

# Saws

## *Basic Definitions*

### *Components*

Saws are comprised of several key elements, a handle<sup>1</sup> for driving and controlling the saw, a saw-plate which makes up the bulk of the saw with the teeth cut into it, and on smaller saws a back which encloses the top of the saw-plate stiffening the blade.

<sup>1</sup> Sometimes, but infrequently referred to as a tote.

The portion of the saw-plate nearest the handle is referred to as the heel, and the opposite end the toe, along the bottom of the plate is the toothline; along the toothline, each tooth has a portion of empty space forwards of it, referred to as the gullet.

When sawing, the gap left behind by the saw is referred to as the saw's kerf, the saw is designed such that it cuts a kerf wider than its plate, accomplished by a combination of grinding an almost imperceptibly slight taper to the blade and setting the teeth such that they splay out slightly from the centreline of the plate.

### *Geometry*

The tooth geometry will vary between individual saws depending on their exact purpose, the geometry is defined by 3 parameters.

Rake, the angle of the cutting face of the tooth relative to a line vertically perpendicular to the toothline, with a negative angle equating to a slope towards the heel of the saw i.e.  $0^\circ$  would be perpendicular to the tooth line, and  $-10^\circ$  would slope slightly toward the heel of the saw. Increasing rake increases the aggressiveness of the saws cutting action, but for the same reason also increases the force required to push the saw through the cut and the difficulty in starting the saw off.

Fleam, the horizontal angle of the cutting face of the tooth and the back face of the tooth in front relative to a line horizontally perpendicular to the toothline, generally speaking the angle of the fleam is

expressed as being a number of degrees, when it means a number of degrees  $\pm$  i.e. a  $10^\circ$  fleam angle would have the cutting face of one tooth angled  $+10^\circ$  past perpendicular, and the next face angled  $-10^\circ$  just shy of perpendicular. Fleam increases the ability of the saw to sever individual wood fibres cleanly by forming knife points, and is essential to the function of cross-cut saws.

Slope, the vertical angle of the cutting face relative to a line horizontally perpendicular to the toothline. Increasing the slope angle increases the keenness of the cutting edge on teeth with fleam<sup>2</sup>, and maximises the amount of gullet space available for sawdust. Increasing slope can also lead to a rougher cut edge, as its positive properties allow the saw to cut more rapidly taking the maximum amount of material per tooth with each pass.

Set, the width of the cutting edge at the outermost extent of the teeth, formed by bending the teeth outward slightly. This is usually set arbitrarily using a saw-set which will have a recommended set for a given number of teeth per inch, and adjusted by experience to suit individual saws and users.<sup>3</sup>

Pitch, is the spacing of the teeth, measured in the number of Teeth Per Inch (TPI, British practice) or the number of Points Per Inch (PPI, North American practice)<sup>4</sup>. Tooth spacing is important primarily in determining how deep a cut the saw can effectively make, as more teeth results in a smaller gullet, which can hold less of the waste material removed by the teeth before it fills up effectively preventing the tooth behind it from cutting further.

When combined into specific filing patterns, these elements dictate almost every aspect of the saw's performance and behaviour in use.

Separate to the tooth geometry is the alignment of the handle to the blade, or hang; this is the angle between a line perpendicular to the back of the handle and the toothline<sup>5</sup>.

### *Filing Pattern*

There are two predominant types of saw tooth, the Rip filed tooth and the Cross Cut<sup>6</sup> filed tooth, these names unsurprisingly enough refer to the intended purposes of each tooth-filing pattern.

The Rip filing is cut into the plate with little to no rake angle and no fleam angle. This filing pattern essentially creates a series of small chisels which remove full-width chips of wood when working down the grain, but which are unable to cleanly sever the fibres of the timber when working across the grain.

The Cross Cut filing is cut into the plate with a rake which varies from very little in fine saws to the theoretical maximum for a saw

<sup>2</sup> Without fleam, cutting slope will have no effect on the saw other than to reduce the tooth area available to cut at the very tip, and as with fleam, the slope angle needs to be opposed on each successive tooth to have the desired effect. Filing slope all at one angle would instead cause the teeth to be higher at one side of the toothline than the other.

<sup>3</sup> It is essential that the saw be evenly set on both sides or it will tend to cut toward the side with less set rather than cutting a straight line.

To understand this, consider how the plate will align itself if one side is pressed against the wood, and the other has extra space.

As a result of this, the sawyer will naturally allow the the plate to lean very slightly into the extra space available in the kerf on the side of the saw with more set, this then points the direction of cut very slightly towards the side with less set, and the error is compounded with each saw stroke, eventually cutting a curve with a very wide radius.

<sup>4</sup> A saw with few teeth per inch is described as being coarse, and one with many teeth to the inch as fine, referring to both the appearance of the toothline, and the quality of the cut surface left behind.

<sup>5</sup> Whilst a seemingly trivial detail, the hang of a saw significantly alters its ergonomics.

In a nutshell, a saw with a higher hang angle, requires you to work from above the workpiece with your arm pointed diagonally downward and conversely, a saw with low hang angle requires you to drop your elbow.

The dropped elbow position allows you to keep your wrist aligned correctly (and thus comfortably) through a much longer stroke, putting all the core muscles into the stroke if necessary; thus it suits a saw with a longer plate. By contrast a high hang angle allows you to comfortably work in a position which puts you above the workpiece looking down at it; thus suiting small saws for making fine accurate cuts for forming joinery.

<sup>6</sup> Often referred to as Fleam Cut.

which cuts on the push stroke of  $-30^\circ$ , with the fleam is cut at a  $7^\circ$  to  $15^\circ$  angle, with each face angled in the opposite direction from perpendicular such that each pair of faces meets at the tip of the saw to form a needle point. The fine points of each tooth act as a knife to cleanly cut the fibres of the timber when working across the grain, but when working along the grain, the gap in the centre between the two sharp edges of the saw's teeth means that material is less effectively chipped and removed.

### *Types of Saw*

There are a number of possible divisions between the types of saw, fortunately for the most part saws which are differently constructed are also for differing purposes; it is my aim to take you through them in the order that one would progress through them in turning a tree into a finished article.

### *Rough Cutting Saws*

These saws are primarily tools for use in the initial process of turning a tree into usable timber. In the main this class of saws has lost most of their significance in light increased mechanisation and the ubiquitous proliferation of timber importers and merchants since the 1840's; prior to this it was common for firms of carpenters or joiners to retain sawyers, timber wagons and teams of horses and to locally fell, saw and season the timber required for upcoming work<sup>7</sup>.

### *Crosscut Saws*

The one and two man crosscut saws are intended for the cutting of logs in the round to a given length after felling, sometimes known as a "Farmers Saw", they share a variety of unique tooth patterns which are variations on the normal Cross-Cut filing. The purpose of these patterns is to provide ample gullet space to accommodate sawdust and chips whilst cutting through a log which could be as much as  $\frac{1}{3} - \frac{1}{2}$  the length of the blade at its widest point.

These saws are simple to use, but require endurance and persistence to make best use of; cutting through a substantial log is necessarily time consuming.

For Bucking smaller logs, a simple X shaped trestle of two logs joined by a lap joint and lashed together is usually used, the major limitation being the size of log which can be lifted onto the trestle,

<sup>7</sup> For a more complete overview of the traditional approach to preparing timber, along with a wealth of other information on the development of the woodworking trades in the late 18th and early 19th century, it is hard to recommend too highly "The Village Carpenter" (?) by Walter Rose, essential reading for anyone interested in traditional woodworking, along with the working of "elm tree" pumps and the millwright's work.  
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rather than the strength of the lashings; Larger logs can be maneuvered using a Peavy or Log Carrier onto a short log with a v-notch chopped into it with an axe. It is of course essential to raise the log off the ground to avoid damaging the tooth line of the saw by striking it against unexpected hard objects on the ground, not to mention somewhat more ergonomic to work closer to normal standing height.

### *Frame Saws*

The Frame saw is traditionally used along with a Cant Hook and Wedges by two people working in a saw-pit or on very large sawhorses to cut timber in the round into planks and beams, along with re-sawing squared up Cants into veneers, planks and feather edged boards. Since the industrial revolution it has been almost completely supplanted by the Circular Saw and later the Wide-Band Saw, and is now of note primarily to historical re-enactors, and a small number of carpenters working on traditional oak-framed buildings, although even in the hands of the latter it is being supplanted by portable Band-Mills and "Alaskan" Chain-saw Mills.

A smaller frame saw of the same design is mentioned in several texts from the 18th century, this smaller design has been the subject of some experimentation in the woodworking press and at the US living museum, Colonial Williamsburg. The conclusions reached during this period of recent experimentation suggest that a small, one man framesaw can be effective at re-sawing unusually wide boards<sup>8</sup> rapidly for producing sawn veneers and thin stock for drawers and Panels. It is suggested that to achieve best results the material for re-sawing should have a kerf established on both edges, for the saw to run in these being established with a "kerfing plane" which takes the form of a stair-saw with an adjustable fence attached to hold the blade a consistent distance from the edge of the board.

<sup>8</sup> It has been a subject of some debate in the woodworking press<sup>(?)</sup> whether they were as effective as claimed in some quarters. There seems to be a tentative agreement that the frame-saw was most effective with very wide pieces, upto around 16" width for but that for boards of less than 8" a coarse toothed rip saw of conventional design is quicker and easier.

### *Handsaws*

The name handsaw gives itself to both a class of moderately sized one-man saws invaluable in the workshop, and to the largest size of crosscut saw within that class. They are normally defined by having a handle with a slight hang, almost aligned with the toothline and a saw plate which tapers considerably toward the toe, usually the plate will be taper ground progressively thinner towards the tip.

## *Rip Saw*

The Rip Saw is generally the largest of the handsaws used in the workshop, with plate lengths between 28" and 30" most common and lengths of upto 36" not unknown, the plates are normally wide for increased rigidity measuring 7½" to 9" at the heel and 3" to 4" at the toe. The saws are unsurprisingly filed in the rip pattern with a rake which is either 0° or very slight for a rapid and aggressive cutting action<sup>9</sup> and tend to be quite coarsely toothed, with Pitch between 3½ TPI and 5 TPI usual, with larger saws for rough work sometimes reaching 2 TPI.

A feature unique to the Rip Saw is the "Thumb-Hole Grip", a larger than normal handle with a small hole forward of the main handle<sup>10</sup>.

The rip-saw is used for cutting rough stock to near-finished size prior to final dimensioning with the planes, it has in the main been supplanted in this role by a variety of small circular sawing machines. However there are a number of reasons that the rip-saw retains relevance in the modern woodworkers toolkit:

- For the re-sawing of boards of rare or valuable timbers into thinner stock it is capable of a combination of a greater depth of cut and narrow kerf than most mechanical saws, minimising wastage.
- For cutting small lengths of timber to width, the rip-saw can be used to cut a board held upright in a vice or held down overhanging the edge of the workbench with a holdfast very rapidly. Usually the time taken to mark, secure and cut the timber by hand is significantly less than the time required to move to the sawbench, set the guard and fence for the required depth and width of cut, and finally saw the timber. In this way it can help maintain an economy of time when preparing small one-off components.
- When preparing long lengths of timber in a large sectional size, it can be convenient to work along the board with the rip saw in the traditional fashion, kneeling on the board to be cut supported between two saw-horses. Manuvuring yourself and a saw around a long heavy timber is safer and less ungainly than attempting to control such timbers on a workshop sawbench<sup>11</sup>.

## *Half Rip Saw*

The Half Rip Saw is a smaller version of the Rip saw, measuring 24" to 28" in length and with a plate width not exceeding 8" at the heel or 3" at the toe. Pitch is normally finer than the Rip saw, most

<sup>9</sup> It is worthy of note that whilst unheard of in hand-tools, in wood machining a positive rake is common for many ripping blades as the design of sawbenches and bandsaws confers ability to apply the necessary force without the risk of deforming the plate of the saw.

<sup>10</sup> The purpose of this hole is not as often assumed for the thumb or forefinger of the dominant hand, but to allow the thumb of the non-dominant hand to be inserted and the remainder of the non-dominant hand to grip the top of the handle, effectively bringing the power of both arms to bear for extended periods of strenuous sawing.

<sup>11</sup> In this way it is possible to accomplish work which would otherwise require the assistance of a properly equipped sawmill.

This said, depending on the amount of timbers to be prepared, your stamina and your budget it may still be well worth a visit to the sawmill, as these kinds of tasks are normally quite heavy work for which the fees of a sawmill will seem quite modest when considering the time and effort saved.

commonly between 4 TPI and 7 TPI, giving a finer finish. The filing is again in the rip pattern, but more usually with a slight negative rake, in the region of  $10^\circ$ .

In the main, the Half Rip comes into its own for ripping small components at the workbench as above, with a more manageable size, finer finish and thinner kerf. With this in mind, the half-rip is usually better suited to making cuts in timber less than  $1\frac{1}{2}$ " in thickness, where the reduced gullet size does not constitute a major disadvantage.

### *Handsaw*

As mentioned above the Handsaw is the largest of the crosscut saws normally used in carpentry and joinery work with prepared timber,<sup>12</sup> The plate will normally be no more than 26" in length and with a width of 5"-7" at the Heel and 2-3" at the toe, Pitch would generally start around 5TPI (as with the half-rip) and extend to around 9TPI, with a negative rake of  $10^\circ$  to  $15^\circ$ . The fleam and slope of the filing will vary with the pitch, decreased fleam and increased slope (around  $8^\circ$  and  $30^\circ$ ) will maximise the speed and depth of cut suiting coarse saws, whilst increased fleam and decreased slope ( $15^\circ$  and  $5^\circ$ ) will result in minimal splintering and surface irregularity suiting finer saws.

The primary use of the handsaw is cutting stock, part-finished components and panels<sup>13</sup>.

### *Panel Saw*

A smaller version of the handsaw, with a plate of 20" to 22" and a width of 5-6 inches at the heel and  $1\frac{3}{4}$ " to 2" at the toe, saw Pitch is normally slightly finer than that of the average handsaw, in the region of 7TPI to 9TPI<sup>14</sup> and a negative rake around  $15^\circ$ , with finer pitched examples sometimes extending to  $20^\circ$  rake. As the panel saw is used for cutting to near finished size, the fleam angle tends to be increased and the slope decreased relative to a comparable handsaw, with fleam of upto  $30^\circ$ , and very slight or no slope to the filing pattern.

Panels saws are most useful in cutting components to final length, and in some cases for cutting unusually large joints; generally marking the point that one would move from working on saw horses or saw benches, to the workbench.

<sup>12</sup> compared to the average Half-Rip saw the Handsaw offers a slightly smaller form factor which smaller people and those working primarily on small pieces may prefer to use a Rip-filed Handsaw. Thus whilst the traditional defining factor of a Handsaw is crosscut filing, it is not uncommon to find woodworkers with a pair of handsaws, one in each filing.

<sup>13</sup> It is generally best to use a Hard-Point (non resharpenable) saw for cutting manufactured panel products such as Ply, MDF and OSB, the adhesives used can be substantially harder than normal timber, resulting in excessive wear on the teeth of re-sharpenable saws tempered for use in timber.

<sup>14</sup> The Fine Panel Saw, with a finer pitch in the 9TPI to 11TPI was formerly common, and still has great utility for woodworkers building larger carcass work from boards of  $\frac{1}{2}$ " or less thickness, where the intermediate size allows reasonable speed of cut, whilst allowing the use of finer pitch and a thinner plate for improved quality of cut, for cutting larger items to finished size.