Balancing the Wheels on a Bench Grinder, version 4

By R. G. Sparber

I recently replaced the wheels on my bench grinder and the vibration was horrible. With a lot of help from my friends, it is much better now.

Nomenclature

First I need to define two terms: radial runout and lateral runout. As viewed while standing in front of the grinder, radial runout is the total movement of the grinding face towards and away from you. Lateral runout is the total side to side movement of this face.

A little Theory

There are two reasons a bench grinder vibrates: static and dynamic unbalance.

Static balancing is exactly what goes on when two kids sit on opposite ends of a teeter-totter and are able to set the plank level.

Dynamic balancing is a bit more complex. So rather than get into the details, I will say that lateral runout in the grinding wheels is the main source of dynamic imbalance. Minimize this lateral runout and reduce this source of vibration.

Safety

A grinder is very good at removing steel but can remove flesh at a far more rapid rate. Don't be stupid. If you are placing your hands on the grinding wheels, unplug the grinder!

Initial Installation of Wheel

If the grinding wheels are new, it is a good idea to run a few test before trusting them. If they were dropped during shipping, tiny cracks may have formed. When running at full speed, these cracks can cause the wheel to explode.

Rest the wheel on your finger and then tap the wheel with a metal rod. The wheel should have a soft ringing sound. Be sure you are not hearing the rod ring out. If the wheel gives off a soft thud, then it is likely cracked and absolutely MUST not be used. It can explode as it reaches full speed or is distorted by use.

Here is a YouTube video demonstrating the procedure:

http://www.youtube.com/watch?v=TtnSYzx8Dk4

Inspect the wheel all over for any chipped out areas. These too are signs of rough handling.

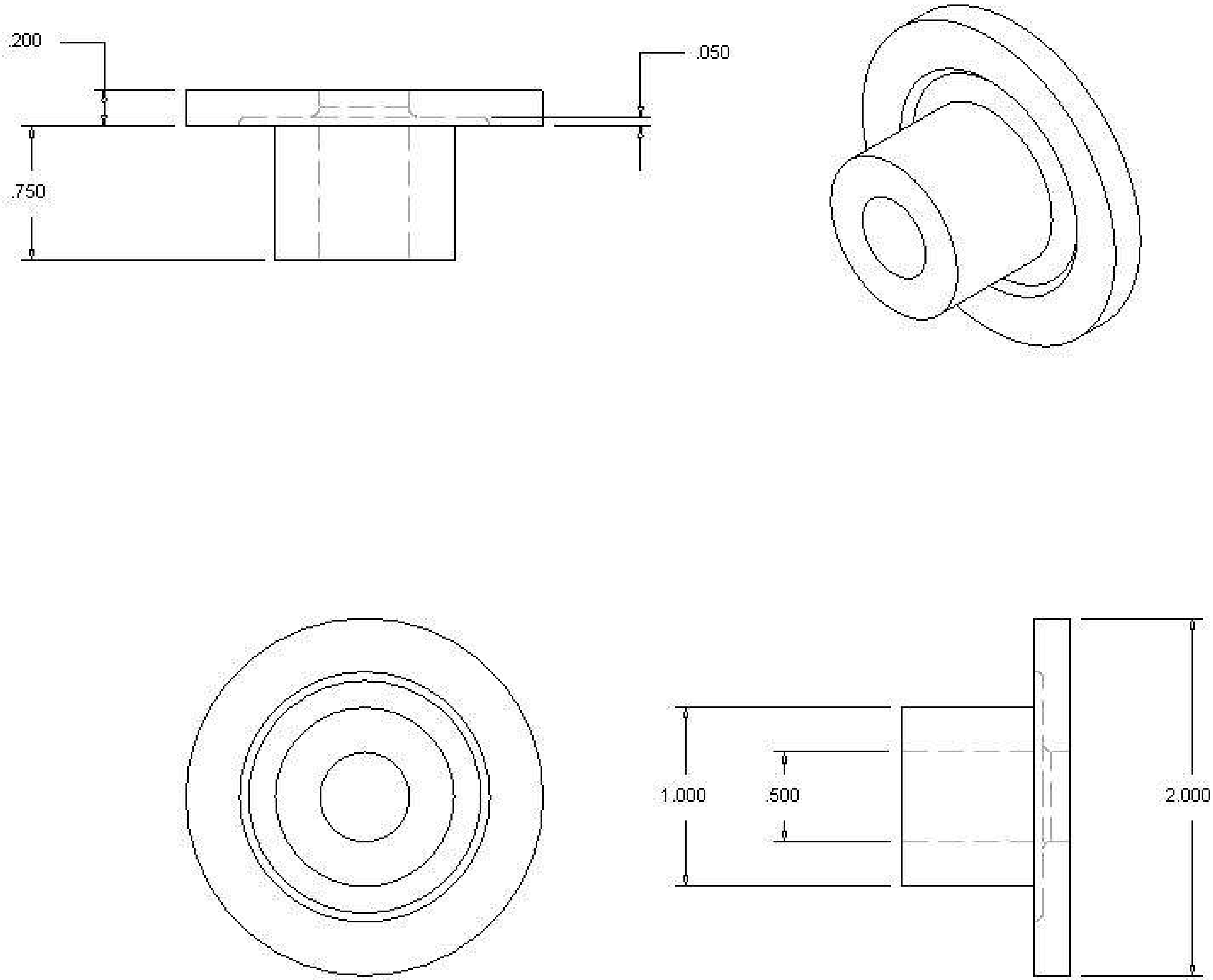
Spindle Check

While you have the wheels removed, it is a good time to verify that the spindle is not bent. This can be done with a Dial Test Indicator or even by just placing a square next to the axel while resting it on the table. If you see any variation, take a closer look. It will be impossible to balance the grinder if the shaft is bent.

Minimizing Dynamic Imbalance

My grinder has a motor shaft that is around 0.550” in diameter. This is turned down to 0.498” at the ends. It is also threaded right hand on the right side of the grinder and threaded left hand on the left side of the grinder. The reduction in diameter gives me a (0.550” – 0.498)/2 = 0.026” step which is all I’ve got for aligning the backing washer such that it is perpendicular to the motor’s shaft. Even a tiny slope over this 0.026” step is magnified by the 6” wheel. For example, if the the wheel has a lateral runout of 0.02”, this translates to an error of 0.0002” at the step. Not good. Although this step is tiny, we do have another reference surface. The 0.498” diameter part of the shaft is aligned to the center of rotation. By using this surface, we get a nice 0.75” of contact area. This can easily be accomplished by making the backing washer and wheel insert as one part. I have assumed you have a 1” hole in your grinding wheel and the motor shaft is 0.500”.

Backing Washer with Integrated Insert



material: steel or aluminum

With the part turned without removing it from the chuck, we can be guaranteed that the contact surface of the backing washer is perpendicular to the hole. The hole can be drilled out to something close to ½" but the finish cut should be done with a boring bar. I cleaned up the hole after boring by running my 0.500" reamer through the hole. This last step is not necessary but it was the easiest way for me to get close to the correct diameter.

Ideally, the 0.500” bore should be a snug fit on the turned down part of the shaft. If you mess up and go over, all is not lost. Wrap a piece of shim stock around the shaft and slide on the part. The goal is to have the part tightly in contact with the shaft so it is in alignment. As a check, run your Dial Test Indicator on the backing washer’s surface to verify it varies less than 0.0005”. This much error translates to a lateral runout of 0.0015” which is not bad (assuming the wheel is dead flat).

By installing these backing washers with integrated inserts, we should have side stepped the majority of the dynamic balancing problem.

Before installing the wheels, read all warnings and instructions printed on the face. You may need to make a pair of washers out of blotter material. As long as they are of uniform thickness, the blotter washers should not increase lateral runout.

Tighten the nut using a short wrench or socket with a centered T handle. You don’t need a lot of torque to secure the wheel. Too much torque could crack the wheel which might then explode as it spins up to full speed.

I found that a battery powered impact wrench worked well for ***removing*** the nuts. Just be mindful that the nut on the left side of the grinder is probably a left handed thread. You don’t want to tighten the nut with an impact wrench.

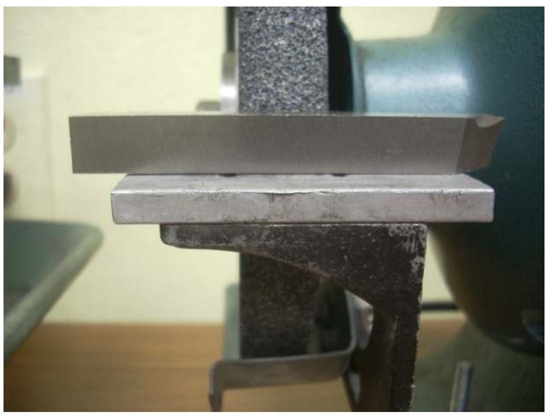
Static Balancing

As you spin one of the wheels by hand, look at the distance between the perimeter surface and the table in front of it, the radial runout. If this gap varies by less than 0.005”, then you are good. But don’t be surprised if it varies by 0.1”. This variation is identical to our teeter-totter with one fat kid and one skinny kid. We need to put the wheel on a diet.

Removing the excess wheel material is easily done with a wheel dressing tool.

First, be sure the dressing tool is hooked over the front of the support table. This insures that the surface of the wheel will be parallel to this edge.

Second, be mindful of how to move the tool. It takes light pressure to spin the star wheels and break off tiny bits of the grinding wheel in the process of truing it. The goal is ***not*** to grind off the star wheels. These star wheels float within the body of the dressing wheel so you must slide the tool back and forth in order to contact the entire width of the surface. Stop often to assess your progress. It is easy to take off more material than necessary. A lot of fine grit is generated so you may want to wear a dust mask.



The dressing tool did a great job of getting the wheel close to true. I was able to get it a little better by following up by grinding the side of an old High Speed Steel tool blank.

Once the wheel has been trued, try not to disturb it. If you do take the wheel off, be prepared to dress it again.

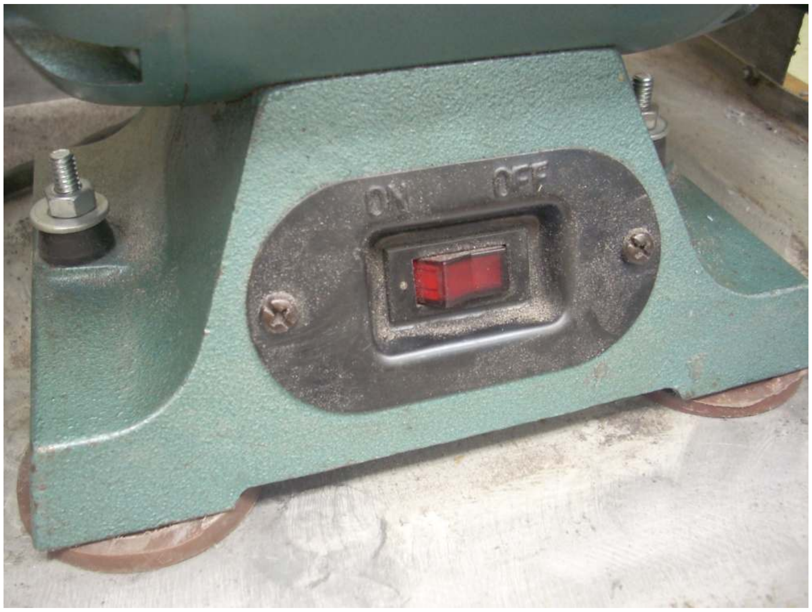
At first I used the outer washers that came with the grinder but then realized that they are a source of static imbalance. So in the end, I turned new ones. Details of how I make precision washer can be found at

http://rick.sparber.org/mpw.pdf

With both wheels dressed and their nuts tighten with a short wrench; it is time to see how we are doing. Plug in the grinder, stand to the side, and switch on power. If these wheels are new, let the grinder run a full minute and stay out of the way in case they explode.

Ideally the grinder will smoothly come up to speed with no vibration. Then when you turn off power, it will quietly slow down until it stops.

If you hear a series of rumbles as the grinder speeds up or slows down, you are hitting resonance points. These points are caused by imbalances that cause vibration which resonate with parts of the grinder over narrow ranges of RPMs. If the grinder is solidly bolted down to a table, then the table can resonate too.



Mounting the grinder on rubber feet and sliding rubber grommets over the hold down bolts will reduce the amplitude of these table related resonances. But to minimize the vibration further, we must do more work.

A Final Ah Ha Moment

As I was going through these steps plus many more that did not pan out, I was unable to reduce the vibration to the level I had before changing wheels. Andy of the atlas_craftsmen BBS suggested I move the wheels around to see if the problem is with the spindle or with a particular wheel. To my surprise, it turned out to be a bad wheel. I had this wheel running with almost no lateral runout and it was dressed so there was almost no radial runout. Yet it was the root cause of my problem. I put back the old wheel and all was well. Enco sent a replacement at no charge and it worked great.

So, if after reducing the lateral runout to less than 0.005” and dressing the face, you still have a lot of vibration, it might be time to replace the wheel.

Acknowledgements

Thank to Neil of the Valley Metal club for teaching me how to correctly use a wheel dressing tool. Thanks to Gregg also of Valley Metal for pointing out that a short box wrench is best used for tightening the nuts and for suggesting that the wheel be trued before starting any other steps to achieve balance. Thanks to "Jim I" of the Yahoo group atlas_craftsman for showing me the importance of removing lateral runout, dressing the wheel, verifying that the motor runs smoothly without wheels attached, plus suggesting that the shaft be checked. Thanks to Andy of atlas_craftsman for pointing out the technique that isolated the problem I was having to a bad wheel. Thanks to Bob of Valley Metal for reminding me how to hold the wheel when testing it. Thanks to David of atlas_craftsman for the suggested nomenclature. And finally, thanks to Brian of Valley Metal for general challenging my thinking. He certainly keeps me on my toes and I really appreciate it.

These generous people again demonstrate that "all of us are smarter than any one of us".

I welcome your comments and questions.

Rick Sparber
Rgsparber@aol.com