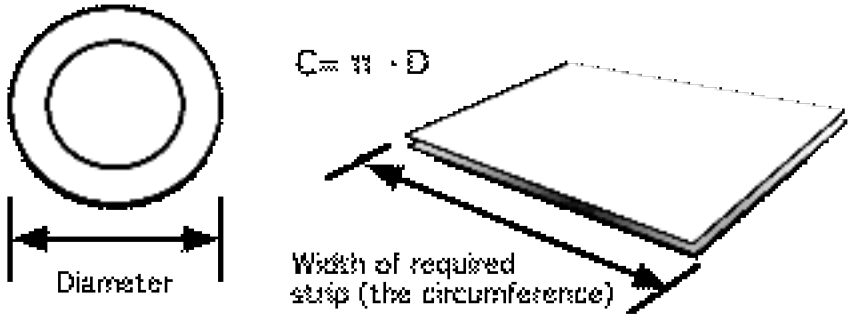
Some goldsmiths keep a few sizes (generally larger ones) of gold tube in the shop and then rapidly draw it down to the sizes they need when a job comes up. This saves having to buy a large selection of sizes to have on hand.

You will also need some tools for drawing. Drawplates in larger sizes are essential. They should be steel and are rather expensive. For very occasional use a wooden draw plate, or brass, delrin or nylon may be used. Best is a proper steel one. While one can draw tubing by hand, in the larger sizes and thicker walls it is really pleasant to have a draw bench.

Because, for all intents and purposes, the wall thickness of a tube does not change during drawing, unless you're down in the very small sizes, you start out with the wall thickness on you want to end up with. Only when a tube has been drawn very small (for example, with an inside diameter of less than 0.5 mm) does the wall thickness appear to change and begin to thicken while drawing the tube.

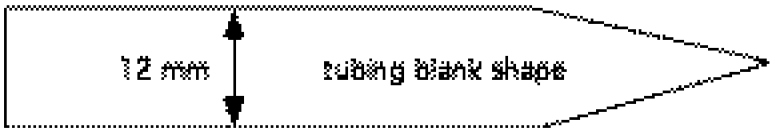
Let us assume then that I wanted a wall thickness of one millimeter on a tube with an outside diameter of 3 mm. I would first determine the circumference of a 3 mm diameter tube. C (circumference) =π x D (diameter) so we would multiply 3.14 times 3 to obtain 9.42 mm (π=pi=3.14 more or less). This represents the minimum width of the blank required to make the tube. The sheet used would be 1 mm thick.

$$C = \pi \times D$$
$$C = 3.14 \times 3$$
$$C = 9.42 \text{ mm width of blank.}$$



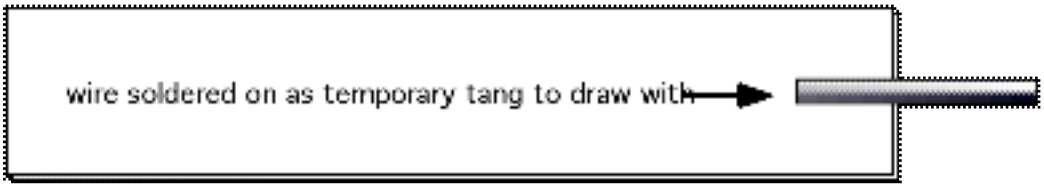
In order to have a nice round tube and get a reasonable length with a tightly drawn seam we start bigger than this so I might choose a blank width of 12 mm or more. We have to plan for some material for a tang to draw the tube with and so we will make the length of our blank at least as long as the final desired length of the tube, plus the tang length (if not longer). The end of the tube to be drawn is cut at a broad taper, and the sides of the strip that we are going to be using to make the tube are parallel.

It is pretty much the same amount of work to draw a short tube as a long tube so you might as well make it quite a bit longer than you need, so that when you draw the tube, you get more than you need, and so develop a stockpile of tubing in various sizes and wall thickness in the process of doing the work you were doing anyway. Often with tube making it is worthwhile making a much longer tube than you need, and cutting off 2 inches. (5 cm) from the back every few holes as you draw it down. In this way you end up with a great selection of tubing in graduated sizes. This is particularly worthwhile with thick-walled tubing. An important principle: always make more than you need—it is the same amount of work and you will need some more tubing at a later date.



actual tube width we will start with

Sometimes, particularly with precious metals such as gold, one doesn't feel like utilizing material for the tang, which will just end up as scrap, so one can take a small piece of brass or even silver wire, and solder it onto the end of the rectangular blank from which one makes the tube. This will serve as a tang to draw with. For gold and similar costly materials it can be a good idea to avoid some wastage by soldering on a wire of a less expensive material instead of making a taper to draw the tube with.

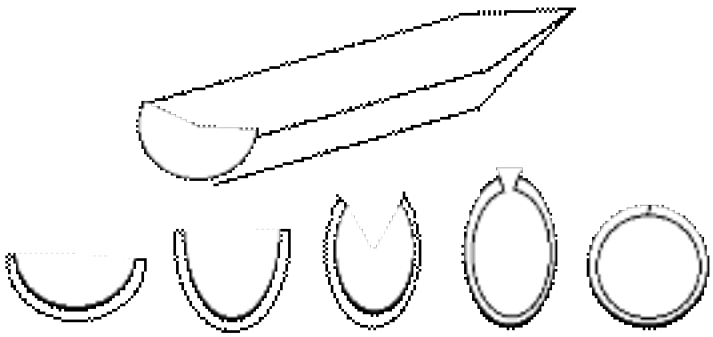


When all is said and done, and the tube is finished, you unsolder that small wire tang, and this way you didn't have to use up some of your gold in a tang for drawing. If I do this I will taper roll the wire and tube beginning to blend them into each other. Roll the end in slightly, back it out and put it in again at 90º to the first direction, then go to the next smallest hole and do the same thing only not as far in on the wire. Continue in this way until you have a smooth tapered point.

Tubing, too, can be step rolled to get a taper on the end for drawing it. You make the tube without any taper to the blank. Then you taper the end with the wire rolling mill as described above. This gives you a solid tang to draw with but the tang material becomes scrap at the end of drawing. One can solder the tapered end for more strength while drawing.

I like to shape my tubing blanks into wood–that is, that I will take a stump and I will use a forging peen, or the peen of my bench hammer, and make a groove or dent into the endgrain of the wood, then shape the tube into that to obtain a half round cross-section. I don't like to use commercial tube-shaping swage blocks, which are steel blocks with half round grooves in them, because I find that they tend to damage the sheet metal of the tube quite a bit during the making. So, again, for me, it's a wooden shape of some type that I form into. The blank is tapped into the groove using the hammer, and rolled sideways while tapping onto it, back and forth, so that the sides of the groove form the metal around the hammer at the same time as the hammer is pushing the tubing blank into the groove. First of all, we shape it into a "U"–shaped cross-section. It is at this point that we can "true up" the two sides of the blank they are now in the same plane and so we can file down the length of the blank, evening up both of them simultaneously.

When you hammer and shape, don't make small dents or nicks you want the shaping to be as smooth and un-bumpy as possible. After you have reached the "U"-shaped position, you then begin hammering at about forty-five degrees to the edge of the trough. You hammer gently while rolling the blank back and forth until the cross-section of the tube becomes somewhat pear-shaped, perhaps even a little bit teardrop-shaped. At this point, we can tap it so that it is more or less round, and we can begin drawing it through the drawplate.

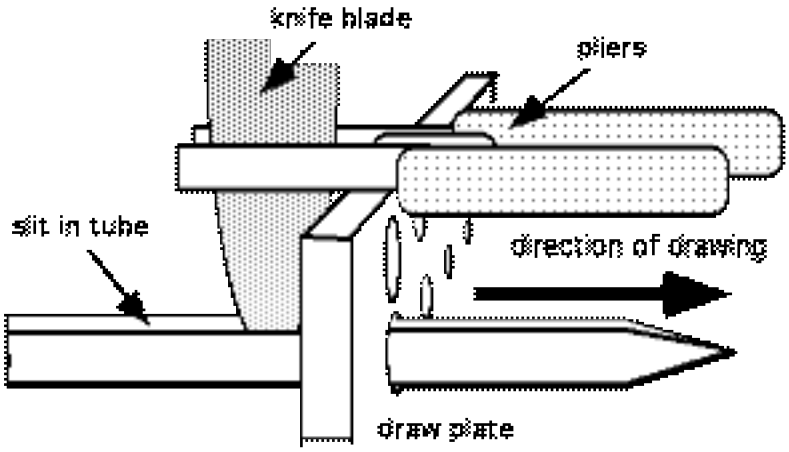


tubing cross sections as it is being prepared for the draw plate

It's perfectly possible to draw tubes under about five or six millimeters in diameter by hand, but for over this size, or for tubes with a very heavy wall thickness, such as a two millimeter wall (which is something that one does sometimes) it is preferable to use a draw bench of some type. We draw the tube through the drawplate until it is smooth and round. At this point, I stop, and I will inject a watery flux solution inside the tube until I see flux run out the bottom of the tube to make sure that the interior seam is protected, then I flux the outside of the tube, and anneal the entire thing. This releases any stresses built into it from making it, and the gap, the seam, will open slightly. Rinse it off with hot water to dissolve and remove flux residues—do not pickle it (we don't want a pickled finish inside our seam because solder does not like to flow onto pickled surfaces)—and then draw it through the last hole that it went through in the drawplate, just to tighten it up. At this point, the seam is tight—as tight as it's going to get—and you have just removed all stresses by doing the annealing procedure. Then re-flux the interior of the tube with a syringe as before, flux the outside as well and solder it, if it's going to be a soldered tube. When drawing it down further, to find the correct hole to draw it through next, take the back of the tube and try and push it into the hole you think is right. When the tube will not go in then the correct hole to use is ***the next one down***, the next smallest hole.

After soldering, any spilled solder is cleaned up, the tubing is pickled, and then it is drawn further until you have reached the outside diameter that you require. One of the things you have to watch out for in making your own tubing is having overlaps of the seam, so when you're closing it up with the hammer, before you even begin to draw, make sure that everything is nice, clean, that the seam consists of even butt joints, and that you have no overlaps occurring.

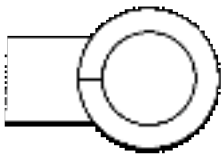
Another thing that can sometimes occur, is that during drawing the tubing twists, so that your seam is not a straight line down the length of the tube, but in fact twists or spirals around the tube, which is not a happy situation. The way that you fix this is, while you are drawing it, you place a butter knife, held carefully, clamped securely with pliers, in front of the drawplate, and insert the knife into the seam of the tube at the same time as the tube is drawn. A sharper knife may be used but this adds an element of danger to the procedure that is not necessary. Drawing the seam of the tube along the knife automatically straightens it rapidly into a single, even, parallel line down the length of the tube.



Straightening a seam on a tube while drawing it.

A warning: if you press down too far with a sharp knife, you'll end up with two lovely half-tubes—I've been there, done that.

For much hinge-making, we don't, in fact, use soldered tubes, because, if you do, then when you install the tube into your hinge, you don't know where the seam is, and usually it's in a nice, open, wrong position, and the solder flows out of it during the solder job, and then you're left with a visible gap or a seam. So, if we're going to be using tubing for hinges, often we do not solder the seam until we're actually installing the hinge knuckle in place, and during that installation, the seam is then soldered closed at the same time as the tube knuckle is soldered down, combining both steps and ensuring that the tube seam faces inwards and so is hidden on the finished piece.



Tube seam faces ir

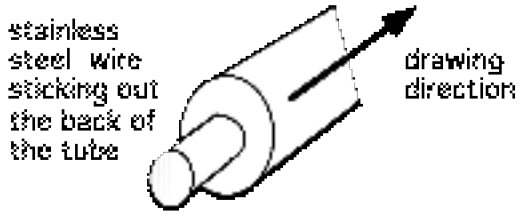
Drawing thick walled tubing

Thick-walled tubing has special applications for hinge-making, and there are some silversmiths' hinges that only work if they're constructed with very thick-walled tubing. Certain bracelet hinges, too, require that the walls be quite thick and strong in order to have the bracelet function, or the catch function, as will be seen in the discussion of hinge-based catches. There are some hints for drawing thick-walled tubing. When drawing thick-walled tubing, it helps to have a draw bench for the extra force that's required, and the sheet metal thickness that you start out with is, more or less, the wall thickness of the tube that you end up with. Definitely start with a fairly large diameter tube it is much easier to make the tube that way and you end up with a lot more tubing. Again, for the larger sizes, wood, Delrin and homemade steel (even unhardened) drawplates will work. All you need are tapered holes in the plate. As always make sure there are no overlaps at the seam.

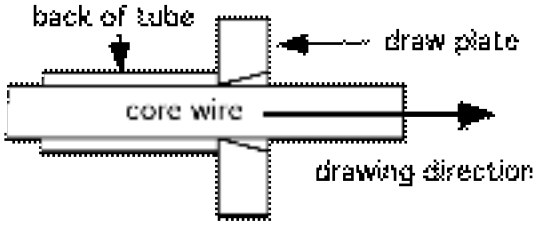
Drawing wire inside

Sometimes a solid core is used to obtain a fixed size of hole in a drawn tube. When the inside diameter needs to be a very exact size, goldsmiths will draw a wire inside the tube at the same time as they're drawing the tubing down. Usually you draw a tube with a core in it only a little bit (through just a few holes) unless the core wire is much harder than the tube

material, as softer cores can bind really effectively into a tube when drawn together. If you use a core, make sure that a good portion of it projects out the end of the tube being drawn so as to allow you to grip it and draw the core wire out again when done. A steel core wire is best as core wires of softer materials may bind and snap off when you are trying to withdraw them at the end. I like stainless steel the best for this.



It can also help to lubricate the core wire with oil or graphite (a pencil lead) prior to drawing to ease its eventual removal. A polished wire core helps as well. The way that it would be removed at the end, is by placing the back end of the tube against the drawplate with the wire that's inside fitting through a hole in the drawplate, and then drawing against the drawplate to withdraw the wire from the tube. A very good selection of hard-drawn, high-polished, stainless steel wire in a number of sizes is available from Small Parts Ltd. (*see sources*).

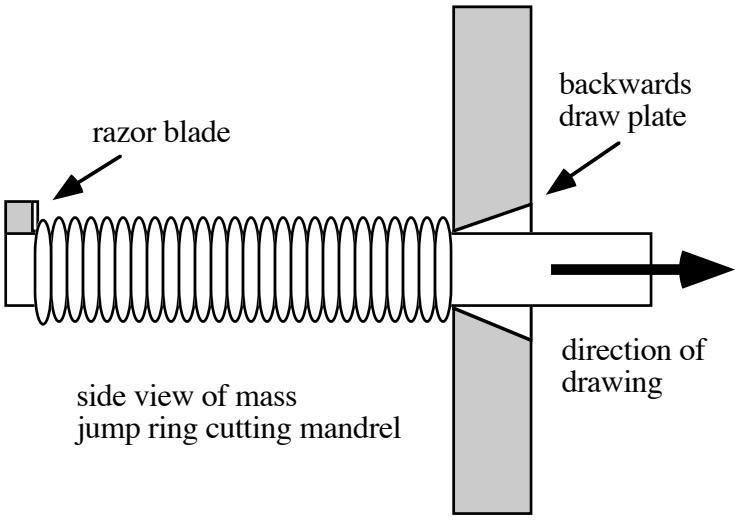


Removing the wire core from the tube.

With a gold tube it is also possible to use a core wire of copper or aluminum which is then etched out at the end of the drawing procedure. This procedure is, however, time-consuming and involves **dangerous** acids or caustic chemicals. Nitric acid, ferric chloride or even hydrochloric acid are used for a copper core—depending upon which acid will not affect the material of the tube that you drew around it: hydrochloric acid or sodium hydroxide (lye) for an aluminum core wire. I have heard that people who have done this got so impatient with the speed of the core removal that they drilled a number of holes into the tube at different places to allow the acid access and then had to plug the holes afterwards. So in general, I don't recommend attempting to remove a wire from inside the tube with acid. I think that if you have to resort to this approach, there is probably something wrong in your design process and you should be able to avoid this situation by more careful planning. Any acid use would require proper safety equipment and chemical handling experience.

If you do use a steel wire—not stainless, but ordinary steel wire—as a core, for drawing inside, and if it by chance breaks off—and yes, I've seen this happen—then we can remove the steel from inside by simmering the tube, if it is a silver or gold tube, in a very concentrated solution of alum and water. You purchase the alum at the supermarket—it's in the pickling section—you make this concentrated solution, you simmer it, and the iron will be eaten out. This method is also used for removing drill bits when they break off inside a piece of jewelry.

Cutting jump rings using your draw bench.
A method of mass-production cutting of jump rings is as follows: one can cut them all at once by taking the drill rod, sawing into the end a bit, soldering in a razor blade or matte knife blade so that it protrudes on one side only (it protrudes only a millimeter or so) and then putting the drill rod through a draw-plate hole of corresponding size, backwards, and drawing it. The drawplate presses the wound rings onto the blade which cuts them. A bottle may be placed around the drill rod to catch them. I learned this one from Christian Gaudernak from Norway.



A lesson in step drawing

One requires a taper on the end of the wire to grip it with when placed through a drawplate for drawing. One may obtain this taper in several ways.

If a notch is filed into the flat slanting slope of your bench pin then the wire and the end to be pointed may be held hard in the notch. The lower end of the notch should be as deep as the thickness of the wire. Then with a 15-20 cm long flat file one files across the surface of the wood and rotates the wire at the same time as filing. Do not lift the file from the wood on either stroke direction. The wood steadies the file as the wire end is turned under it. The groove automatically makes a taper on the end of the wire. Other options include using a belt sander, a sanding disc and so on.

The end of a wire or tube can be tapered and pointed by *step drawing* it. One uses the hand wire rolling mill for this. Set the wire mill rolls tightly together, but not so tight that turning them with the handle is affected.

Take the end of the wire or tube that needs pointing and place it into a wire mill hole that is barely too small for it. Roll the wire about 2cm into the mill.

Reverse the direction of cranking and roll the wire or tube back out.

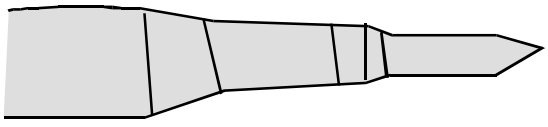
Turn the wire or tube 90º, insert it into the same hole it was just rolled in and roll it in and out again the same distance. By doing this one flattens any flange or burr that might form from the wire mill. Any time one uses the wire mill the wire or tube end must go through every hole twice at 90º for the same reason.

Place the wire or tube end into the next smallest hole and crank it in, but only about 1.5 cm this time. The same procedure of reversing the rolling direction to back it out, turning it 90º, back in and then out is repeated with this hole, but always to 1.5cm.

This is then repeated in ever smaller holes and in each hole the wire or tube is inserted less far thus creating a series of ‘steps’ on it. The overall effect is to produce a tapered, work hardened wire point. The work hardness helps prevent the tapered point from breaking off while drawing it.

This method of rapidly tapering rods is used to good effect as a production method of forging metal into tapers. For example one can step roll and taper a thick rod at each end to use it for a bracelet. One then uses a planishing hammer to smooth the surface and sands it before polishing it. The product is identical to one made by hammering the metal out into a taper by hand.

While the procedure above refers to using a rolling mill's wire roller one can step draw both wire (not worth it for the work in my opinion) or tubing to have it in discrete steps or a more tapered look.



this is sort of what the step drawn point looks like

Maximum usable degree of deformation between annealings in silver alloys. ***(Brepohl)***

Designation	Degree of Deformation in %	Designation	Degree of Deformation in %
Ag 925	70	Ag 835	60
Ag 900	65	Ag 800	55

Maximum usable degree of deformation between annealings in gold alloys.

Designation		Degree of Deformation in %	Designation		Degree of Deformation in %
180	Au 750 yellow	65	1406	Au 585 red	75
1803	Au 750 medium	60	14 W1	Au 585 white	40
18 W	Au 750 white	55	807	Au 33 pale yellow-green	60
1407	Au 585 pale	85	806	Au 333 yellow	50
1401	Au 585 yellow	55	801	Au333 yellow (Ni)	40
1403	Au 585 medium	60	808	Au 333 medium	55
1404	Au 585 medium	60	811	Au 333 orange	55
1405	Au 585 orange	55	811	Au 333 red	55

Trouble shooting when rolling sheet metal (as when making tube blanks)

Symptom	Cause	Remedy
The sheet is warped	Irregular roller pressure (Center is worn)	Anneal and planish the part of the metal that has not been stretched enough. The rollers should be turned down to dress them.
The sheet is warped	The direction of rolling was changed without annealing.	Anneal and planish the part of the metal that has not been stretched enough.
The sheet curves to one side.	The rolls have more pressure on one side: The rolls are worn on one side or the regulating screws are tightened unequally.	Have the rolls turned down to dress them. Equalize the screw positions.
The metal cracks on the edges.	An unsuitable ingot mold The material has been stressed beyond it's breaking point. The material has impurities in it. There has been large grain formation caused by too-frequent annealing.	Open the cracks out broadly with a saw and anneal. Re-finish the ingot mold. Re-melt and purify the metal.
The sheet is heavily cracked, brittle, has mosaic-like crack formation.	Usually the metal has impurities or else exceeding the breaking strength or large grain formation.	Re-melt and purify the metal or send it to the refiner.

From: Page 179, "Theorie und Praxis des Goldschmieds" by Erhard Brepohl. Published by Fachbuchverlag Leipzig-Köln, 1994