Band Resaws

Operation, Setup & Alignment

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Introduction

This paper describes procedures and tools for setting up band resaws, including some common feed systems. These methods are simple, fast and accurate, but most importantly they cover the aspects that must be considered to obtain good cutting accuracy and production.

Production Goals

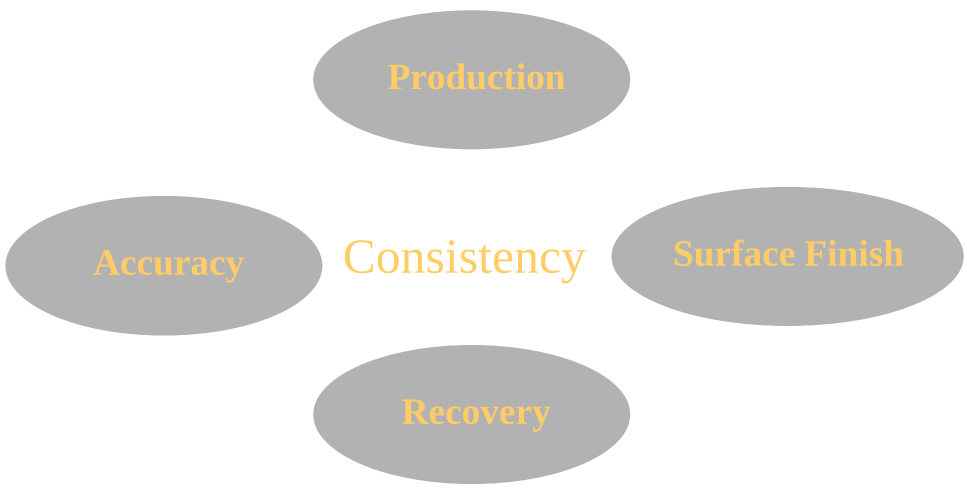

Figure 1. Compromises in saw design and operation.

The interesting, and sometimes frustrating, aspect of saw design is that it is difficult to simultaneously achieve all of the goals show in Figure 1. For instance, high feed speed usually results in a rough surface and a thick blade is needed to withstand the larger cutting forces. In an ideal world, we would have a thin saw that could be fed as fast we liked while still producing smooth, straight lumber. In the meantime, most saws will be designed specifically for an application.

The first trade-off is between what the customer wants (smooth, straight boards) while attempting to minimize costs (small kerf loss, straight cuts and high feed speeds). Further refinements of the trade-offs depend on the product or customers' requirements.

The important issue is to decide which factors are priorities. This will affect the selection of blade design and feed speeds. However, when it comes to the setup and maintenance of the machine, there should be no compromises. The benefits of the machine running consistently well are always greater than the costs, to say nothing of the reduction in frustration and stress. Achieving consistency means predictability of production and quality. More important, it is a foundation from which further improvements can be made.

Saw Blades

The table below lists some solutions to common sawing problems. Notice that most of the so-called saw problems are caused by some other problem that ends up damaging the saw. Saws are the most fragile part of the sawing system. If the saw is coming off the machine damaged, this is a strong indication that something needs to be fixed or adjusted. This is especially true if the saw cuts well at the beginning of the run, but then performance deteriorates.

Be aware that with saw sharpening services, you get what you pay for. If the saw filer cannot afford to spend much time on your saws, then they will not perform well. All of the teeth need to be inspected, and the whole surface of the blade needs to be looked at for flatness and uniformity of the tension. Compare the extra cost for the saws to the cost of lost production from unscheduled saw changes and the cost of mis-manufactured product.

Marking teeth	Clean the wood (no rocks or sand)
	More time by filer straightening teeth
	Better control of wood (reduce bent teeth if wood moves)
Cracking	Correct machine alignment (cross-line)
	Slower grinding (avoid ‘burning’ gullets)
	Ensure the strain system is active (not sticking)
	Check and replace wheel bearings
Snaking	Match the feed speed and saw design
	Replace dull saws
	Keep guides close to cut
	Better control of wood
	Straighten movement of wood (feed alignment)
	Adjust the saw tension

The Bandmill

The drawing below shows the important components of a bandmill. All of them need to be setup and operating correctly for good performance.

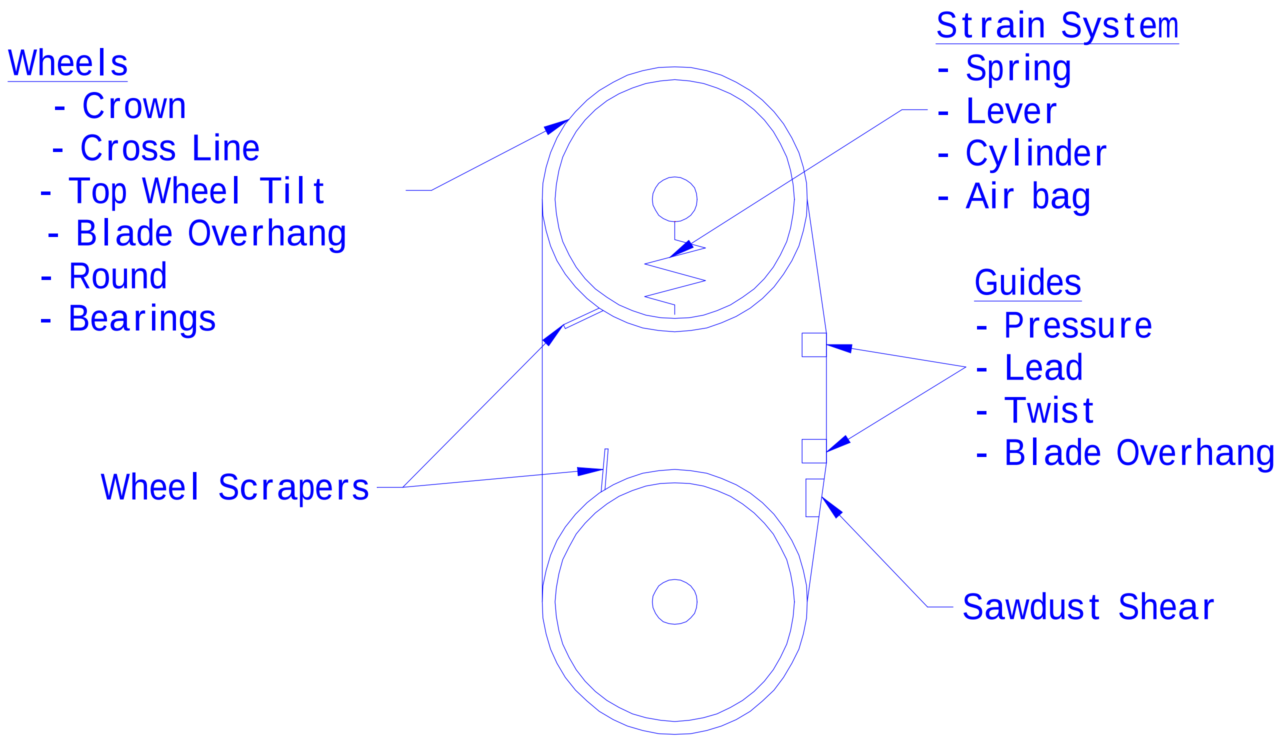

Figure 2. Main parts of a bandmill

Strain System

The strain system has two purposes: to allow the top wheel to drop for saw changes and to stress the blade so it will be stiff. From a saw stiffness point of view, it is not desirable to have the strain as high as possible because this will cause saw cracks. Also, beyond a certain point, increasing the strain does not significantly increase saw stiffness because of local bending of the saw in and around the teeth.

The critical aspect of the strain system is that it maintains a constant load on the saw regardless of how much the heat from cutting expands the blade. The top wheel should move up and down depending on the temperature of the blade. If this does not happen either the strain will be too low, resulting in a snaking saw, or the strain system may lock in the 'up' position, subjecting the blade to too much stress, resulting in saw cracks.

Wheels

The scrapers and shear keep the surface of the wheels clean and keep debris from between the wheel and the blade. If sawdust or chips get between the blade and the wheel, the blade can be damaged. Also, wheel wear will be accelerated.

The purpose of crown (Figure 3) is to keep the blade on the wheels. In general, the blade will center itself on the high point of the crown. Typically the crown is about 0.005". A flat wheel will run, but it will be difficult to track the band (adjust the amount the teeth overhang the wheel). Never try a hollow wheel. The blade will not stay on the wheels.

A wheel should have at least some crown (even 0.001") for the band to stay on the wheel and allow control of the tracking. On the other hand, too much crowns is bad as it leaves the front edge of the blade loose, which means a loss of blade stiffness.

Wheel wear is mostly on the front edge, behind the teeth. If the edge is worn too much, the wheels need to be reground. The amount of acceptable wear depends on the machine and its use, but 0.030" is definitely too much. A common indication of too much wheel wear is that the filer is adding more tension to the saw to make it cut straight. Eventually, so much tension will be added that saw cracks will appear.

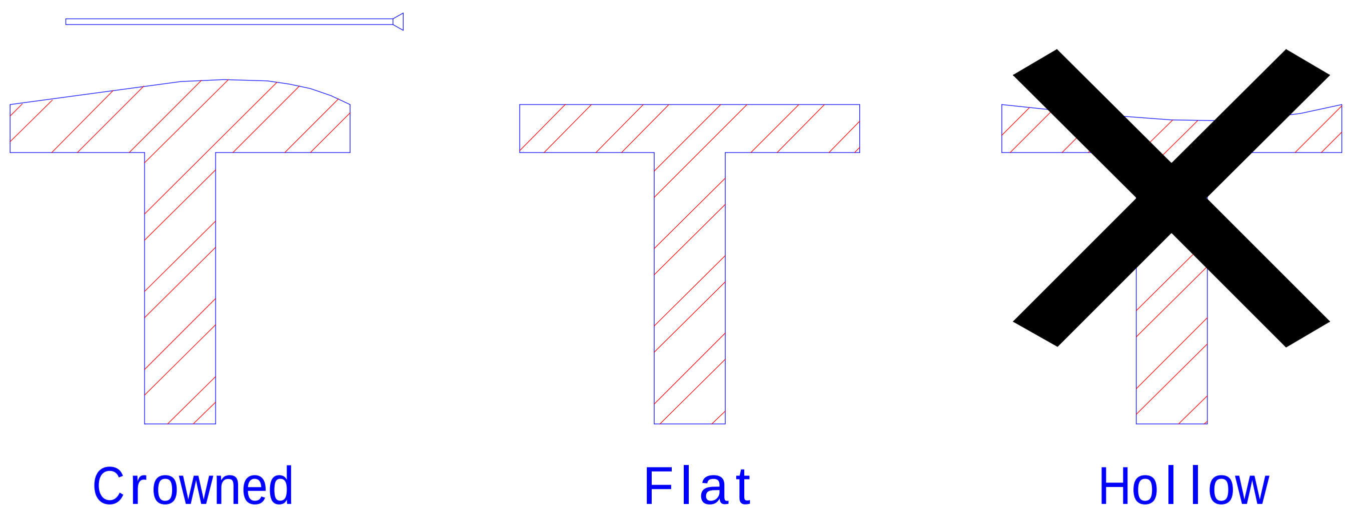

Figure 3. Wheel crown. Avoid hollow or exactly flat wheels.

Cross Line

Cross line refers to whether the top and bottom wheels are parallel. See Figure 4. If they are not parallel, the blade will be twisted, sometimes resulting in cracking and saw stiffness problems.

When measuring crossline, the bandmill has to be strained to its operating strain. This will allow the bottom wheel and the column to be stressed to their operating locations, which could be different from the unstrained condition.

A procedure for measuring and adjusting crossline is given in Appendix I.

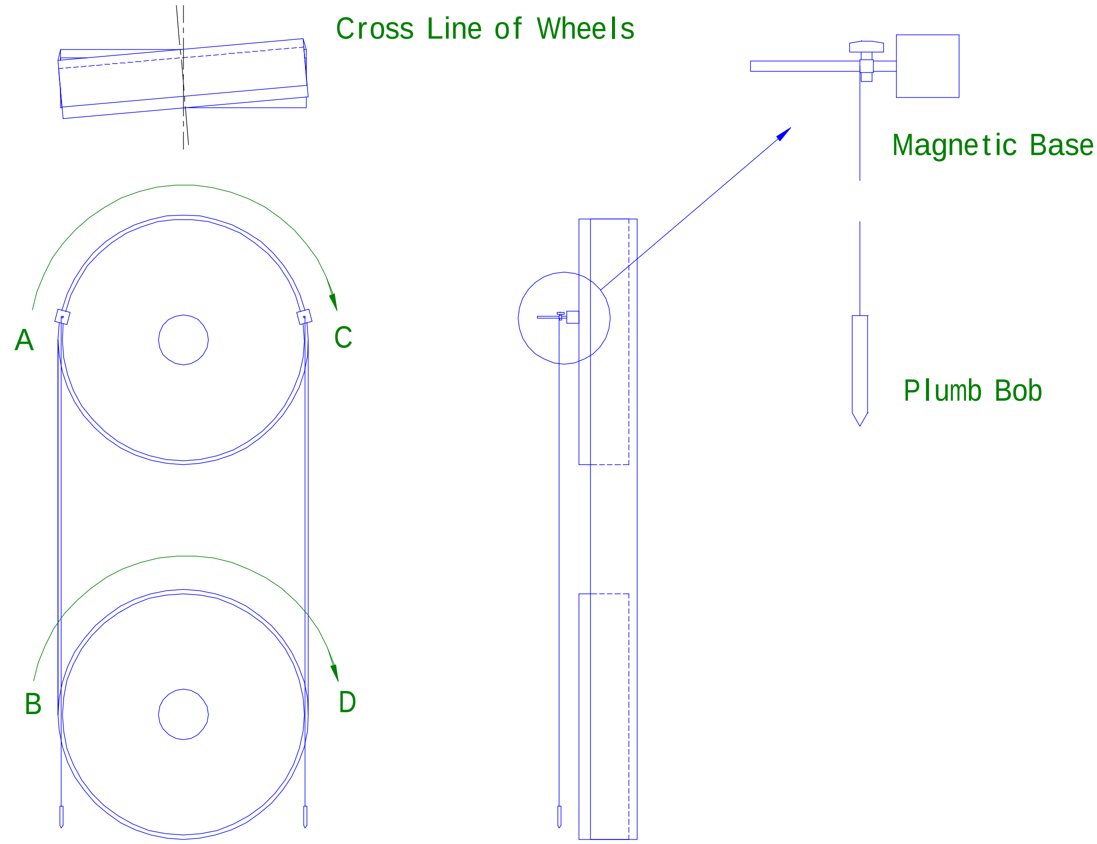

Figure 4. Method for measuring cross line with a single plumb line.

Axial Alignment of Wheels and Guides

It is important that the rims of the wheels on the side where the teeth overhang the wheels are in line with each other. In other words you want the blade to overhang the same amount on the top and bottom wheels. If the overhang on one wheel is too large, but minimal on the other wheel, then the front edge of the blade will curl inward and change the attack angle of the teeth. Sometimes the top wheel needs to be moved axially (parallel to the shaft) to make the overhangs equal.

Even more important is to position the guides so they fully support the saw. If the blade overhangs the guides by more than 3/8 inch, then the blade will curl inward. On the other hand, do not run the back so the bottom of the gullets run on the wheels or the guides because this will rapidly wear the wheel and guide faces.

Guides

The guides have a very large effect on blade stiffness, and therefore, on cutting accuracy. It is very important to have the guides as close to the wood as possible. The saw can be fed harder as well if the guides are close together.

Guide Pressure
Many bandmills have pressure guides, in which the guides push the blade outwards so they are in solid contact with the blade. This improves saw stiffness and accurately positions the blade. All these systems use replaceable cartridge guide blocks that are machined flat to a precise width. Jack-bolts, located behind the cartridges, are used to position and adjust the guides.

Having the correct amount of guide pressure is important. Too much pressure and the guides will wear quickly, resulting in a change in the position of the saw. Also, because the front edge of the guides wears the most, the blade will curl slightly so that the teeth are not presented squarely to the feed. If there is too little guide pressure the saw stiffness is reduced.

Typically, the guide offset is in the range of 3/8"to 3/4". The higher the strain, the lower the guide offset. The amount of guide offset can be calculated with the formulas in Appendix II.

Guide pressure is set by hanging a plumb line from the top wheel. A piece of key-stock, say ½" thick, is placed between the face of the wheel and the string to set the offset. The guides are then set out until they just touch the string. (Another method for setting guide pressure is given in Appendix II.)

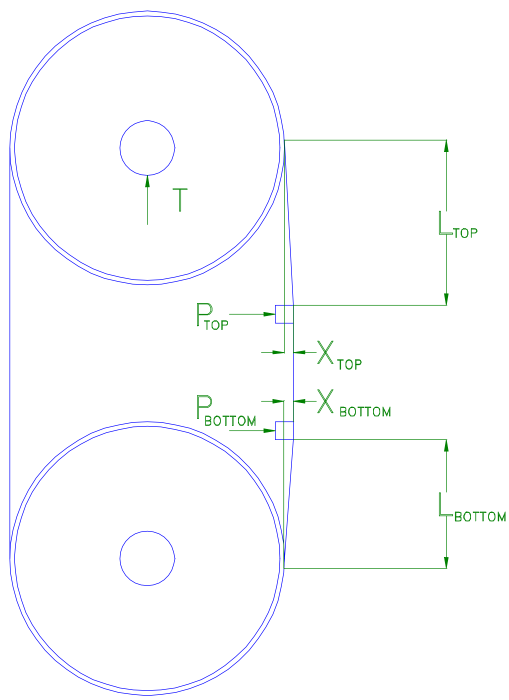

Figure 5. Geometry of guide offset showing the spans to the wheels.

Guide Lead and Twist

In general, the saw should be set up parallel to the feed, however, you may find that a small amount of lead works better. No matter what lead you use, the goal is to ensure that the lead is always set to the same amount and you can verify the lead.

It is not advisable to set the guide lead to be parallel to the face of the wheels. First, this is usually done by dropping plumb lines from the top wheel, which is not accurate because it is difficult to measure from the string to the guide. Secondly, even if the wheels are perpendicular to the feed, there is no guarantee that the face of the wheel is square to the wheel rim. The best practice is to set the lead to feed.

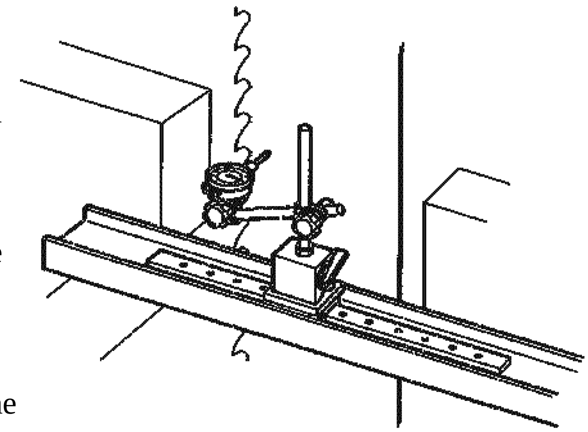

Figure 6. A straight edge fitted with a linear bearing for quick-check of saw lead.

A common problem is inconsistent positioning of the pressure guides due to problems with the accuracy and repeatability of the guide dresser. The distance from the face of the guide to the point where the guide is against the jack bolts must be the same for each guide. If there are differences between guides, then the saw will be positioned differently after each guide change, with will cause the between-board deviation to increase.

The final steps for guide alignment are to check that the top and bottom guides are parallel and that the saw is plumb. The quickest and most accurate method is to use a spider to check for twist and a sine bar to check plumb. Be aware that the saw is slightly curved between the guides so the plumb measurement must be done at mid-span.

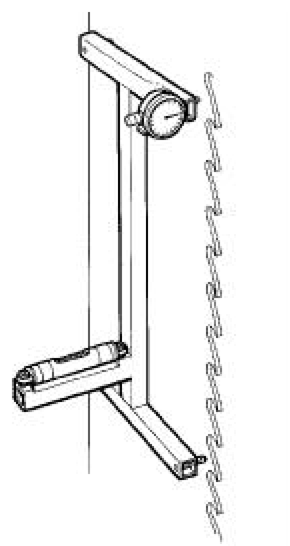

Figure 7. Using a spider to check for twist between the guides. This unit also has a level.

Feed Systems

Line Bar

Line bar bandmills, such as shown in Figure 8 are mechanically simple, but they rarely run well. Part of the problem is that because they are so simple it is assumed there is nothing that can go wrong.

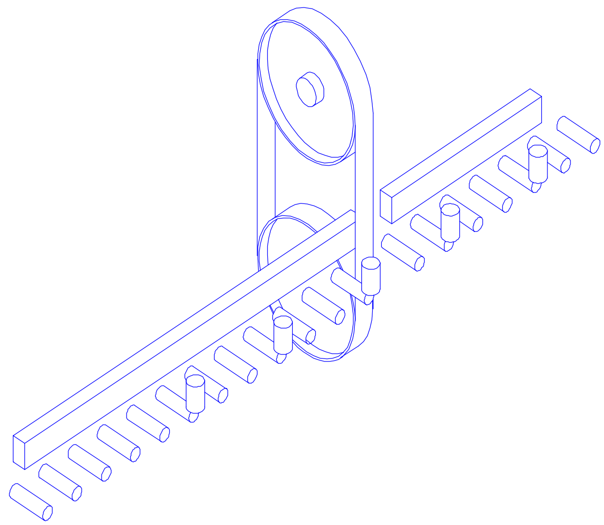

Figure 8. Typical layout of a line bar resew. All of the parts shown, for at least the distance of a board length on both sides of the saw, must be checked for alignment.

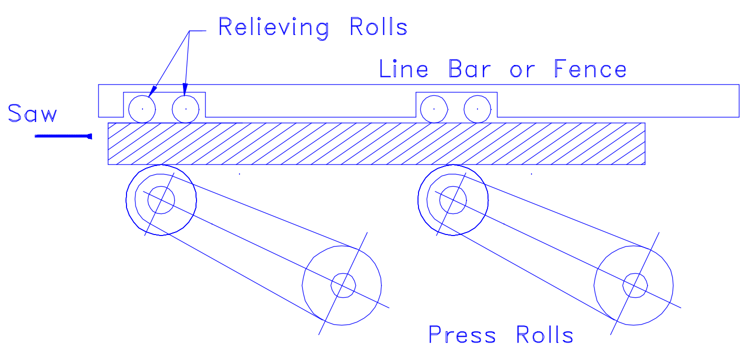

Figure 9. The surfaces of the line bar, press rolls and the relieving rolls must be plumb.

The main component of the feed is the line bar, which must be straight and plumb. Common problems with the line bar are:

- The line bar is worn hollow where the press rolls come in, and is more worn on the bottom.
- If the line bar has relieving rolls, they are too proud of the surface, causing the trailing edge of the board to suddenly move sideways as it leaves the roll.
- The line bar is made in several sections but only the one closest to the saw has been maintained. Often the other sections are proud of the main line bar.
- The outfeed line bar is set back too far to support the wood during the last few feet of the cut.

The most neglected parts are the bed rolls and the press rolls. Some typical problems are shown in Figure 10. Often, the bed rolls have worn into an hourglass shape next to the line bar. For narrow boards this is not a problem, but for wider pieces the cant will lean away from the line bar. The same thing will happen if the bed rolls are not level, as shown in Figure 10. If the press rolls cannot provide enough force to lift the cant and hold it against the line bar then the line bar board will be bevelled.

The top of the bed rolls must be at the same elevation. If there is a high roll it will create two situations, neither of which are desirable because, for an instant, there is a loss in control of the wood.

1. When the front edge of a board hits the high roll it will jump up and there is a chance that the board will come away from the line bar for a moment. The same thing will happen when the trailing edge of the board falls off the high roll.
2. When the board is centered over the roll the board can pivot (teeter-toter) on the roll.

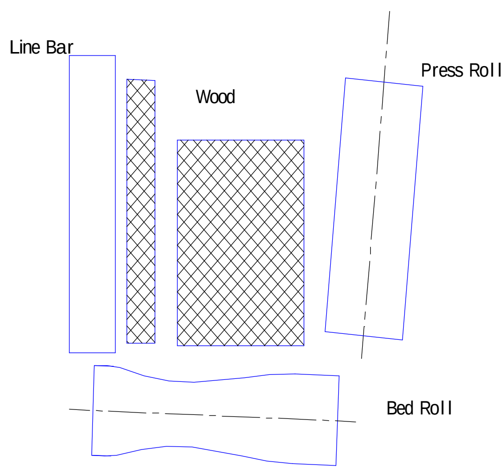

Figure 10. Typical alignment problems with bed rolls and press rolls. The two rectangles represent a narrow board, and a wider cant to show how pieces of different sizes will ride through the feed differently.

The other common problem is that the press rolls are not plumb, as shown in Figure 10. When this happens it is not certain that the top or bottom of the board will be kept against the line bar and bevelled boards will result.

The alignment of the bed and press rolls also has an effect on the life of the bearings since the loads are not distributed as was intended by the designer. For example, the bottom bearing for the press roll shown in Figure 10, will take all the load developed by the press roll cylinder. As a result, the bottom bearing will fail quickly. If the press roll were plumb, at least some of the force would be transmitted through the top bearing. Another example is the high bed roll, discussed above, which will take more of the weight of the board than the neighbouring rolls. Misalignment causes loads to be concentrated on components that were not designed for the extra loading.

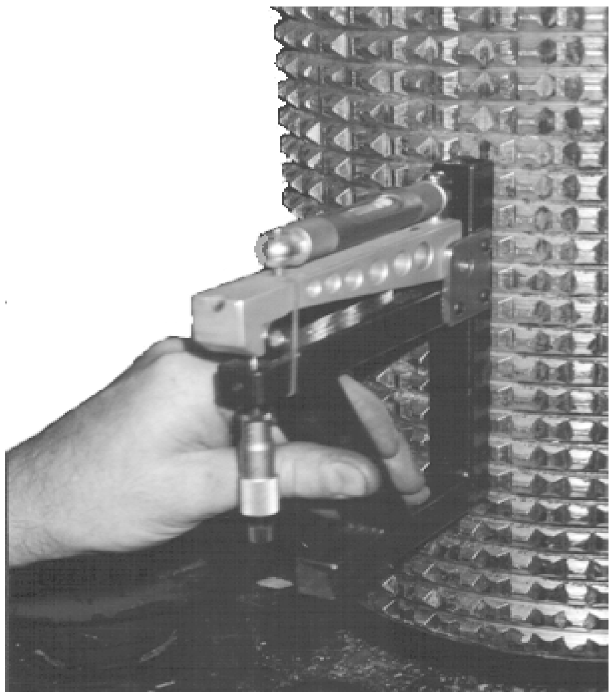

Figure 11. Checking the plumb of a press roll with a sine bar.

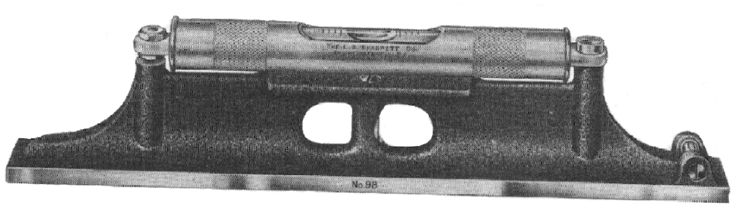

Figure 12. Starrett #98 Machinist's level. Used to ensure that bed rolls are level. When placed on a long straight edge, the relative elevation of the bed rolls can be checked.

Double Roll Type Feeds

The double roll feed system is used for making bevel siding or when splitting larger pieces. Although the rolls drive the wood well, there can be problems at the end of the cut when only one set of rolls, or no rolls are holding the wood. These problems occur because the front of the wood is often allowed to move too much, which will cause a snipe or snake near the end of the cut. These problems can be reduced by using rails on the outfeed to guide the wood and keep it upright. A similar problem occurs if the wood is not supported until it leaves the saw because the support is too short. Gravity will pull the front end down and the back end will lift up.

When the wood is uncontrolled, as described above, not only is the product damaged, but it is likely that the saw will be damaged as well.

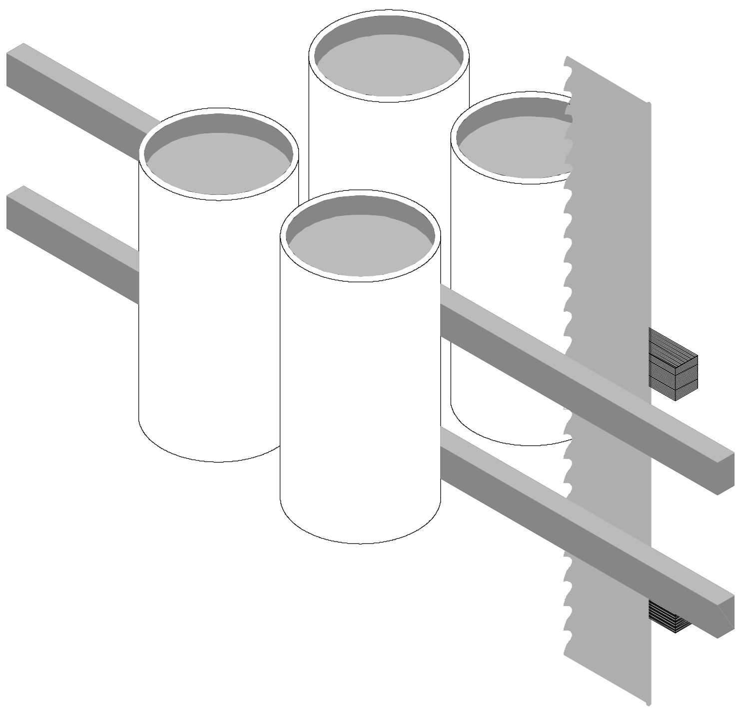

Figure 13. Double Roll Feed. Using a straight bar to make saw and rolls parallel.

In the figure above, a straight bar is used to check whether the saw is parallel to the rolls. A further check is run a wire along the feed system: the bar should be parallel to the wire.

Some other basic checks:

1. The rolls should be the same diameter and be true cylinders (no taper from top to bottom)
2. There should be no looseness in the bearings.
3. The face of the rolls should be plumb, or at least parallel to each other.

Feed Speeds

There are two factors that determine how fast wood can be fed into a saw:

Bite Per Tooth: The roughness of the surface which is determined by the bite per tooth (distance between tooth marks). This is a similar concept to knife marks per inch used for molders and planers. The larger the bite, the rougher the surface.

What bite to use is best done by making a few cuts at several feed speeds and examining the surface finish. The selection will depend on what the customer will allow. If the surface is too rough, the options are to slow the feed or use a blade with a smaller tooth spacing (pitch).

Gullet Capacity: If the gullets become overloaded with sawdust sawing accuracy will decrease. The capacity of the tooth to carry the sawdust out the cut is determined by the gullet area (see Figure 14). Since the amount of sawdust produced is proportional to the depth of cut and the feed speed, deeper depths of cut and faster feed speeds require larger gullets.

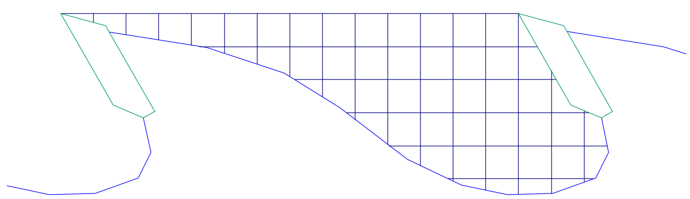

Figure 14. Gullet area of a tooth. A common method for measuring the area is to count the squares.

Usually, the feed speed for deep cuts is limited by gullet loading, while the bite per tooth limits the feed speed for shallow depths. Each depth of cut will have a maximum feed speed based on gullet loading. Figure 15 is a typical depth-speed chart.

It is very common that deep cuts are fed too fast and shallow cuts fed too slow. When correct feed speeds are used for each depth of cut, there is usually an improvement in product quality, because the deep cuts are straighter and an improvement in production because the shallow cuts go through faster.

Appendix III contains the formulas for bite per tooth and allowable feed speeds based on gullet loading.

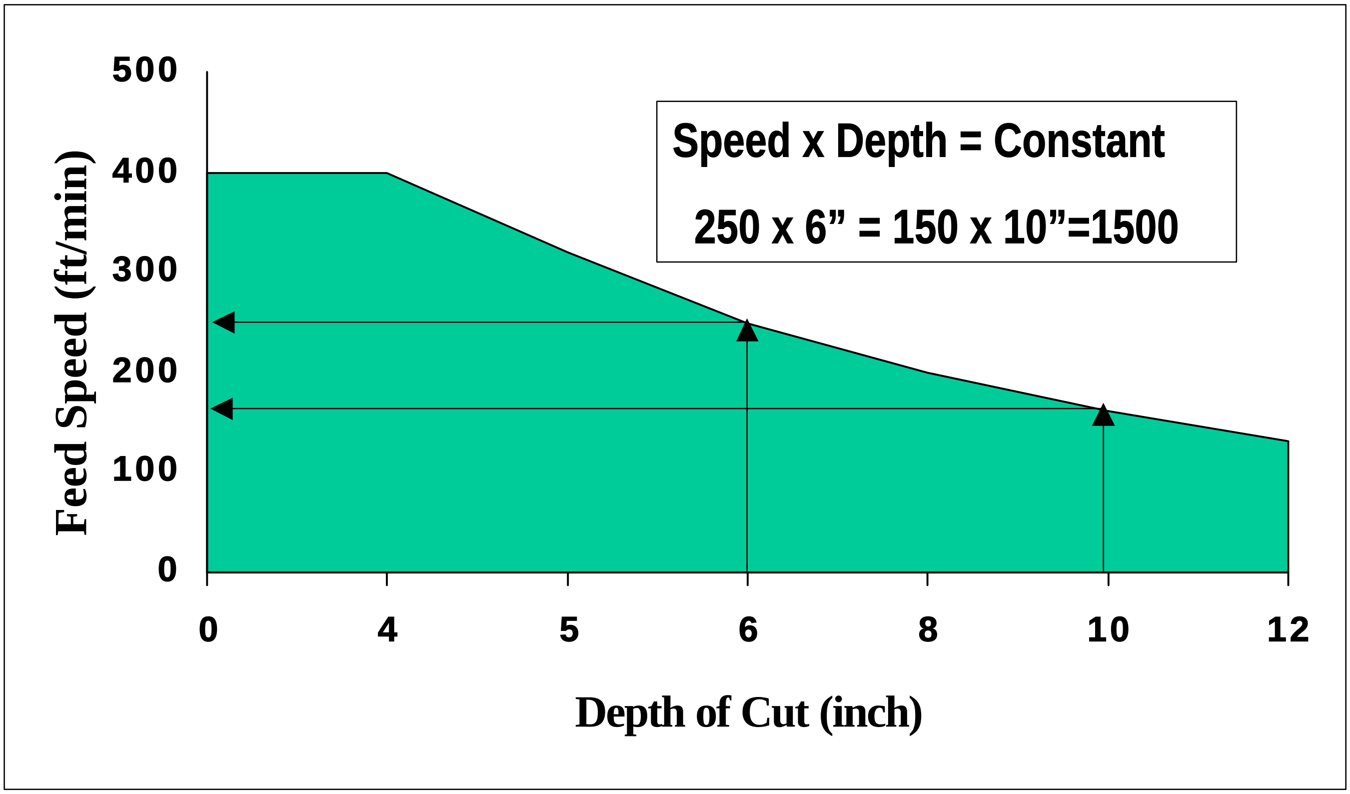

Figure 15. Typical feed speed chart for several depths of cut. At 400 fpm the maximum allowable bite is reached. For depths larger than 4", the feed speed is limited by the capacity of the gullet to carry the sawdust out of the cut.

Appendix I

Using a Plumb Line for adjusting Crossline

The method described here for measuring crossline is slightly different that usual method of hanging two plumb lines over pieces of key-stock. However, it is faster and inherently more accurate. Refer to Figure 4.

1. Put a blade on the machine and run it for a while. Leave the strain up for the following steps.
2. Clean the rim of the top wheel at Point A and the bottom wheel at Point B, as shown in the diagram below. Attach a magnetic base to the top wheel at Point A.
3. Attach the plumb bob to the magnetic base so that the line hangs over the clamp. To steady the plumb line, the plumb bob can hang in a can of oil, or let the point drag through some sawdust you hold in your hand.
4. Measure and record the gap between the line and the wheel rim at Point B.
5. Rotate the wheels until the magnetic base is at Point C. Ensure that the line is still hanging over the clamp. Point D, on the bottom wheel, will be the same clean point on the bottom wheel. By taking the measurements this way, any error due to runout of the wheel rim is eliminated.
6. Measure the gap at Point D and compare it with the previous reading.
7. Adjust the top wheel as necessary.
8. Recheck the measurements.
9. As a final check, remove the plumb lines and run the machine for a few minutes, then stop and lock out the machine.
10. Measure the distance from the edge of the blade to the wheel rim.
11. By hand, rotate the wheel *backwards* for one complete revolution of the band.
12. Again, measure the distance from the edge of the blade to the wheel rim. If the distance is different from the first measurement, then there is still crossline.

Appendix II
Guide Pressure Calculations

Recommended Guide Pressure

Wheel Diameter (ft)	Guide Pressure (lb)
3	60
4	80
5	100
6	120
7	140
8	160
9	180

or

Blade Width (in)	Guide Pressure (lb)
3	30
4	40
6	60
8	80
10	100
14	140
16	160

T = Strain (lb)

X = Guide offset (in)

Y = Sine bar micrometer reading (in)

L = Span (in)

P = Guide pressure (lb)

if you know:	Calculate.....		
	Guide Offset	**Guide Pressure**	**Sine Bar Setting**
Guide Offset		$P = \frac{X \times T}{2 \times L}$	$Y = \frac{5 \times X}{L}$
Guide Pressure	$X = \frac{2 \times P \times L}{T}$		$Y = \frac{10 \times P}{T}$
Sine Bar Setting	$X = \frac{Y \times L}{5}$	$P = \frac{Y \times T}{10}$	

Example: L = 30”, T = 15,000 lb., 5 ft wheel with 10” wide blade.

From the tables above, the Guide Pressure (P) should be 100 lb.

Guide offset = $X = \frac{2 \times 100 \times 30}{15000} = 0.40$” (use 3/8”)

Sine bar micrometer setting $= Y = \frac{10 \times 100}{15000} = 0.067$”

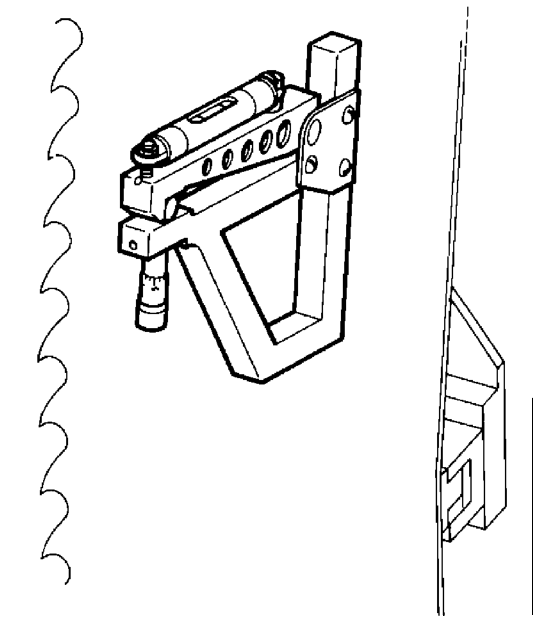

Figure 16. Using the Sine Bar to measure the slope of the top span for calculating guide pressure.

The Sine Bar can be used to check both the guide offset and guide pressure. This is done by measuring the slope of the blade between the guide and the wheel. The larger the offset, the larger the slope. This is a simple, fast and accurate method for setting guide offset.

Place the Sine Bar on the span between the top guide and the top wheel. Center the bubble in the level by adjusting the micrometer.

To measure the guide pressure, record the micrometer reading, the strain and the distance from the guide to the wheel. The formulas for guide offset and guide pressure are provided in Appendix II.

The guide pressure can be set by first calculating the required micrometer setting, then adjusting the guides in or out until the bubble is centered in the level.

Tilted Guide Face.

A final touch that reduces guide wear and the stresses in the blade due to bending over the guides, is to tilt the face of the guides so there is equal pressure on the top and bottom edges of the guide. To do this, set the sine bar at half the setting needed for the guide pressure. Adjust the guide jack-bolts until the level bubble on the sine bar reads zero.

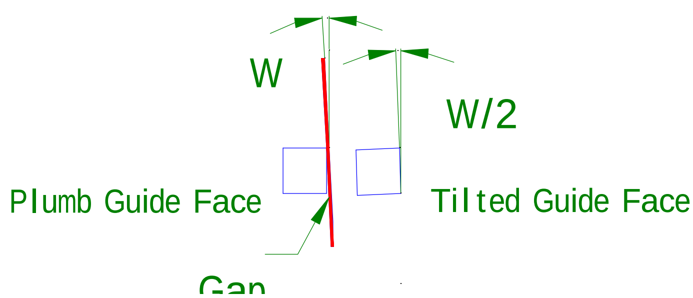

Figure 17. Tilt guides half the angle of the angle of the blade. This puts equal pressure on the top and bottom edges of the guide.

This setup also reduces the amount of sawdust and slivers that pack into the guides because the gap is closed.

Appendix III

Feed Speed Formulas

Saw and Tooth Shape

d	Circular saw diameter or bandmill wheel diameter (inch)
P	Tooth pitch (inch)
n	Number of teeth
k	Kerf
h	Thickness of saw plate
s	Side Clearance (inch)
s_{MIN}	Minimum recommended side clearance (inch)
a	Gullet area (sq. inch)

Operating Conditions

N	Shaft speed (rpm)
c	Blade (or rim) speed (sfpm)
b	Bite per tooth (inch)
D	Depth of cut (inch)
f	Feed speed (fpm)
f_{MAX}	Maximum recommended feed speed (fpm)
f_{MIN}	Minimum recommended feed speed (fpm)

Performance Prediction

GFI	Gullet Feed Index
GFI_{MAX}	Maximum allowable Gullet Feed Index

Power Consumption

E	Estimated power required (hp)
C	Energy factor depending on wood properties

C	=	35	for North American softwoods
		40	for dry fir
		70	for hardwoods

Evidence from the Wood

X	Distance taken by ‘m’ bites on a board
m	

Formulas

$$c = \frac{3.14 \times d \times N}{12} \quad \textbf{or} \quad N = \frac{12 \times c}{3.14 \times d}$$

$$b = X / m \quad \textbf{or} \quad X = m \times b$$

For Circular saws only………

$$P = \frac{3.14 \times d}{n} \quad \textbf{or} \quad n = \frac{3.14 \times d}{P}$$

$$b = \frac{12 \times f}{n \times N} \quad \textbf{or} \quad f = \frac{b \times n \times N}{12}$$

$$f = \frac{b \times c}{P} \quad \textbf{or} \quad b = \frac{f \times P}{c}$$

$$GFI = \frac{b \times D}{a} \quad \textbf{or} \quad b = \frac{GFI \times a}{D} \quad \textbf{or} \quad D = \frac{GFI \times a}{b}$$

$$GFI = \frac{f \times D \times P}{a \times c} \quad \textbf{or} \quad f = \frac{GFI \times a \times c}{D \times P}$$

$$f_{MAX} = \frac{GFI_{MAX} \times a \times c}{D \times P}$$

$$f_{MIN} = \frac{s \times c}{P} \; (b = s) \quad \textbf{or} \quad s_{MIN} = \frac{f \times P}{c}$$

$$s = \frac{k - h}{2} \quad \textbf{or} \quad k = h + 2 \times s$$

$$E = \frac{C \times k \times f \times D}{144}$$