Making a Rack

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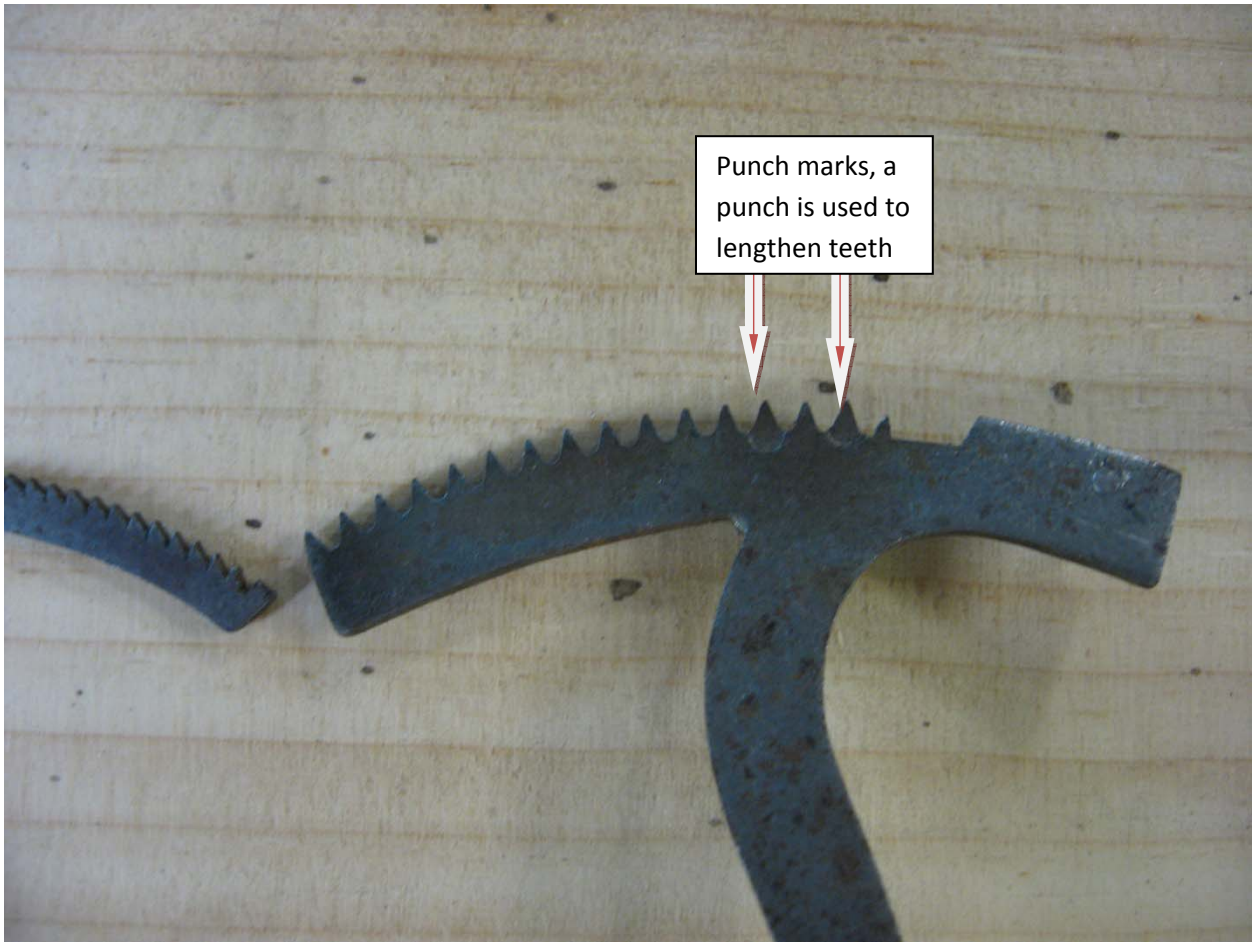
Making a Rack

The making of a rack is one of the less obvious and less intuitive jobs one may face in a clock shop or hobby shop. There are few people who make them these days. Even the gear cutting specialists stateside tend to avoid offering such services, at least openly. For what reason I am unsure, I net as much per hour cutting racks as anything else I do in the shop, frequently better.

For those in the audience who find the concept of making a rack to be onerous, I suggest that making a rack is no more difficult than cutting any other clock wheel. And therein is the whole secret, the rack is no more than segment of a wheel. Treated as a wheel, indexing the blank as a wheel, and using an escape wheel or ratchet wheel cutter, a proper rack can be made no more than a couple of hours.

Why would we want to cut a new rack when we have the old one you ask? I suspect many of you have seen the broken / filed / hammered / soldered / rusty / worn originals that come in the door. They have been poorly repaired so many times they are past salvation and cutting a new rack is easier and is a better solution than messing further with the old rack. There have also been examples of bad original work where tooth spacing was poor from the start and wear / time and other poor repairs have made the rack unreliable.



Example of a "hammered and punched" rack

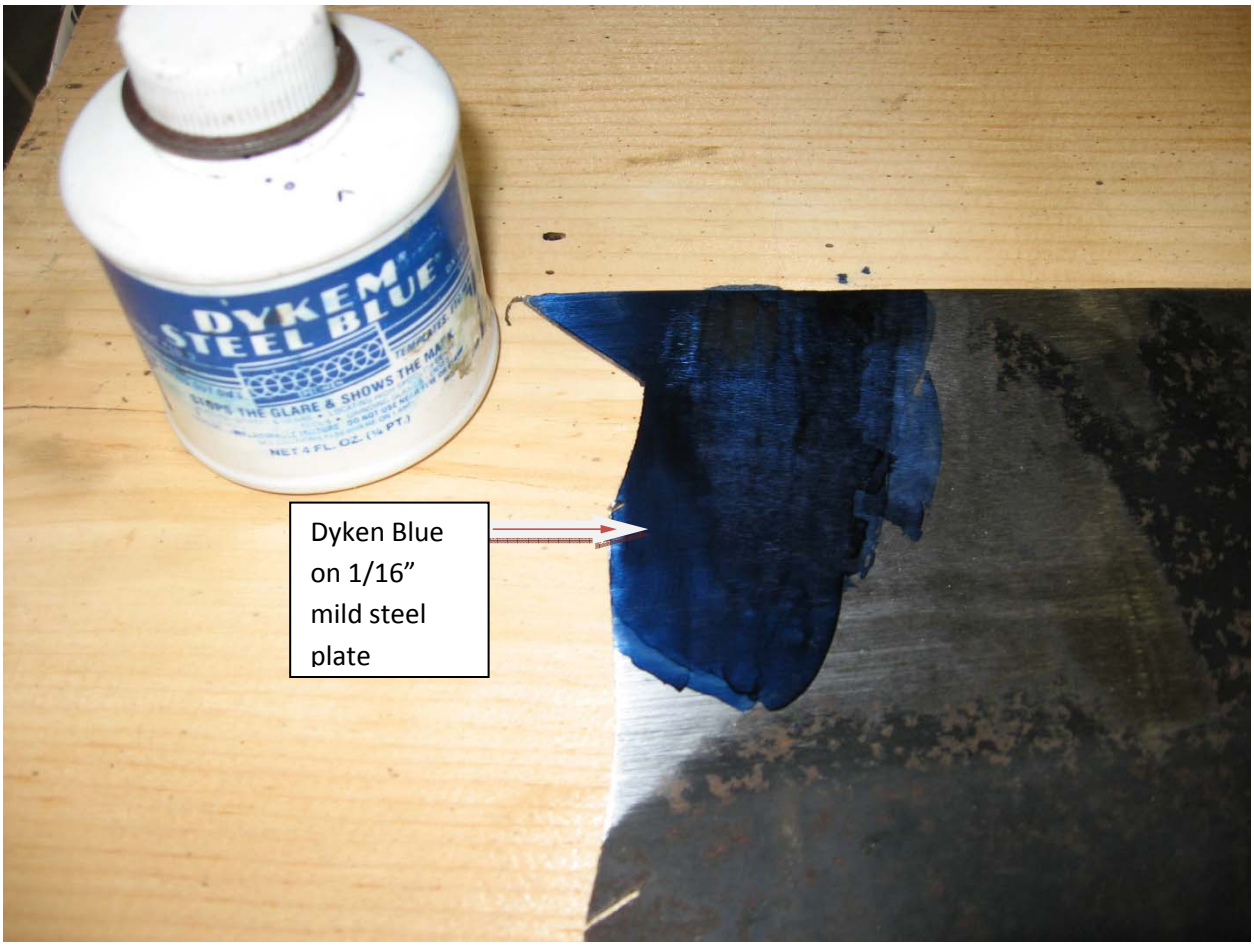
For purposes of this discussion we will work in "inches" not mm. Why? Generally, because most of my equipment is calibrated in inches, and that is the system I grew up with. Everything we will discuss will translate directly into mm, so nothing is lost by my reticence to move to a better system.

The making of the blank is certainly easier if you have the old one as a starting point. Let's assume in this case we do. We can discuss later how to proceed if we do not have an example to work from.

1. From the old rack we need to trace the geometry onto our new rack material. I personally like and generally use 1/16" mild steel. While racks for carriage and many European clocks are pretty consistantly

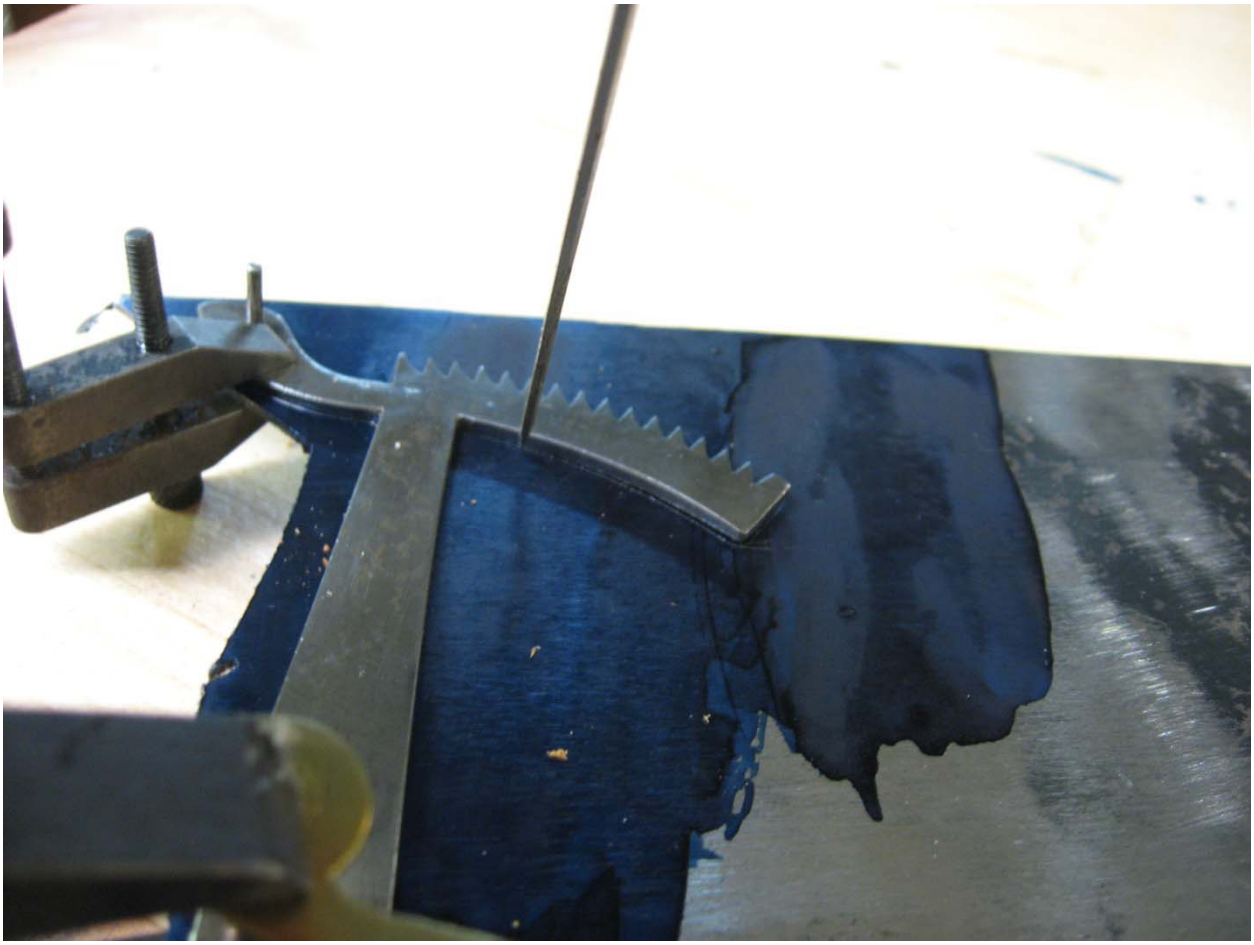
brass, most tall case clocks use steel racks, and for purposes of this demonstration steel is what we will use.

2. The outline of the old rack as well as the center pivot point should be transferred to the new rack material. I like to use layout blue like this:



Layout of new rack

Example of Dykem Blue compound on the material and scribe around the old rack with a very sharp and very thin scribe.



Scribing the outline of the original rack

The intent is to accurately transfer the outline of the rack. Do not attempt to mark out the layout of the teeth in this fashion, just mark the tip of a “good tooth” as a reference point, the first tooth is preferable.

a. Center punch the pivot point of the blank

b. Using a compass scribe an arc approximately .015”-.025” larger in radius than the longest tooth you marked in step 2
c. Mark carefully the position of the first tooth of the old rack on the new blank

3. Using whatever method you prefer cut out the blank to the scribed lines. Options may include
   a. Jewelers saw
   b. Powered scroll saw
   c. Metal cutting bandsaw
   d. Mill
   e. CNC mill

As an aside I have frequently used a CNC mill to make the blanks, if I were making several of the same size, I would certainly use the CNC mill. However, 99% of what I do is restoration work, and “something is always

different" between racks, so I tend to find the bandsaw much quicker to rough out a single blank. The bandsaw used in this case is a Chinese made device that I bought for less than $200 USD 20+ years ago. It has paid for itself many times over by reducing a lot of manual effort to the flip of a switch. It paid for itself in jewelers saw blades I didn't break in a matter of months…..not to mention the 2" angle iron cuts made while I making electric rewind mechanisms for tower clocks. For this particular rack example I roughed out the blank in 7 minutes on the bandsaw and spent 2 more minutes on the 1" belt sander taking off some rough spots that offended my sensibilities. There was no need to "clean it up" until finished, I just wanted to and did so. If I trash it, it was a wasted few minutes.

Rack blank as completed by sawing on the "el chapo" band saw.

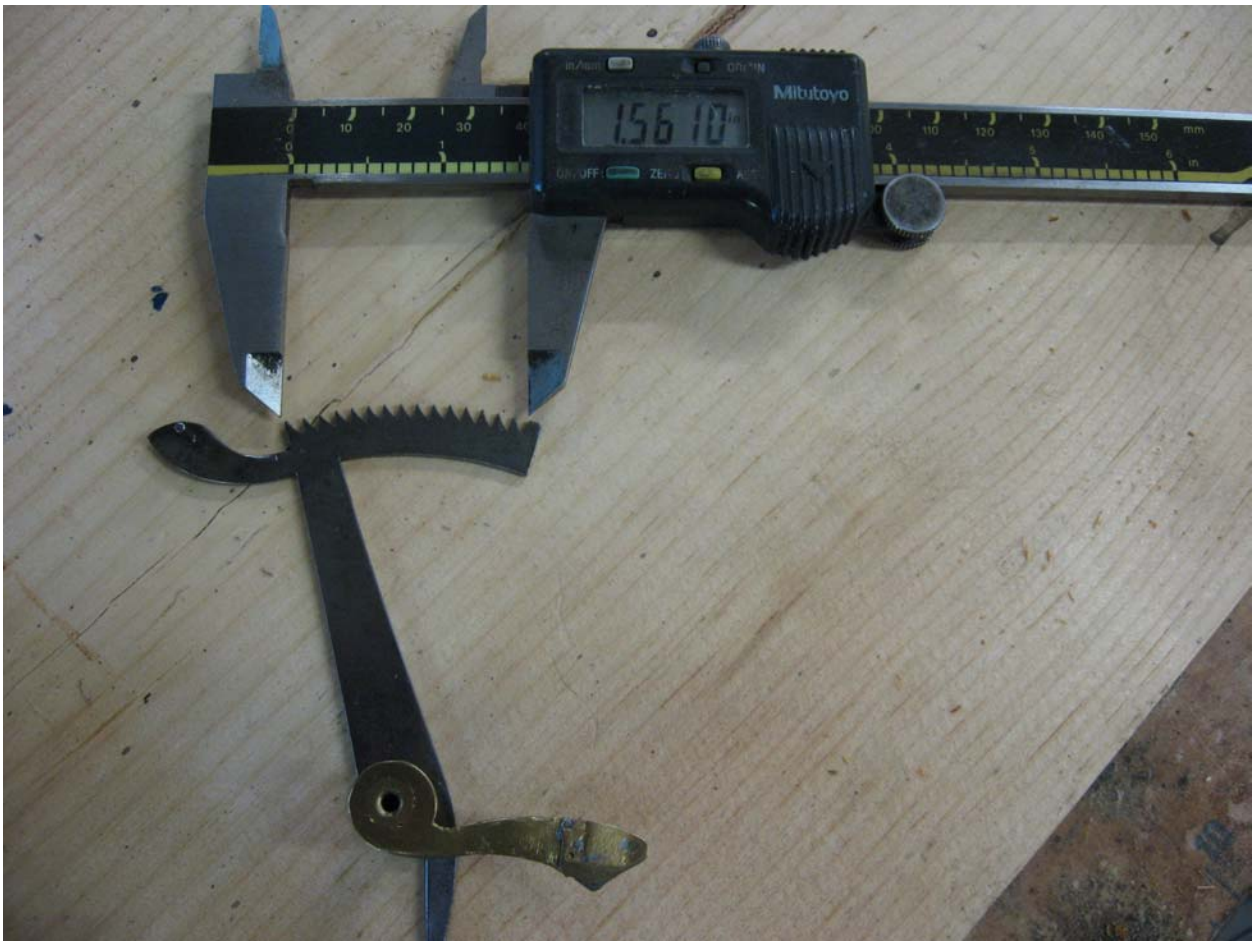
4. Now that we have a blank, and it can remain "in the rough" until the teeth are cut, we need to prepare to **"do the math".** We start by

completing our measurements. (note, these measurements should be as accurate as you can reasonable measure them, meaning we need to have the measurements within .005” or better if possible) Absolute accuracy is not required, or necessarily useful. The premise here is there is no need for 10ths when the accuracy of rest of the device is in .005” increments or so.

a. Measure and record from the old blank the distance from the center of the pivot point of the rack to the longest tooth, assuming it engages the gathering pallet properly
b. Measure the distance of the tip of the first tooth to the tip of the last tooth and record the distance, 1.565” in this case

c. Count and record the number of teeth spanned in step “b”, 15 in this case

Measure the radius of the rack



Measure the span of the teeth, count the teeth

Measure a single tooth to compare with calculations

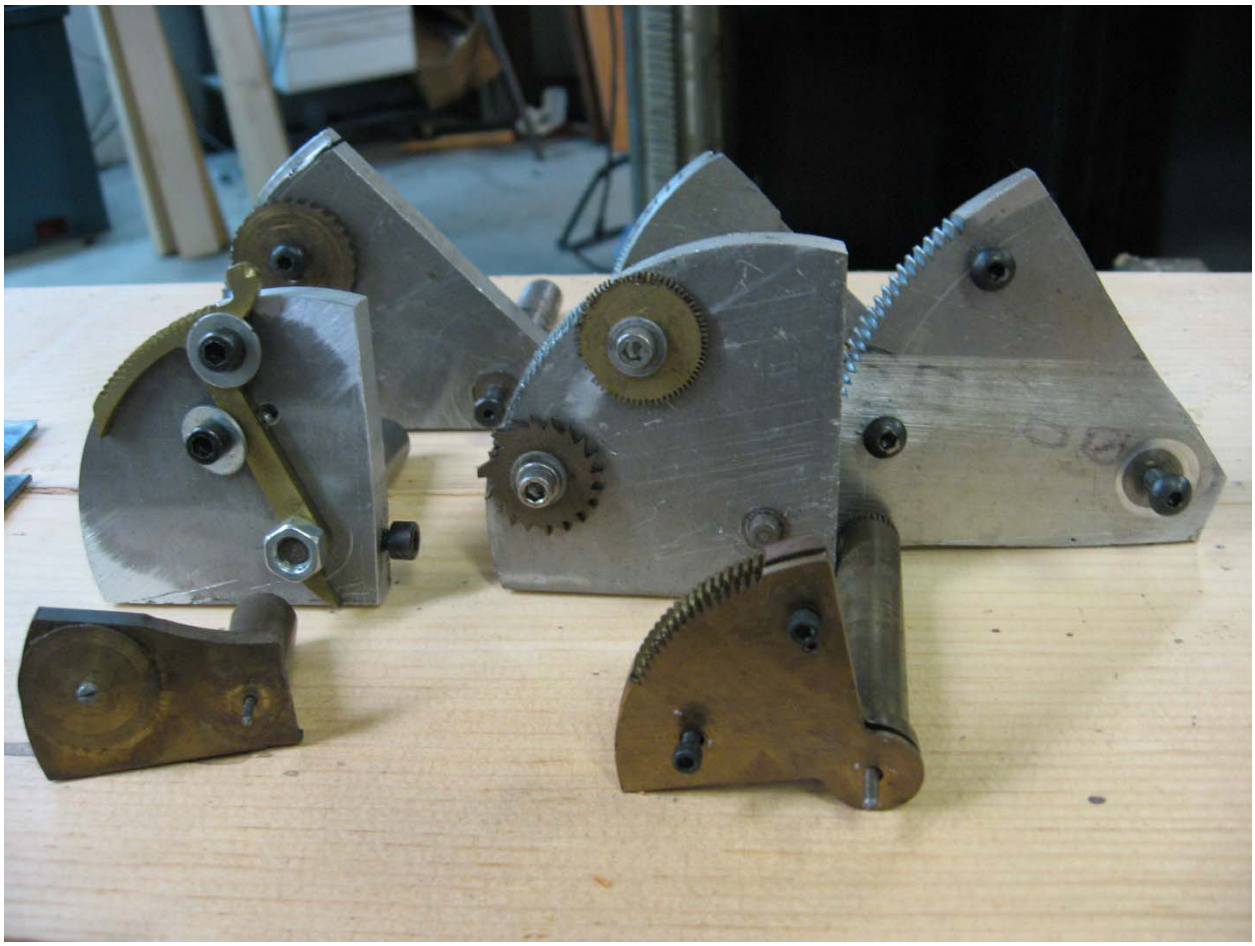
5. To the math, don't worry, very little is required, no calculus here!
    a. Divide the span of the teeth (item b above) by the number of teeth counted in step "c"
        i. This gives you the pitch of a tooth expressed in inches, for most tall cases expect a pitch of something about like .080-.110". In our case we calculate the pitch to be .100" (1.565 / 15)
        ii. Calculate the circumference of the rack as if it were a wheel
            1. For those of us separated with our grade school math that would be pie times the 2x radius or diameter x pie. In this case the radius is 2.521" so

we would multiply 2.521 x 2 x 3.14 which equals 15.831" circumference.

iii. In step "I" we determined the pitch of the teeth to be .100". So, our next step is to calculate how many teeth would be required if this were a full circle and we do that by simply dividing the circumference by the pitch. Or in this case 158.3 teeth on our "wheel" will yield the needed pitch. It is useful at this time to verify the calculations by comparing our calculated pitch by measuring several teeth on the rack. The actual measurements should be very close to the calculated pitch. If they are not, now is the time to find the error before we make expensive scrap.

6. We have now determined the measurements of our "rack wheel" as well as how to index the "wheel" to duplicate the old rack. In this case I would use an index setting of 158. (a 1 tooth error = .100"/158 which is well below the design tolerances of most tall case clocks)
7. The next step is to select a proper cutter to give us the required tooth profile in our new rack. I use escape wheel cutters almost exclusively for this purpose. Thornton's full range of escape wheel cutters has allowed me to make racks for miniature carriage clocks up through small tower clocks. Also, another good choice would be using ratchet wheel cutters and in some cases even a non radiused tooth can be cut using a conventional dovetailing tool. I don't recommend a non radiused tooth, unless that is how the original was made. Clearances tend to be a bit critical in the rack to gathering pallet relationship and the slight arch of the shaped tooth will give just a few thousandths more clearance and provide just a bit longer lip on the gathering pallet. Sometimes that is critical, sometimes not. But, to my eye, the radius looks "right" and a straight back looks "wrong". Another aside, I personally would not encourage fly cutting a steel rack as a first time effort. It can be done, certainly. Just not what I would recommend as a way to start with a steel rack. A shop made multi tooth cutter would be preferable over a fly cutter.

8. Now, as to cutting the rack itself, it is very important to make a rigid fixture that holds the rack blank very tightly. See the photo below for several examples.



Several rack holding fixtures as examples

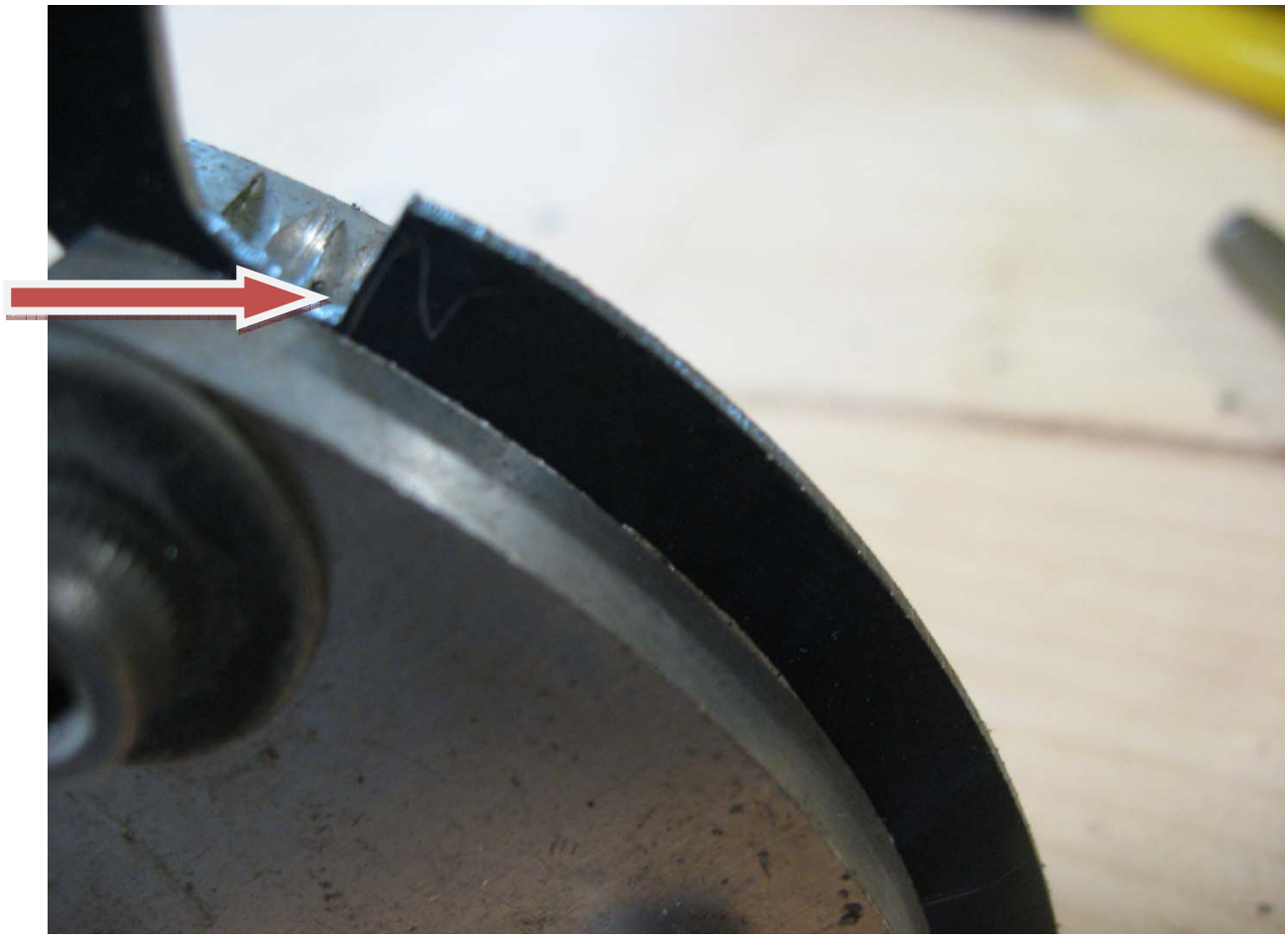
Like all my other gear cutting I tend to support the fixture at both ends to add rigidity, reduce vibration, and reduce spoilage. Yes, coolant and or lubrication are necessary when cutting steel. Spindle speed should be set appropriately as should feed rates. Chatter is deadly, if it chatters, squeaks, squeals, and or vibrates there is a very high probability we have just made scrap.

a. It may be difficult to clearly figure out a set up that allows the cutter to cut into the work versus trying to ”climb mill” which is something to completely avoid under these circumstances, rotate the cutter in the correct direction, all while making certain

you can see the cut while underway. I am reluctant to admit that more than one time I have ended up with the teeth on the new blank being reversed…..quite embarrassing and cause enough to retreat to the nearest provider of serious libation to sooth the wounds….

b. Personally speaking, I like to make a trial run before I run the cutter into the blank, for the first tooth. I leave the cutter just off the surface of the blank and run through the entire process of cutting the rack to make certain the first tooth and the last tooth correspond closely. Much better to figure out there is a problem before the blank is ruined and you have to start over.
c. I recommend starting the rack cuts from the first tooth location; remember we marked that location on our blank in section 2 c?
d. I do cut full depth of the teeth in one pass, but that does require rigidity as well as coolant / lubrication, making do with less of any of the aforementioned approaches requires more passes, and then the likelihood of chatter or mistakes goes up considerably.

Blank mounted on arbor



The first tooth location can be seen in this photo.

Cutting with lube and coolant is a messy process but cannot be avoided when cutting steel IMO

Completed rack now ready for finishing and fitting to the tube, locking pin, and tail