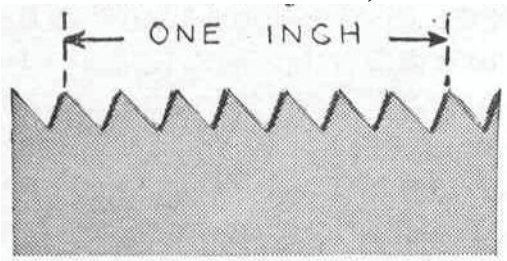
Saw Sharpening

Ken Greenberg
September 23, 2004

Theory

Points

The coarseness and fineness of saw teeth are conventionally measured by points – this is the number of teeth in an inch, and is the number you will find stamped into the heel of many saw blades. Note that points are not the same as Teeth Per Inch, which should always be one less. Consider this diagram:

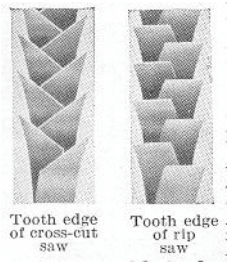


8-point cross-cut teeth, showing how points are counted

Logically, if the first tooth of the inch belongs to this inch, then the last tooth belongs to the next inch – thus the number will be one smaller. Just use points, as they are the more conventional terminology.

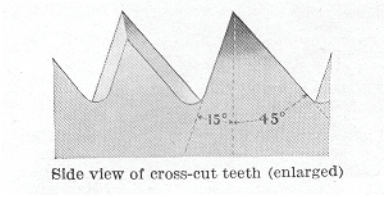
Tooth Shapes

The shape of a saw tooth reflects its intended purpose. There are many specialty saws, which are outside the scope of this discussion, so we can focus only on the rip and crosscut as the two most common ways of shaping the teeth of saws. These cover the majority of “hand” saws (the term sometimes applied to saws without backs) and saws with reinforced backs due to the thin blades in use.



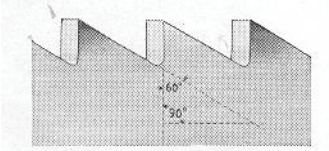
Tooth edge of cross-cut saw | Tooth edge of rip saw

Consider the needs of sawing through a structure like the traditional “bundle of soda straws.” Almost any shape can be used to cut parallel to the tubes, and a chisel works about as well as anything else. It has the advantage of being simple to form. However, a chisel shape is less efficient in cutting across the tubes, where a knife shape that can slice through the tube requires considerably less effort. For this reason, the cross cut is considered more general purpose. The panel saw (a backless hand saw about 20 inches long and designed to fit in a portable toolbox) is always filed crosscut, based on the idea that if you are only going to have one saw with you, this is the tooth shape you want.



Side view of cross-cut teeth (enlarged)

Why a rip saw at all, then? The theory is that a coarse cut made with a chisel shape (and probably fewer teeth per inch) is faster, and you're going to plane the resulting surface anyway. Thus, you want to go fast and not care so much about smoothness of cut, and the rip saw meets these criteria. A chisel removes more material that a knife in a given time.



Side view of rip teeth (enlarged)

Angles

The performance of a saw is somewhat optimized by choosing the correct angles when sharpening. Rip saws are relatively simple, since they are filed straight across, giving them a flat leading edge. However, you still need to worry about the angle of the leading edge of each tooth in relation to the line of teeth itself, called the **rake angle**. In comparison to an unsharpened rip saw, just filing the teeth at 90 degrees to the edge of the saw will be a considerable improvement. In such a case, the saw file will be held with one of its faces vertical and pushed straight across the leading edge of the tooth. However, depending on the kind of work you are doing, it may be useful to "tune" this slightly by making the tooth leading edge "lean back" a few degrees. Not much is required for ripping, but being consistent in this regard requires either a great deal of practice or a little mechanical assistance in the form of a guide or gauge (the latter is preferable). All kinds of rake are possible, including negative rake, wherein the tooth actually leans forward a bit.

Since crosscut saws are sharpened with knife edges, there are many more angles to worry about. Instead of filing with the cutting edge of the file almost vertical, you want to file with the non-cutting side of the file (two out of three file surfaces actually cut on each stroke) almost horizontal. This results in a nominal 60 degree rake angle, about right for a cross cut saw. But as always, some tuning of this angle to fit the job at hand can improve performance considerably. Few saws would be sharpened with the leading and trailing edge at the same angle, as this would cut very slowly. Instead, a more aggressive cut is chosen by making the leading edge steeper and the trailing edge shallower (they still have to add up to 60 degrees).

That determines the tooth profile as viewed from the side, but not the angle of the faces of each tooth. To set this, you don't file at 90 degrees to the saw blade but at an angle closer to 60 degrees. This angle produces the bevel, and is called the **fleam angle**. And finally, the handle of the file is held down slightly so that you are filing "uphill" to achieve the proper tooth shape. Clearly, you need to be thinking about holding the saw file properly in a three dimensional space (pitch, yaw, and roll) when sharpening a cross cut. It is just more complicated due to the complexity of the tooth shape.

Practice

Tools and Equipment

Files

Since much of the work involved in saw sharpening involves filing teeth (either for shaping or for putting the bevel on), this is your primary tool. These come in various lengths and tapers, and there are tables available to show you what the right size for your saw is. There is probably little reason to try to get a

complete set, but when you get a new saw you should check to see if you have the correct size file for it. If not, you might as well acquire one, as you will need it eventually. Files do wear out, so it is sometimes useful to keep more than one on hand. I have a lot of eight point crosscut saws, which call for a 6 inch slim taper file, so I have more than one file in this size. I normally use five files, although I would acquire an additional size if I really needed one. It all depends on your saw inventory.

File size	Saw Points
4 inch Extra slim taper	15-20
5 inch Extra slim taper	12-14
6 inch Extra slim taper	9-11
6 inch slim taper	7-8
7 inch slim taper	4-6

You can get files in all the usual places. They are common as dirt at yard sales and flea markets, but don't buy one that looks pretty much worn out, even for a quarter. New ones are available from Sears (who carries Simonds files as their own brand) – make sure you get the ones with the black tangs. Or, you can buy them from Pete Taran, who has a much more complete selection. Pete sells Sandvik files these days. Some of my files are Nicholsons from Ace Hardware, which seem OK too.

One question that comes up from time to time is – why not just use one file for all sized saws. After all, an equilateral triangle is the same in any file size. There are three reasons why you should choose the correct file size.

1. If the file is too big, you will wear out only the bottom part of it, along the edge. Then when you try to sharpen a saw with larger teeth, you will be using an edge that is partly sharp and partly dull. This will work very badly.
2. A saw file is not a true equilateral triangle. If it was, you would cut yourself every time tou picked it up. In fact, the edges are rounded with larger files being more rounded. If you use a file that is too big, then the rounding will prevent it from cutting all the way down to the bottom of the gullet and you will only be sharpening the tops of the teeth.
3. The larger the file, the larger the teeth formed in it. A tiny saw file has many little lines closely spaced. As the file gets larger, the lines get further apart. A saw with many small teeth (like a dovetail saw) is likely to be thinner as well. You don't want to be hitting a thin saw with file lines that are too far apart as it will set up more vibration. You want the spacing of the lines to be appropriate to the thickness of the saw so you always have a couple of lines "in the work."

Saw Vise

I list this second because I think it is the next thing you need. It's a real epiphany to use one for the first time. But you can start without one, creating a sandwich of saw filling with wood on either side, clamped in a vise. It just doesn't work nearly as well. Or, you can make your own, in which case you would probably try to make it as wide as possible, say two feet. This can then be clamped in your end vise. Or just try to find one at a yard sale for $5 like I did. I see them frequently, and most people don't even know what they are.

There are a number of reasons why you want a good saw vise, especially one with a built in tilt setting like mine.

- Holding the saw tightly provides resistance to the file as it sharpens. You need to push against something.
- Filing a saw creates incredible amounts of vibration, which must be damped.
- You want to preserve your hearing against the annoying screech of an unclamped saw being sharpened.
- A tilting vise allows you to be consistent in filing "up" towards the top of each crosscut tooth (i.e, in the pitch dimension).

Saw Jointer

Got a flat mill file? Got a 2 x 4? Make your own. See what mine looks like. Basically, its just a file holder. You can buy one if you like, but it isn't going to work much better. You don't need to joint the saw every time; I usually joint any saw that I am sharpening unless I'm just doing a quick touch-up. It takes almost no time and results in a better job.

Saw Set

There are dozens of variants of these that were invented by someone. The best is the Stanley 42X. I got mine at a yard sale for $5, and it works fine. Others can be used pretty well, but the double plunger action of the 42X (first grab the saw, then push the tooth) is hard to beat.

Shop-made Aids

In addition to the above saw jointer, there are a number of helpful gauges that can be made from scraps of wood. These are not strictly necessary, but since they cost nothing but your time, it is well worth your effort to make them.

Rake Gauges

These gauges go on the end of the saw file opposite the handle and give you an ongoing hint as to what rake angle you are creating. They are more necessary when shaping teeth than when pointing them, since the file will tend to follow the existing rake angle when you are doing the latter step. However, it does not hurt to use one, and it is sometimes an advantage to be able to grip both ends of a file. You need one for each combination of file size and rake angle that you wish to use.

Fleam Gauges

While the Rake gauge monitors "roll," the Fleam gauge monitors "yaw." You use this gauge to maintain consistency in the bevel (or fleam) angle you put on each tooth. You don't need this for rip saws, of course, since their fleam angle is zero. Basically, this is a stick that sits on top of the saw and establishes a line to which you want file parallel.

Jointing

Leonard Lee says to joint saws every time you sharpen since you are going to recreate the bevel anyway. If the saw was out of joint, this will fix it, and if it wasn't you have not lost anything. Since saw jointing essentially costs nothing in the way of new equipment, you might as well try it. At very least, hold the saw teeth against a flat surface and see if they contact the surface evenly. If not, joint the saw before doing anything else. If they are pretty much even, you are probably safe to just move on to pointing (or filing) the teeth, unless the teeth are really mis-shapen, in which case joint first anyway.

Just remember that if the teeth have all been jointed so that the tips are all even but slightly flattened on top, when you file the teeth so that each tooth just comes to a point you will have also created equal sized gullets. The only way to achieve this is really by jointing the saw.

All you are doing is placing a mill bastard file in a shop-made holder and running it over the saw teeth until they are even. The file holder is there to protect your hands. This isn't rocket science. The saw jointer also works well for other things, like scrapers.

Shaping

Most of the time, you won't need to completely shape saw teeth. The exceptions are if you have really messed up a previous sharpening job, or you just bought a saw from someone who really messed up a previous sharpening job. (Possibly, you deliberately want to change the shape of the saw teeth, in which case this step also needs to be done.) You can tell if the teeth are wildly uneven in size (The Brits call this cows and calves) or just horribly mis-shapen. Too bad, but you will have work to do. The first thing you need to do is make them all the same height by jointing the saw properly.

You are now going to make triangular teeth at the proper rake angle. For rip saws, this is 0 to eight degrees – I like 5. For cross cuts, you want something like 15 degrees for a fairly aggressive cut. If for some reason you don't feel aggressive, increase the angle. Make a gauge to help you in this step. Instructions are on www.vintagesaws.com. You'll need it

Even for crosscuts, you will shape the teeth by filing all of them from the same side and straight across the saw. You are not worrying about fleam angles yet, just the proper shape. This can easily be accomplished by just filing them all in the same direction with a rake gauge. Once you have them shaped properly and all the same height, then you get to worry about setting the bevel angle on your crosscut saw.

Of course, most saws you sharpen will only need this done once, because they only go "out of shape" if you mess up a sharpening job. Once you've got it right, touching up the sharpening job will keep the saw in good shape without reshaping the teeth.

Pointing

I am using Leonard Lee's terminology here; Pete Taran calls it Filing. It's hard to pick a good term, since several steps use files and all of them make points as an end result. By pointing, I mean putting the bevels on the teeth (or, if they are already there, making them better.)

For a rip saw, this is really very similar to shaping the teeth. Once you have made the teeth be the proper shape, you are pretty much done, since rip teeth are filed straight across. When I sharpen a rip saw, I still tend to sharpen every alternate tooth from the same side of the saw, just because I was taught to do it this way.

For crosscut teeth, pointing is the hard part. You want to simultaneously put a bevel on the leading edge of one tooth and a bevel on the trailing edge of its neighbor. (Trust me, you can't help it, it just happens.) Of course, the leading edge is the important one. But the angle of the bevel is critical, you don't want to lose the rake angle, and you want to maintain proper "60 degree geometry" by sharpening up towards the tip of the tooth. Thus, the pitch roll and yaw problem.

The rake gauge should still be used in this step, which takes care of roll. Keep it horizontal and you won't have any problems. You now get to use the fleam gauge you made above to track yaw. It determines the bevel or fleam angle you are putting on the tooth.

And you want to lower the handle slightly (in the pitch axis) to maintain geometry. This is most easily done if you have a tilting saw vise, since you just set the vise to the desired angle and keep the file level. If you don't have such a gauge, you will need to lower the hand holding the file handle slightly to keep the file in contact with the tooth at the correct angle. In a geometrically-perfect world, you would drop the handle the same amount as the fleam angle (i.e., 20 or 25 degrees), but there are two reasons not to do this. First, it's pretty uncomfortable to sharpen a saw this way. Second, this actually weakens the tooth slightly. So you are better off just adding a small amount of tilt. I tilt the saw vise about ten degrees. But you don't lose much if you just file straight across. This is not a critical dimension.

There's an old saying that if you start out doing things the right way, you never have to "unlearn" them later on. We're going to use this as a mnemonic device, because you start out with everything "right" when you sharpen a crosscut saw.

I. You place the saw in the saw vise with the handle to the **right**.
II. You put the rake gauge on the file with the line slanting to the **right** facing in.
III. You put the fleam gauge on the saw with the line slanting to the **right** showing.

You are going to be sharpening from the heel to the toe, so align the saw with the teeth nearest to the handle clamped securely in the vise. In addition to sharpening the teeth from the handle to the toe, you are also going to be angling the file from the handle to the toe (i.e., with the handle closer to the handle, easy enough to remember). As you push the file forward, you will be moving towards the toe. Very consistent.

Well, perhaps we should stop and make sure we are on the correct teeth first….

If you have a saw that already has bevels on the teeth and they were done correctly, it's sort of obvious which side of which tooth gets filed. You're not going to put a bevel on both the left and right side of the same tooth. But if you just reshaped the saw teeth, there won't be bevels in place. It's pretty likely there will be set, though, and you can use this as the real guideline.

Start at the right end of the saw (nearest the handle) and examine the first few teeth. There are two gullets (the low point between the teeth) of interest, the one between the first and second tooth and the one between the second and third tooth. In one case (and only one case), the tooth to your right will be leaning away from you and the tooth to your left will be leaning towards you. Put the tip of the file in that gullet before you forget which one it was, because that's the one you want to start with. You want to make sure you're in the correct place **right away** – uh oh, another mnemonic.

Make sure the rake guide is parallel to the teeth and the file is angled so as to be in parallel with the fleam guide. The tip of the file should be pointing towards the tip of the saw and the handle towards the saw handle. Push the file forward. You will be cutting a bevel on the leading edge of the tooth on your right and the trailing edge of the tooth on your left. Note that the bevels are sort of on the inside of the teeth, if it helps you remember. If the tooth is leaning away from you, you put a bevel on the side towards you, and the next tooth (leaning towards you) gets a bevel on the side away from you.

You are now going to sharpen the tooth "just enough". Well, that's a bit confusing, since I haven't said how much that is. Remember that when you jointed the saw, you made the top of each tooth slightly flat. What you are going to do now is file the tooth until the flat top just disappears, and the tooth just comes to a point. How will you know? No easy way out of this, you just have to look at the tooth as you sharpen it to know when to stop. It's fairly likely that no two adjoining teeth are going to require exactly the same number of strokes. Sorry, you just have to get close to the saw and watch how each tooth is coming along.

When you have finished the first tooth, move to your left, skipping a gullet. You are going to sharpen every other tooth from this direction. The ability to count to two is a critical skill for saw sharpeners. When in doubt, back up and check you are in the right place. It's hard to recover from this kind of error. Luckily, the teeth you have just sharpened are going to be blindingly bright compared to the others, and it should not be difficult to figure out where you were. Common sense does not hurt here, either. You can see the bevels on the teeth leaning away from you, but not on the teeth leaning towards you, since you are looking at their un-bevelled outsides.

Eventually, you will move to the left enough to have to move the saw in the vise. You don't want to be sharpening teeth in mid-air, so you will probably have to move the saw once or twice unless you have a really big saw vise.

When you get to the end, you no longer have to worry so much about doing things **right**, but just about doing the side that's **left**. (Don't you just hate mnemonics?) Put the saw in the vise with the handle to the **left**. Remove the rake guide from the file and reverse it so the line leaning to the **left** is visible as you file. Turn the fleam guide over to the line leaning to the **left** is visible.

Now find the gullet that you did not start on last time (remember , there were two choices). The tooth leaning away from you will be on the **left**. Start filing there, making sure that you are again filing a bevel on the inside of the tooth. Move from left to right this time, as always from the heel to the toe of the saw and filing heel to toe.

When you are done, you might stone the outside of the saw slightly to remove any burrs.

Setting

Setting a saw is a relatively simple operation, assuming you're not going to do this with a saw wrest but are instead going to be using a Stanley 42X or some other setting tool. You are trying to achieve a set of about 20% more than the thickness of the saw blade itself. Be conservative, since most decent saws are taper ground (thicker at the teeth) and don't require very much set as a result. It's easier to add more set than to take it away, so that's yet another reason to be conservative. You should strive for consistency more than anything. You will know it if your saw does not have enough set, since it will bind. If you have too much set, the saw will be hard to push, although you might attribute this to other causes. You achieve consistency by always applying the same amount of pressure at the same point. That point for a crosscut saw is about where the bevels meet. For a rip saw, it's the same place except you have to imagine the bevels, since they aren't there. Just a bit down from the point, in other words. Other than that, this is a forgiving operation. It does not matter where you start, or whether you move left to right or right to left. Just try real hard to only push on teeth that are already bent away from you.

Missing Teeth

Saw teeth do break. Sometimes you hit a nail or other obstacle in the wood and the saw loses the battle. Other times, saws just seem to become more brittle and a tooth can snap off in use (or worse, when sharpening). A missing tooth in a saw is not a tragedy. It will still work, and it will come back as if by magic given enough sharpenings if you are careful. Only is you are missing a lot of teeth should you consider filing them all off and starting over – and if you do, you might want to consider finding someone with a Foley retoothing machine. Of course, it is possible to create a complete new set of teeth just using a file if you are careful and have a lot of time. The Foley machines were not around forever.

The tradeoff you need to consider is that removing all the teeth and starting over will remove a lot of metal. It's the equivalent of quite a few sharpenings, and if the saw is already thin from years of use, you may not want to remove that much metal. I tend to avoid all the work involved if there's only one tooth missing (very common) or there are a few missing teeth and they are not right next to each other.

If you want to simply lay the groundwork for the tooth's reappearance, then just sharpen the saw as normal until you come to the missing tooth. Then very carefully file down into the gullets around it. Make sure the adjoining good teeth have the proper shape. Then you may choose to manipulate the saw file angle manually to create a small point on the broken tooth. I believe this may help further deterioration of the shape from fracturing the edge. On fine backsaws I don'' usually do even this much. The teeth are so small that they generally will reappear in about two sharpenings.