Practical Alignment Tools and Techniques

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Accurate sawing requires attention to proper alignment and maintenance. Alignment is critical to modern sawmills using thin kerf saws. In fact, the improvements in machine design were critical to the development of thin kerf sawing systems. About two-thirds of sawing problems are caused by misalignment, not saw preparation. Good alignment reduces down-time and machinery wear and should be part of the quality control process and the preventive maintenance program: fix problems before they affect production or the quality of the finished product. This paper describes the use the tools and instruments needed to ensure proper alignment.

Alignment Tools

The measurements of alignment determine whether components are

- Straight
- Flat
- Level
- Plumb
- Square

How these measurements are done depends on the precision required and on the size of the machine being measured. A piano wire or a laser is usually needed for a complete alignment check, but many, if not most problems can be found with a few simple tools.

Eighty percent of alignment checks can be made with a basic set of measurement tools. Although checking the straightness of a carriage rail requires more sophistication, most surfaces or rolls that guides the wood must be either level or plumb. These tools are:

- A precision machinist's level
- An 8 foot aluminium straight edge
- A box level or "sine bar"
- A set of feeler gauges

Machinist's Level

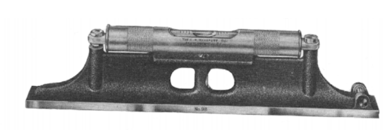

Figure 1. Starrett #98 machinist's level

A precision machinist's level is the most important tool to have. Only machinists levels, such as the Starrett #98 or better, are acceptable. Carpenter's levels or the levels on machinist's squares are not accurate enough.

Machinist's levels have calibrated divisions on the vial. For all sizes of the Starrett #98, each division represents 0.005" per foot. It is usually possible to estimate the reading to within half a division, or 0.0025" per foot. However, if a part is to be set exactly level, it is possible to distinguish less than a tenth of a division, or 0.0005" per foot. More precise levels are available that have sensitivities of 0.001” per 50”: these are generally too sensitive for sawmill work.

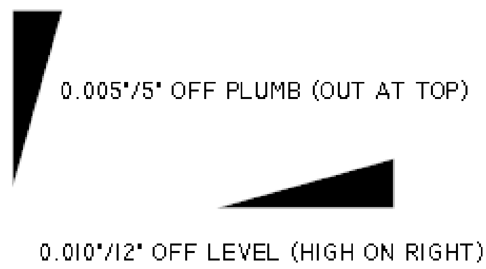

Figure 2. Examples of the method for recording level or plumb measurements. Direction of the wedge shows direction of deviation from plumb or level.

Measurements should be recorded in units of inches per foot and a triangle can be drawn to show the direction that the surface is away from level or plumb. See Figure 2 for an example. A benefit of using calibrated levels is that the amount of shim stock needed to re-level a part can be quickly estimated. For example, if the level read 0.010"/ft. and the part is 18" wide, then 0.015" needs to be placed under one end of the part to make it level.

Most horizontal surfaces, such as the bed plate of a canter or vertical arbour edger, the arbour and bed rolls in an edger, and the skids on a carriage, must be level. The tolerance required is less than 0.005" per foot. Parts that must be dead level are the base plates that the guides sit on in a vertical arbour edger.

Levels can also show changes in elevation in, for instance, a canter bed plate. Gradual changes in level (elevation) can not be detected with a level, but these changes do not cause accuracy or feeding problems. However, sudden changes in elevation are a problem and they can by quickly detected with a level. Also, the level can be used for a quick check of carriage rails. If the level reading changes by more than 0.005" per foot between two points separated by 10' along the rail, then there is significant wear or movement of the rail.

Straight Edge

An eight foot straight edge (a machined 4" aluminium I-beam) can be used with a level to check the elevation of the bed rolls in an edger by placing the straight edge on the rolls. When the level is placed on the straight edge, it should read level and there should be less than 0.020" clearance between the top of any roll and the straight edge. The clearance is measured with feeler gauges.

Box Level or Sine Bar

Measurements of plumb are made with a box level (Figure 3) or a "sine bar". Components that should be level are side head anvils, press rolls, carriage knees, guide reference plates for horizontal arbour edgers, vertical arbours. These surfaces should be plumb to within 0.005" per foot.

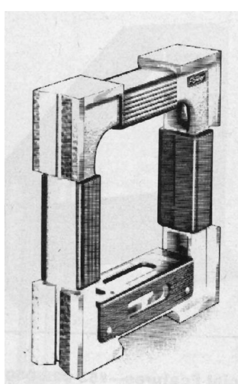

Figure 3. Box level.

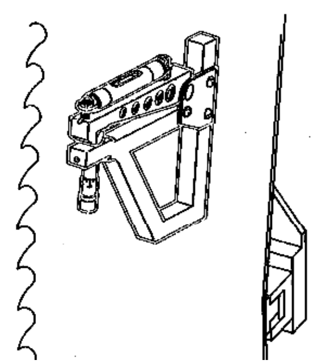

Figure 4. Sine Bar.

The sine bar (Figure 4) is basically a level mounted on a square so that the plumb of a surface can be measured. Rather than using the divisions on the level vial to measure deviations from plumb, a micrometer adjustment is used to set the bubble to zero. The amount of off-plumb over a 5" distance is read directly from the micrometer.

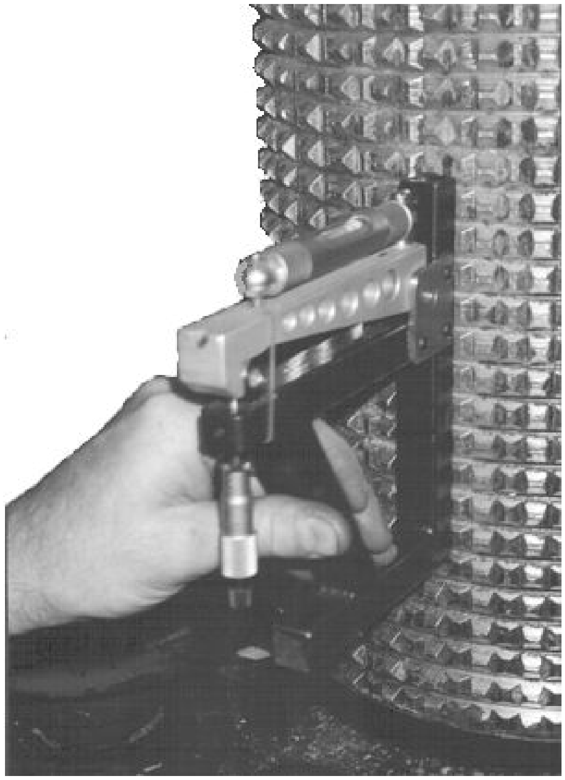

Figure 5. Checking lean and tilt of a press roll with a sine bar.

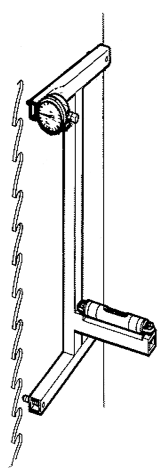

Figure 6. Spider used to make top and bottom guides parallel. There is also a vial for adjusting the blade to be plumb.

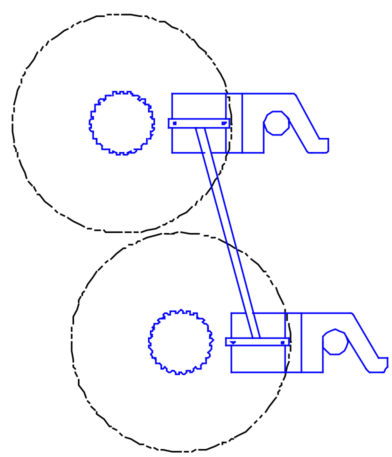

Figure 7. Spider for checking double arbour guides for parallel.

Tight Wire Measurements

A tight wire is the most common tool for checking straightness. It is cheap, simple and, using the measuring tools described below, as accurate as a laser system.

Wire Set-up

The best material for the wire is stainless steel "down rigger" (fishing line) wire, rated at 150 lb. test strength. This wire has a twisted design like rope so there is more damping and less time is wasted waiting for the wire to settle down. Down rigger wire does not coil up nor kink like piano wire, and it can tied into a knot for attaching the ends of the wire. These advantages over piano wire make down rigger wire much easier and faster to install and use.

The use of weights to tension the wire is awkward and somewhat dangerous. Also, many weights are needed to get the wire really tight. Any sort of boat winch, 'come-along' (Figure 9)or strap winch is easy to use and provides much more tension than weights.

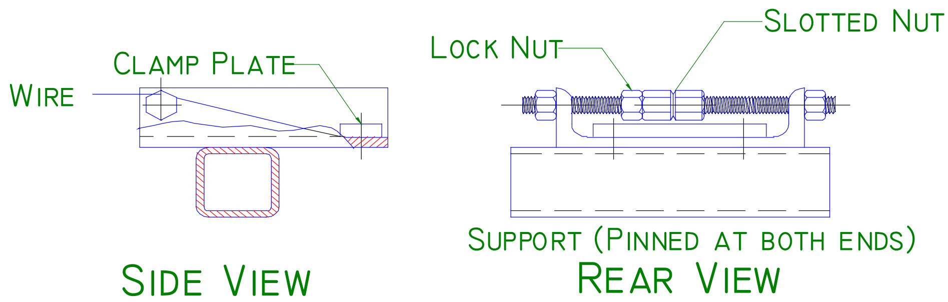

Figure 8. Adjustable wire mount. Various types of support can be pinned and bolted to a stable base.

Much time can be saved when installing a wire if winches and adjustments for the wire that are permanent or can be quickly mounted with alignment pins. Both ends of the wire should have slotted adjustment nuts (see Figure 8). If the repeatability of the mounts can be trusted, a tight wire can be installed in a few minutes. See Figure 10

"Bucking-in" the wire requires two reference points or an arbour. These two points can be the center of spline at the ends of a canter, the center of a sharp chain, or the ends of a carriage track. For edgers, a common base is to set the wire 90° to the arbour with a swing arm. If the wire position does not turn out to be true because the end points were off, draw the shape of the spline, track etc. to scale. From the drawing, reposition the wire so that the fewest parts have to be moved to align them to the wire.

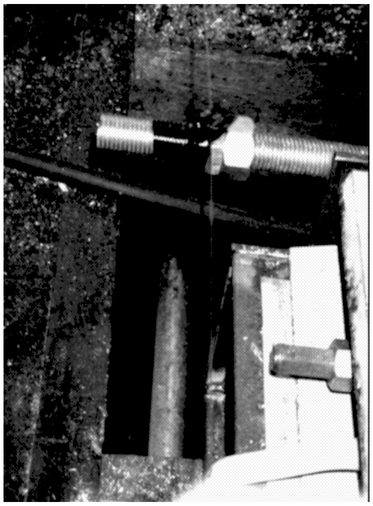

Figure 10. Wire support pinned and bolted to a plate welded to the end of the I-beam under the carriage rail. Tape used to ensure wire stays in the notched nut.

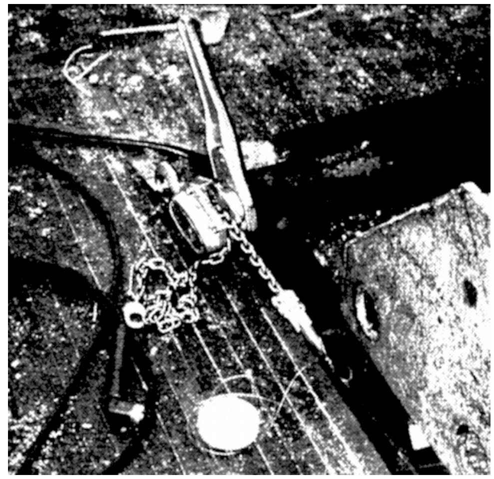

Figure 9. A winch or "come-along" should be used to tension the wire rather than weights.

A method for fast bucking-in is, for example, to take measurements from a swing arm attached to the arbour. Then measure the length of the wire and the distance between measurement points. See Figure 11 .

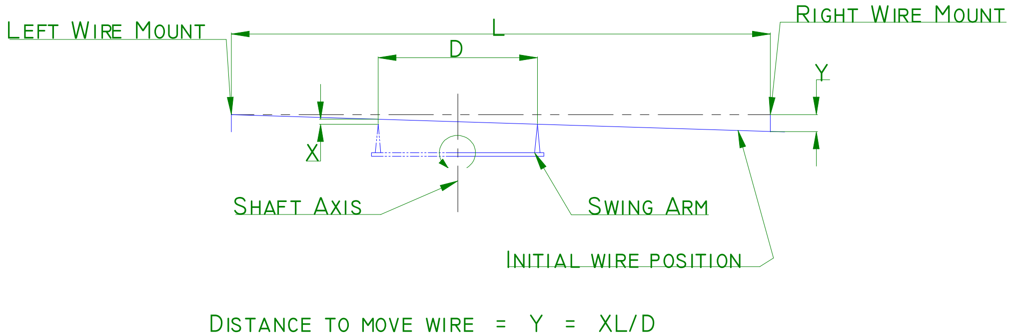

Figure 11. "Bucking-in" a wire to an arbour. The same method and formula are used for bucking-in to two points on a rail or spline.

Example:	
Difference at end of swing arm	= X = 0.015"
Swing distance	= D = 32"
Length of wire	= L = 45’ = 540”
Distance to move end of wire	= Y = (0.015)(540)/(32) = 0.253"

This amount of movement can be measured with digital calipers. This is where the adjustable mount is very useful. With this method the line is bucked-in without any trial-and-error, usually within 0.002" with only one set of measurements. The same method and formula are used for bucking-in to two points on a rail or spline. However, the distance 'D' may be as long as the wire.

Measuring to a Wire

A frequent objection to using a tight wire is that the measurements to the wire are not accurate. Even with digital calipers and good lighting it is difficult to measure within 0.005". For some measurements this is adequate, however with an electronic sensing head on the end of a dial gauge, measurements within 0.001" are easy and 0.0005" are possible. The electronic sensing head shown in Figure 12 contacts the wire without deflecting it. When contact occurs between the probe and the wire, an electric circuit is completed, which turns on the small red lamp on the sensing head.

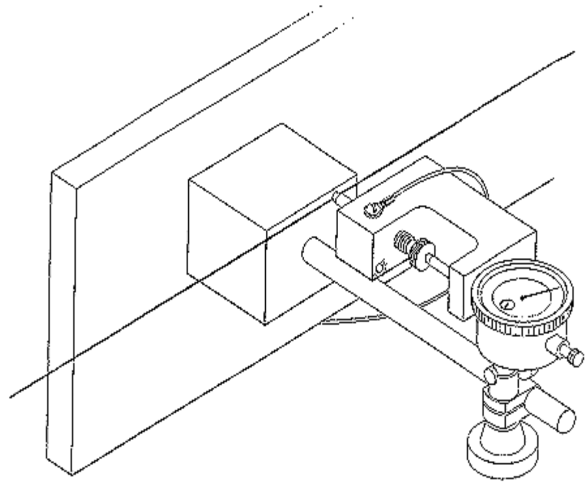

Figure 12. Electronic sensing head mounted on a magnetic block.

Swing Arm

A swing arm is used to determine if a roll or shaft is 90° to a tight wire. See Figure 13 . The amount off square is termed "lead". For this measurement to be accurate, the swing arm does not have to be exactly 90° to the shaft. However, it must be very rigidly attached to the shaft and not bend. When checking the lead on a slabber, the head itself is used as the swing arm.

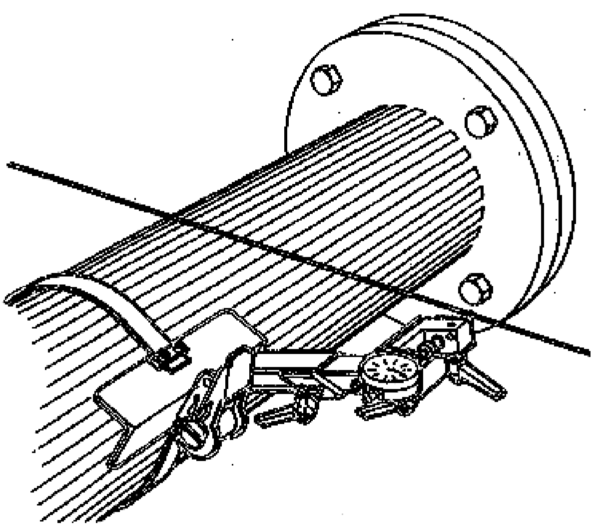

Figure 13. Swing arm with sensing head attached to an arbour.

Lead is measured in units of inches per foot. The direction of the lead (left or right) is determined by direction the roll would push the wood. Left and right are defined when looking from the infeed end of the machine. The swing distance is the distance between the points were the swing arm touches the wire. See Figure 11 The distance to the wire is measured with an electronic sensing head attached to the end of the arm.

The accuracy of measuring the lead of a shaft increases as the length of the arm increases, assuming that the longer arm is stronger to avoid flexing. Errors will occur if the bearings are badly worn: the readings will not be repeatable because the shaft can move axially in the bearings.

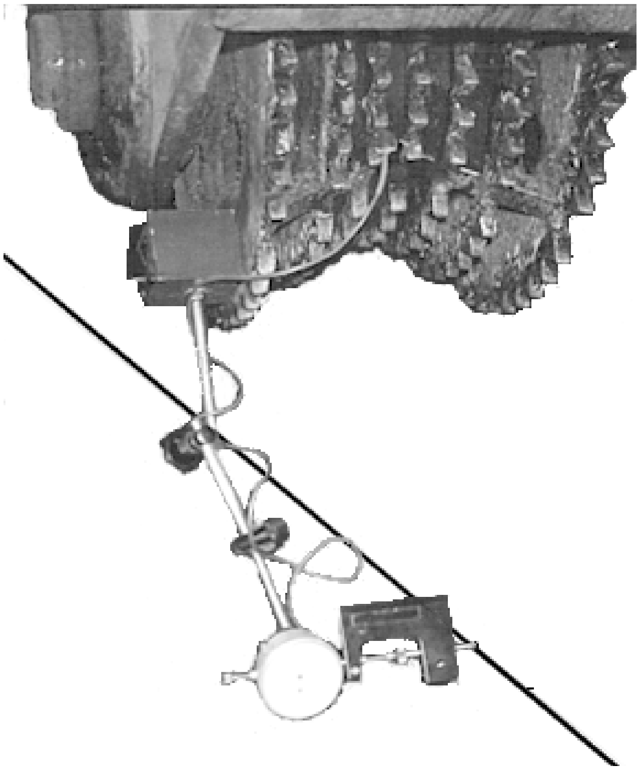

Figure 14. Measuring the lead of a canter infeed press roll. Lead will cause the log to roll sideways.

Elevation Measurements

As mentioned above, the more severe deviations from level on a carriage track or bed plate can be detected with a machinist's level. For measurements of elevation over long distances the options are:

- Laser measurement system
- First order surveyors level or Alignment telescopes
- Water level (precision)

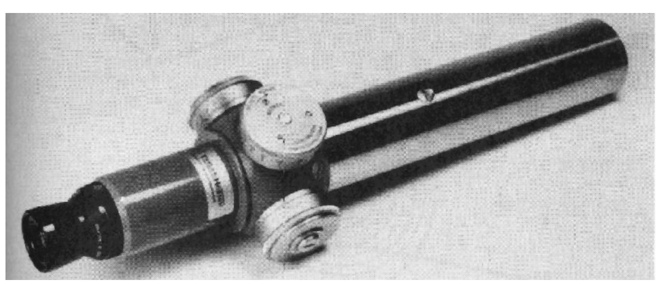

Figure 15. Alignment telescope.

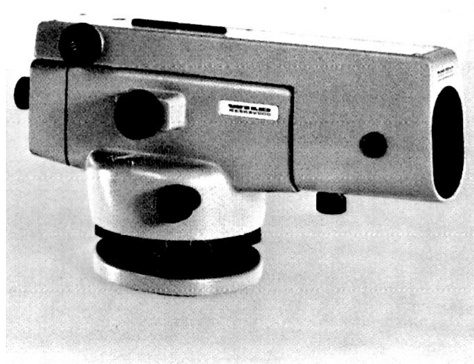

Figure 16. Leica N2 Automatic Level with Wild GPM6 parallel plate micrometer.

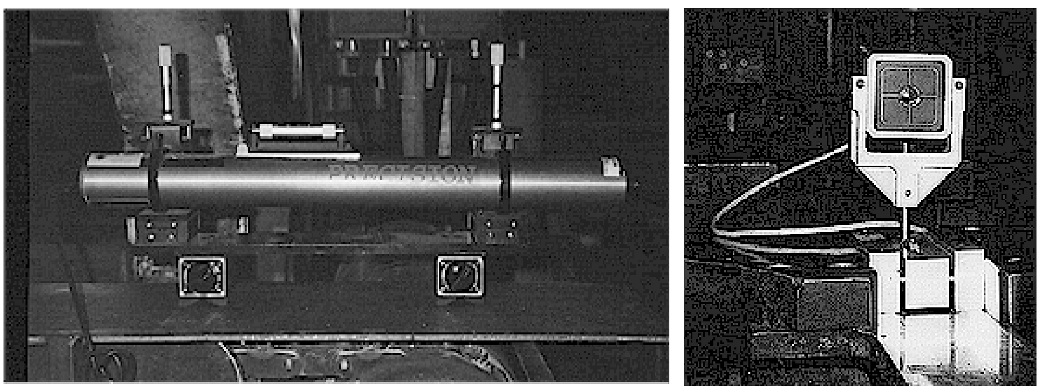

Figure 17. Laser and measurement receiver for machine alignment.

The alignment telescope (Figure 15 and 16) and the laser (Figure 17) are expensive instruments requiring skilled operators and will not be discussed here. Of these instruments, the alignment telescope is generally considered to be the most accurate.

The precision water level is a long tube with containers at both ends. The elevation of the water in the containers will always be the same. The procedure is to leave one container in the same place while the other is moved around the machine. Commercial water levels are available (Figure 18 and Figure 19)and that have depth micrometers for measuring the changes in water level. They are easily accurate to within ±0.005", and ±0.001" under good conditions, which in adequate for most sawmill equipment.

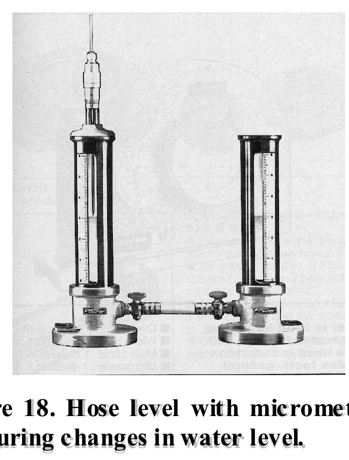

Figure 18. Hose level with micrometer for measuring changes in water level.

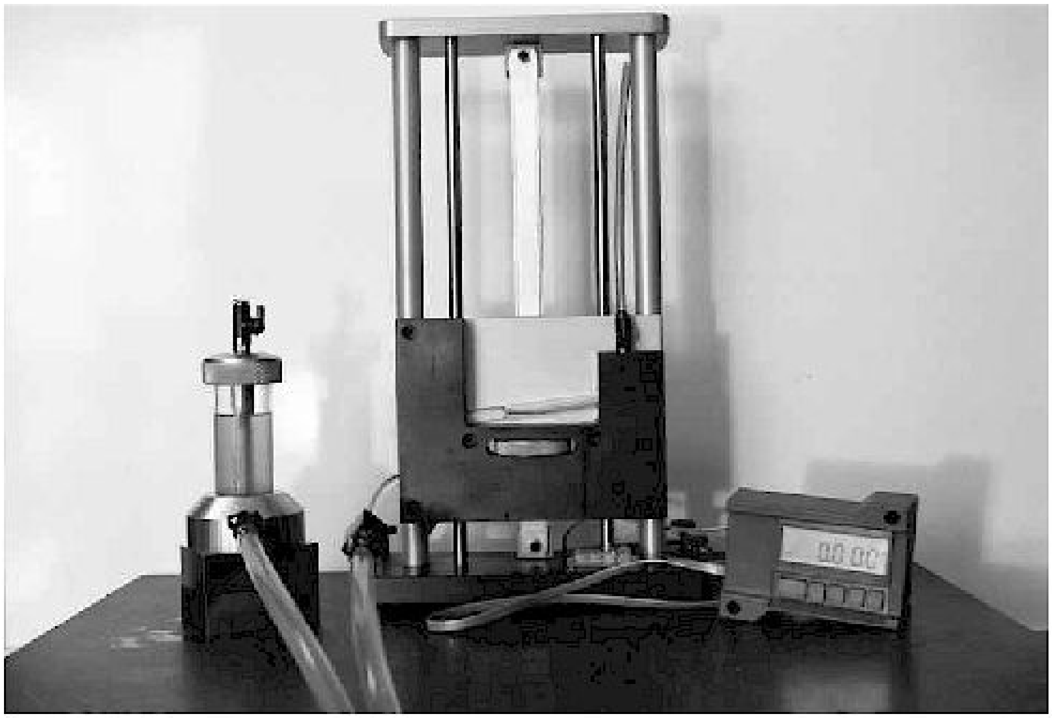

Figure 19. Hydro-Level for measuring elevation. Inclined vial on base unit allows accuracies of 0.001 inch.

Quick-check Jigs

A machine that is well aligned can tolerate the small inaccuracies that occur when a part is replaced, and will cut well until the next major alignment. Also, new parts can be aligned off other surfaces with some degree of confidence. An example is an adjustment of slabber head lead on a sharp chain system. Ideally, the lead should be measured from a wire running down the middle of the machine. However, if the sharp chain is kept straight, then it can be used as a reference line. It is imperative that the alignment of the chain be correct so measurements from it can be trusted.

When the surfaces are reliably aligned special quick-check jigs can be built for checking critical parts. Often the alignment of a critical part can be checked in 15 minutes at lunch if a problem is suspected. So far, quick-check jigs for bandsaw lead; slabber head lead and anvil clearance; bandsaw guide alignment (see Figure 20 and Figure 22) and edger guide alignment (see Figure 21) have been developed
Quick-check jigs are usually partly or wholly custom designed because there are so many variations in machine sizes and arrangements. The main criteria are:

- light weight
- accurate (measures to 0.001")
- simple to place and use
- robust for frequent handling

Keep quick-check jigs in a cupboard near the machine so they are clean and safe, yet easily available.

The best tools for a quick assessment of a machine are a machinist's level, and 8' straight edge and a sinebar (or box level). Most of the parts that guide the wood must either be level, plumb or in line with other parts. If these parts are not set up right, then going through the more complex procedures involved in saw and guide alignment are a waste of time and money.

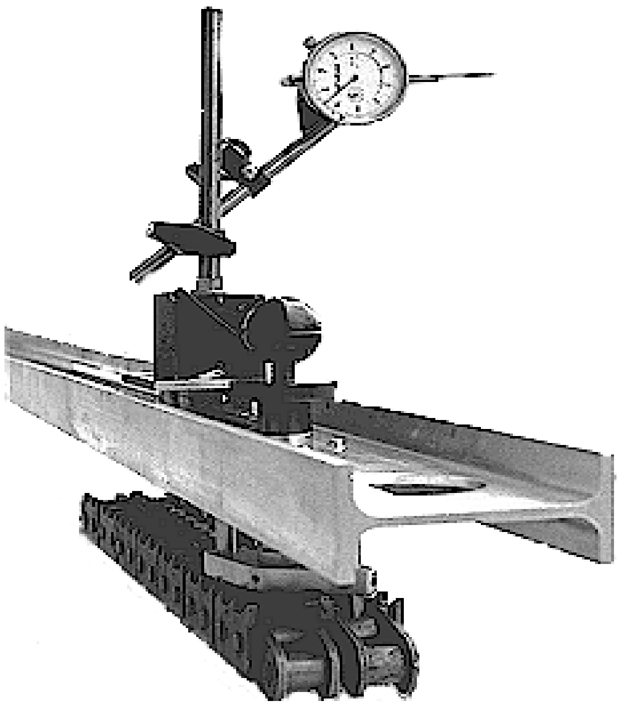

Figure 20. Self-centering attachment for mounting a straight edge on a chain. Other centering devices can be used for splined beds. Dial indicator is mounted on a linear bearing.

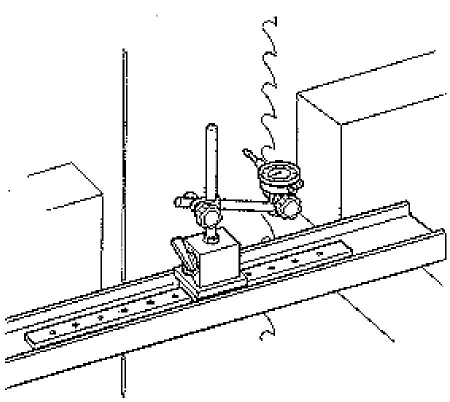

Figure 22. Straight edge with linear bearing used to check saw lead relative to the line bar.

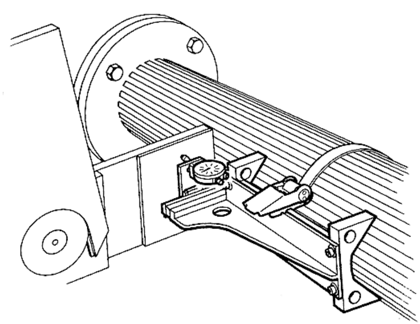

Figure 21. Guide jig for measuring amount that guide is off-square to the arbour.