Alignment Problems and Techniques for Saw Grinders

Bruce Lehmann
TKT Engineering Inc.
Surrey, B.C., Canada

This paper presents some simple tools and methods for accurate setup and alignment of top, face and side grinders. Methods for exact adjustment of side clearance angles and the squareness of the top and face are discussed, as well as problems relating to grinding very thin saws.

Introduction

As saw blades become thinner, the accuracy of tooth grinding becomes critical. Thin saws bend more easily during cutting, but also during grinding if the grinding pressures are too large. Furthermore, thin blades are damaged by the increase in cutting forces when the teeth are dull or an asymmetry in tooth shape produces a lateral bias to the cutting forces.

Several tooth inspection systems have been developed (1,2,3), which show grinding defects very clearly. However, not every saw can be inspected due to the time required. Also, the protractors on grinders do not have fine enough divisions for precise setting. In most cases, the adjustments to the grinder are still done by trial-and-error until a satisfactory tooth shape results.

This paper presents measuring methods for aligning saw grinders. As in most quality control programs, it is better to ensure that the machine making the part is accurate rather than just inspecting the final product. This is particularly true for tooth angles, which are very difficult to measure.

Common Grinding Problems

1. Tooth Dubbing

Dubbing is a rounding of the corner of the tooth caused by the grinder trying to remove too much material in one pass, causing either the blade or the grinding wheel to bend due to the larger grinding pressure. See Figure 1. In top and face grinding, the wheel bends because the tooth is very strong in the plane of the plate. In side grinding, the tooth bends instead of the wheel. The consequences are that the tooth edge is not sharpened (and may made even be more dull), and the cutting angles

right at the cutting edge are incorrect.

Although dubbing can occur when the operator tries to remove more material than the wheel is capable, there are several other causes:

- bent teeth: not levelling out to the teeth
- tips not brazed centered to the plate
- in side grinding: uneven grinding pressure
- in top grinding: tips not concentric on the post which the saw rotates

Once the dubbing starts, it is difficult to remove except by slow grinding. Other consequences of dubbing are:

- the extra grinding pressure causes heat, which could damage the tipping material or create chill cracks.
- Fast filling and dulling of the grinding material, which is aggravate the dubbing problem.

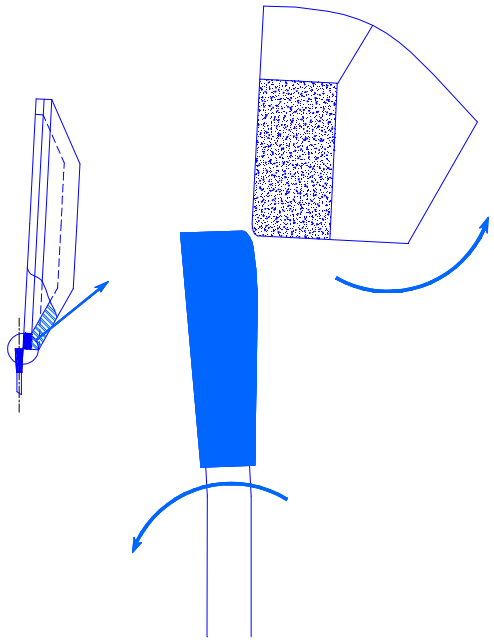

Figure 1. Dubbing (rounding) of the tooth surface due to too much grinding pressure. Either tooth or grinding wheel can bend.

2. Non-square top and face angles

For rip saws it is critical that the top and face angles be exactly 90 degrees to the saw plate (unless Alternate Top Bevel is used). Even a error of 0.1 degrees has been found to affect cutting accuracy(4).

The squareness of the top and face angles is determined by the angle setting on the grinding head and by the relative angle of the adapter post to the grinding wheel. A common problem is that the adapter post is not level, so even grinders with no angle adjustment can produce non-square teeth.

Grinders that can do alternate angles are difficult to center (square) accurately. These grinders usually have an adjustment screw that limits the left and right bevel angles. Locking the grinder at zero is done by turning the screw until the grinding head can not more. The problem is that there is backlash in the adjustment mechanism which causes the grinding head to lock to one side of zero. The angle is biassed to the side from which the head was adjusted inward.

3. Unequal side clearance angles

Unequal side clearance angles can result form dubbing, but mostly result from unequal settings on the grinding wheels. This is usually a problem with the machine, not operator error. The most common error is that the protractor pointers are not zeroed correctly. The second problem is that the

protractors usually only have 1 degree markings with a small distance between marks, so errors of 1/4 degree are unavoidable. Since there are two heads to set, a side to side difference as much as 1/2 degree may not be detected.

Test for Centering Adapter Concentricity

For top grinding and side grinding, it is important to have the saw rotating about the same center each time the saw is put on the adapter (mount). If the saw sits differently on the adapter, the amount removed by the grinding wheel will vary from tooth to tooth. In some cases the grinding wheel may not even touch some teeth. However, on the opposite side of the saw, the wheel will attempt to remove too much tooth material, resulting in dubbing, a glazed wheel, or perhaps a broken wheel.

Ensuring that the saw is concentric to the center post is important for side grinding as well as top grinding. If one wheel is slightly duller than the other, and they are attempting to remove too much material, the result will be uneven side clearances due to either the tooth or the wheels bending.

The following procedure describes the test assuming a splined saw with pins on the adapter that fit into the lobes in the saw. The procedure can be modified for adapters that hold the inner diameter of the saw by marking the saw at intervals around the eye.

1. Mark one lobe and one tooth on the saw
2. Mark one pin on the centering adapter
3. Place the saw on the adapter, with the marked lobe on the marked pin
4. Measure the radial height of the marked tooth with a test indicator.
5. Remove the saw from the adapter and replace so that the next lobe is placed on the marked pin.
6. Measure the radial height of the marked tooth with a test indicator.
7. Repeat steps 5 and 6 for the remaining lobes.
8. Chart the range in tooth heights for each lobe position

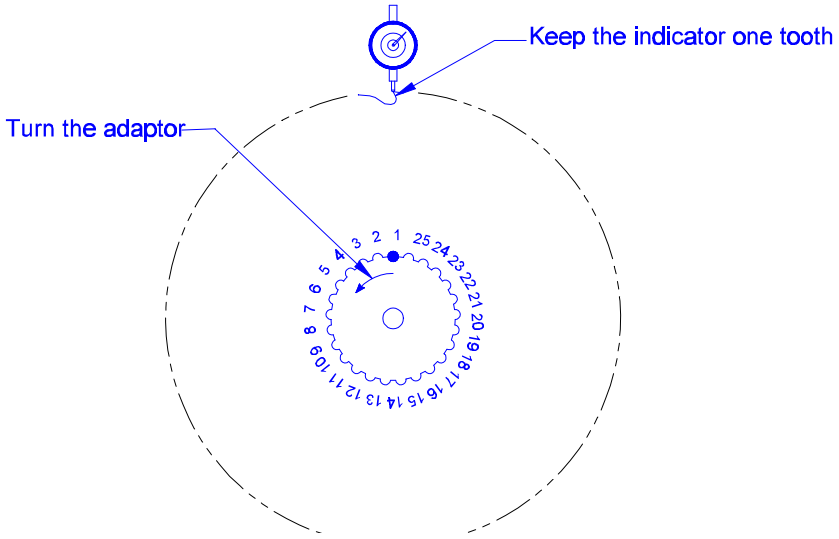

Figure 2. Setup for measuring concentricity of centering adapter.

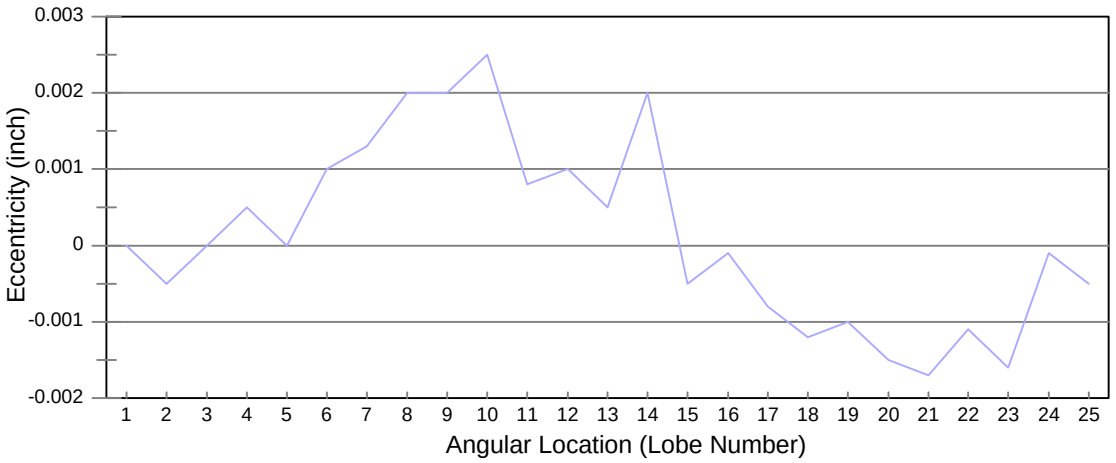

Figure 3. Typical eccentricity chart of a centering adapter.

Accuracies of Measurements for Square or Parallel

Whic type of gauge to use is a problem when measuring tooth angles. First, the tooth is very small, and secondly, the angles should be measured to within 0.1 degrees. The first problem can be avoided by measuring the actual angles of the grinding wheels, rather than the tooth.

Table 1 is a list of angle measuring instruments and their relative accuracy. Note that the common method of measuring the side clearance angles by measuring the side clearance at the top and bottom of the tooth is not accurate enough.

Table **1**. Relative Accuracy of Various Instruments and Techniques for Measuring Angles

Measurement	Reading	Error per inch
Precision square	0.0002"/6"	0.000033"
Precision Level	0.0005"/12"	0.000042"
Sine or Tangent Bar	0.0001"/5"	0.00002"
Vernier Protractor (1 min.)	1/60th degree	0.00029"
TKT SineBar (Plumb)	0.001"/5"	0.0002"
Test Indicator (on angle gauge)	0.0001"/0.25"	0.0004"
Vernier Protractor (5 min.)	1/12th degree	0.0015"
0.10 Degree		0.0017"
Side Gauge	0.001"/0.25"	0.004"
Square across tooth face	0.0005"/0.125"	0.004"
1.0 Degree		0.017"

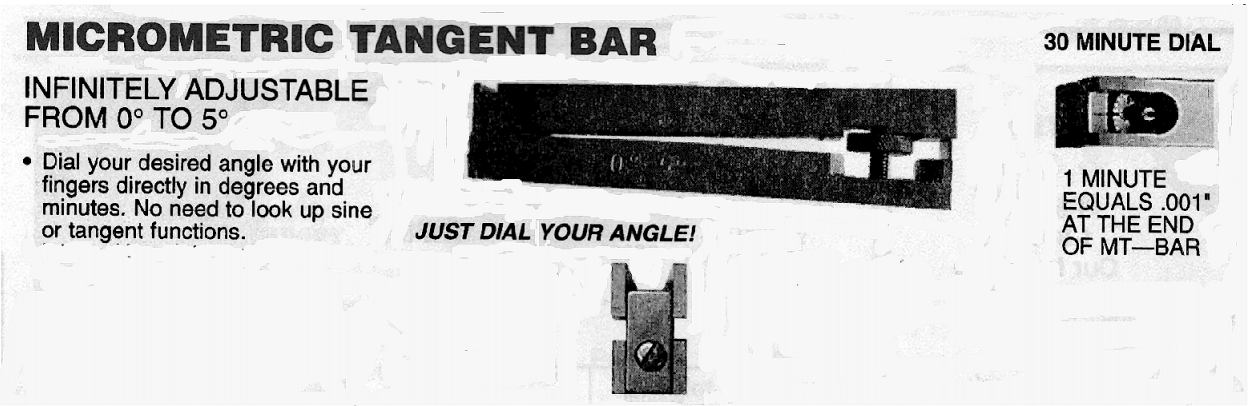

Figure 4. Tangent bar for accurate setting of small angles. *Rover Industries. USA*

Squaring a Top and Face Grinder

For all grinders, the easiest method for checking alignment is to measure the level or plumb of all machined surfaces. This can be done with a precision level and a box level or sine bar. The most important part to check is the center post on which the saw sits. It may be bent, loose, or the supporting plate may be loose on its slide.

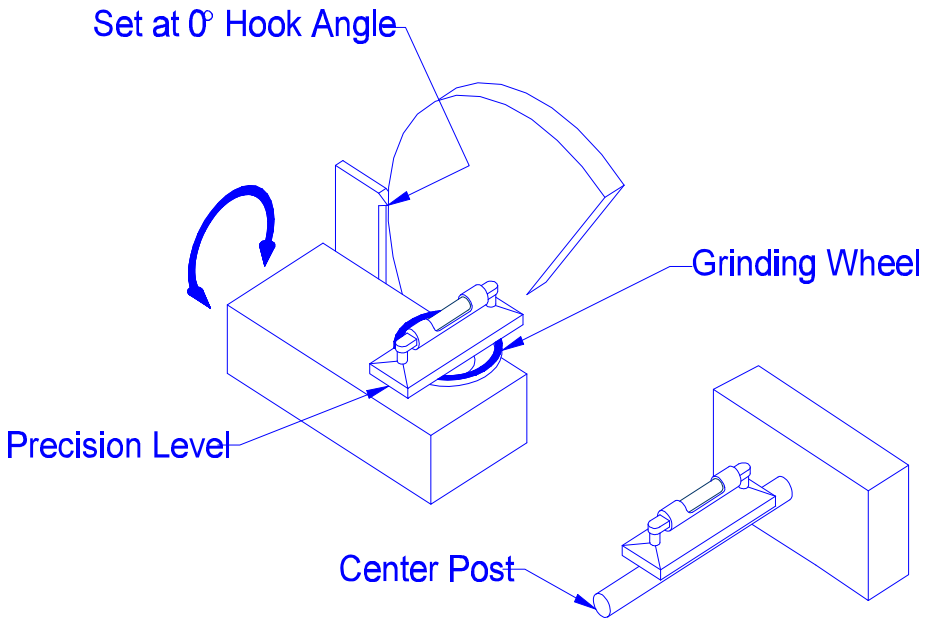

Figure 5. Top and Face Grinder. When the hook angle is set at 0°, the center post and the face of the wheel should be level.

Once the center post is level, the face of the wheel can be checked by setting the grinder to a zero hook angle, so the face of the wheel is horizontal. See Figure 5. Adjust the grinding head until the

level shows zero. This measurement is very accurate, and has the further benefits of being fast and easy.

Setting Side Grinder Angles

As with setting top and face grinder square, the center post will be used as the reference for all measurements because most centering adapters hold the saw square to the post. Even if the clamp under the tooth is square, it is not strong enough to twist the saw.

Figure 6 shows the basic layout for measuring side clearance angles. A V-block is clamped to the centering post and its surfaces can be used for references. From these surfaces, angle gauges can be attached. A test indicator is mounted on the grinding head so that the tip runs on the angle gauge. If the grinder is set to the correct angle, the indicator reading will not change as the grinding head is cycles in and out.

For peripheral grinding, as shown in Figure 6, the indicator is mounted on the grinding head, but for cup wheel grinding it is easier to have the indicator base slide on the angle gauge, while the indicator tip runs over the face of the wheel.

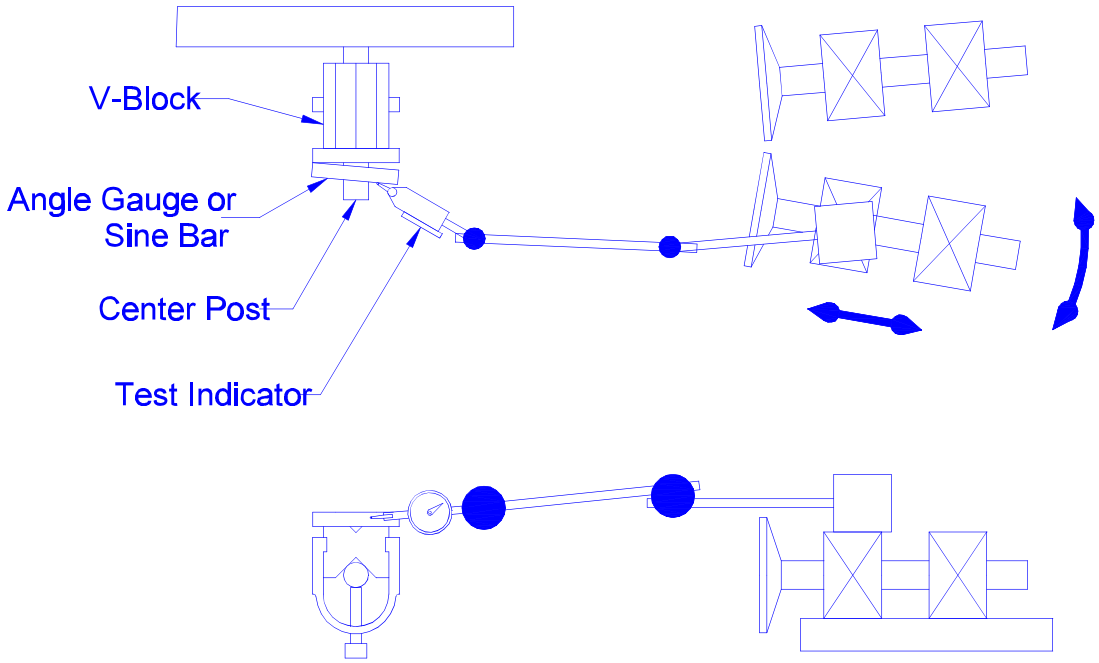

Figure 6 Using and angle gauge to check and set the radial clearance angle. Turn over angle gauge to ensure angle for other wheel is the same. Test indicator should have graduation of 0.0001 inch.

Conclusions

Accurate alignment and setting of saw grinders is critical for accurate sawing, especially for thin saws. Since the measurement of tooth angles is very difficult, a better method is to set the exact angle on the grinder. Until the protractors become more precise, external measurements are required. However, the alignment of these machines can be done easily and precisely with a few instruments.

References

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